CALIFORNIA DEPARTMENT OF
FOOD AND AGRICULTURE

ANIMAL HEALTH AND FOOD SAFETY SERVICES

MEAT, POULTRY and EGG SAFETY BRANCH

PROCESSING INSPECTOR

APPLICANT

TRAINING MANUAL

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FOREWORD

It is not the intent, nor the purpose of this manual to be all inclusive, but to provide guidance, and support to both applicants and licensed Processing Inspectors. The information in this Training Manual has been compiled to assist the Processing Inspector applicant to become licensed and to operate effectively as a Processing Inspector. While it does not cover every detail that may be encountered in the day-to-day work of inspection, it provides a foundation for Processing Inspectors to work from and a reference to be used in the course of their duties.

The information contained in this manual, Federal Meat Inspection Act and the Federal Poultry Products Inspection Act is in no way to be construed to supersede the provisions of the California Food and Agricultural Code pertaining to processing inspection.

The primary purpose of the legislation requiring inspection is the PROTECTION of THE HEALTH OF THE PUBLIC. To this end, the Secretary of the California Department of Agriculture is charged with the enforcement of the law and the regulations declared there under. The Secretary discharges this duty through the Meat, Poultry and Egg Safety Branch and through a body of Processing Inspectors, licensed by the State of California and under the supervision of a MPESB inspector, to act as inspectors in plants exempted by the Federal Meat Inspection Act and the Poultry Products Inspection Act and not exempted by the California Food and Agricultural Code.

California Code of Regulations Title 3. Food and Agriculture Division 2. Animal Industry
Chapter 4. Meat Inspection Subchapter 1. Meat and Poultry Inspection
§ 900.3. Scope of Inspection.

(a) State inspection is required for those establishments and products subject to inspection pursuant to Chapter 4 (commencing with section 18650), Chapter 4.1 (commencing with section 18940), Chapter 4.5 (commencing with section 19051), Chapter 5 (commencing with section 19200), and Chapter 6 (commencing with section 19501), of Part 3, Division 9, Food and Agricultural Code, and Chapter 2 (commencing with section 24651), and Chapter 3 (commencing with section 24951), of Part 1, Division 12, Food and Agricultural Code, and that are not under inspection by the United States Department of Agriculture,

3) Operations involving the preparation of products of cattle, sheep, swine, goats, or poultry traditionally and usually conducted at retail stores and restaurants, when conducted at any retail store, restaurant, or similar retail-type establishment, for sale in normal retail quantities or service of such articles to consumers at such establishments when involving curing, drying, smoking for preservation , or rendering. A normal retail quantity is an amount in accordance with 9 CFR section 303.1(d)(2)(ii) (2006).

The examination for a Processing Inspector's license is given in two parts; written and oral. The examination is based on the California Food and Agricultural Code and the regulations declared there under, together with the information found in this manual. Any other information, training, or assistance needed by the applicant will be furnished by a Branch employee.

§ 901.4. Examinations.

(a) The Department shall conduct mandatory inductive training for persons desiring to become licensed pursuant to Chapter 4.1 (commencing with section 18940) of Part 3, Division 9, of the Food and Agricultural Code. The inductive training shall relate to subjects covered in license examinations and job requirements and shall include the following areas:

(2) Meat Processing Inspection Training for applicants to become processing inspectors.

(A) Basic sanitation of equipment and facilities;

(B) Sanitary product handling;

(C) Records and record keeping;

(D) Recognizing localized disease conditions;

(E) Rodent and pest control;

(F) Proper formulation of meat food products;

(G) Fat and moisture control;

(H) Control of restricted ingredients;

(I) Trichina control; and

(J) Adulteration and mislabeling.

(b) Plant management shall provide time and resources for the training of employees who apply to become livestock meat inspectors or processing inspectors. The time and resources provided shall be what are required to enable the applicant to acquire the knowledge and skills necessary to pass the written and oral/practical examinations required to become a livestock meat inspector or a processing inspector.

After successfully passing the examination and following licensing, inspectors are subject to continuous training in the performance of their duties as Processing Inspectors. Annual maintenance training sessions are provided by the Meat, Poultry and Egg Safety Branch. Processing Inspectors are required to attend these meetings as a condition of maintaining their license.

§ 901.5. Mandatory Maintenance Training.

(a) The Department shall conduct mandatory annual maintenance training for licensed livestock meat inspectors and processing inspectors. The Department shall provide licensees with training information at least one month before scheduled training, including the location and dates of training classes throughout California.

(b) Each licensed livestock meat inspector and processing inspector shall be responsible for attending formal annual maintenance training provided by the Department. The training shall cover topics such as sanitation, ante- and post-mortem inspections and dispositions, humane handling and slaughter of livestock, product formulation and restricted ingredient control, pathogen reduction, microbiology, and current topics in meat and poultry processing and inspection.

(c) Failure of a livestock meat inspector or processing inspector to attend annual maintenance training, as specified in subsection (a) of this section shall be grounds for non-renewal, suspension, or revocation of the livestock meat inspector or processing inspector license.

(d) It is the responsibility of official establishment management and of licensed livestock meat inspectors and processing inspectors to make arrangements in the work schedule to attend annual maintenance training.

The Meat and Poultry Inspection Branch, through its Veterinary Medical Officers and Meat Food Inspectors provides assistance, advice, training, and necessary supervision to Processing Inspectors in carrying out their duties. State licensed Processing Inspectors are employed and paid by licensed retail meat processing establishments to carry out the mandate of State law requiring the inspection of retail meat processors.

FOOD AND AGRICULTURAL CODE SECTION 19010-19017

19000. Each person, before acting as a licensed processing inspector in a retail meat processing establishment, shall apply to the department and receive from the department a license after passing an examination and a demonstration that shows the applicant's ability to understand laws and regulations that pertain to meat inspection and a practical knowledge of all the following:

19001. (a) A licensed processing inspector shall conduct a sanitation inspection before the establishment commences operations for the day, and shall make periodic inspections throughout the day.

(b) The licensed processing inspector shall order the establishment not to begin operations or to cease operations at any time that the establishment sanitation fails to meet the requirements of this chapter and the regulations adopted thereunder, or at any time any product is not handled, retained, condemned, or disposed of in violation of this chapter or the regulations thereunder.

(c) The licensed processing inspector shall direct the application of the mark of inspection as provided by regulations on products that are inspected by him or her and found to be wholesome, not adulterated, and derived from (1) United States Department of Agriculture inspected carcasses, or (2) fallow deer carcasses at a custom slaughterhouse.

19002. The department may suspend or revoke the license of a licensed processing inspector for permitting the processing or labeling of products not meeting the requirements provided for in this article.

19013. No person shall operate a meat processing establishment unless all livestock and poultry products used in processing and to be sold have been inspected by the United States Department of Agriculture, fallow deer products have been inspected at a custom livestock slaughterhouse, or poultry products have been inspected in accordance with the requirements of Chapter 3 commencing with Section 24951) of Part 1 of Division 12 and the processing of the product is inspected by a licensed processing inspector.

19014. Plant sanitation, sanitary dressing procedures, processing procedures, vehicle equipment, facility standards, and sanitation, including transportation and storage of products, shall follow procedures which may be set forth in regulations or operations manuals adopted by the department.

FOOD AND AGRICULTURAL CODE SECTION 19030-19039

19031. A violation of the provisions of this chapter is a misdemeanor.

19032. Any person that violates any provision of this chapter, or any regulation that is issued pursuant to it, is liable civilly for a penalty in an amount not to exceed five hundred dollars ($500) for each such violation. If the court finds that the violation of this chapter was a serious violation, or that the violation is a second or subsequent violation, the person is liable civilly for a penalty not to exceed fifteen thousand dollars ($15,000) for each such violation.

19033. The Attorney General shall, upon complaint by the director, or may upon his or her own initiative, if after examination of the complaint and evidence he or she believes a violation has occurred, bring an action for civil penalties in the name of the people of this state in any court of competent jurisdiction in this state against any person violating any provision of this chapter.

19033.1. (a) In lieu of any civil action brought pursuant to Section 19032 and in lieu of seeking prosecution pursuant to Section 19031, the secretary may levy an administrative penalty not to exceed five thousand dollars ($5,000) upon any person for each violation of this chapter.

(b) Before an administrative penalty is levied, the person charged with the violation shall be given a written notice of the proposed action, including the nature of the violation and the amount of the proposed penalty, and that person shall have the right to request a hearing. The request shall be made within 20 days after the person receives notice of the proposed action. A notice of the proposed action, which shall be sent by certified mail to the last-known address of the person charged, shall be considered received even if delivery is refused or if the notice is not accepted at that address. At the hearing, the person shall be given an opportunity to review the department's evidence and to present evidence on his or her own behalf.

(c) Any person upon whom an administrative penalty is levied may appeal to the secretary, within 20 days of the date of receiving notification of the penalty, as follows:

(1) The appeal shall be in writing and signed by the appellant or his or her authorized agent and shall state the grounds for the appeal.

(2) Any party, at the time of filing the appeal or within 10 days thereafter, may present written evidence and a written argument to the secretary.

(3) The secretary may grant oral arguments upon application made at the time written arguments are made.

(4) If an application to present an oral argument is granted, written notice of the time and place for the oral argument shall be given at least 10 days prior to the date set therefore. This time requirement may be changed upon agreement between the secretary and the person appealing the penalty.

(5) The secretary shall decide the appeal based on any oral or written arguments, briefs, and evidence received.

(6) The secretary shall render a written decision within 45 days of the date of the appeal, or within 15 days of the date of oral arguments. A copy of the secretary's decision shall be delivered or mailed to the appellant.

(7) The secretary may sustain the decision, modify the decision by reducing the amount of the penalty levied, or reverse the decision.

(8) A review of the secretary's decision may be sought by the person against whom the penalty was levied pursuant to Section 1094.5 of the Code of Civil Procedure.

(d) After completion of the review procedure provided in this section, the secretary may file a certified copy of the department's final decision that directs payment of an administrative penalty and, if applicable, any order that denies a petition for a writ of administrative mandamus, with the clerk of the superior court of any county. Judgment shall be entered by the clerk in conformity with the decision or order. No fees shall be charged by the clerk of the superior court for the performance of any official service required in connection with the entry of a judgment pursuant to this section.

(e) Any money that is received pursuant to this section shall be deposited in the Department of Food and Agriculture Fund.

19034. In addition to the remedies provided in this chapter, the department may bring an action in superior court and the court shall have jurisdiction upon hearing and for cause shown, to grant a temporary or permanent injunction restraining any person from violating any provision of this chapter or the rules and regulations promulgated under this chapter. Any proceeding under the provisions of this section shall conform to the requirements of Chapter 3 (commencing with Section 525) of Title 7 of Part 2 of the Code of Civil Procedure. The department shall not, however, be required to allege facts necessary to show or tending to show lack of adequate remedy at law or to show or tending to show irreparable damage or loss. The court may require such acts or course of conduct as necessary to effectuate the purposes of this chapter.

19035. It is unlawful for any person to slaughter any livestock or prepare any such livestock products which are appropriate for use as human food at any custom livestock slaughterhouse or retail processing establishment except in compliance with the requirements of this chapter.

19036. It is unlawful for any person to do with respect to any livestock which is appropriate for use as human food, any act, while it is being transported or held in storage after the which is intended to cause or has the effect of causing it to be adulterated.

19037. It is unlawful for any person to violate any provision of the regulations promulgated by the director which are applicable to this chapter.

19038. It is unlawful for any person knowingly to represent that an article has been examined by a licensed livestock meat inspector, licensed processing inspector, or department inspector or exempted under this chapter when in fact it has respectively not been so examined or exempted.

19039. It is unlawful for any person to assault, resist, impede, intimidate, or interfere with any person while engaged in the performance of duties under this chapter.

SECTION I - GENERAL

Definitions:

a. Meat, Poultry and Egg Safety Branch: Headquarters: 2800 Gateway Oaks, Sacramento, 95833, Mailing address: 1220 N street California 95814, Phone: (916) 900-5004, FAX: (916) 900-5334.

The Branch is charged with the enforcement of the meat, poultry and egg inspection laws and regulations. It has responsibility for providing training, assistance, advice and supervision of licensed Processing Inspectors.

b. Branch Employees: Individuals, Veterinarians, and Meat Food Inspectors employed by the Meat, Poultry and Egg Safety Branch who are authorized by the Branch Chief to do any work or perform any duty in connection with meat, poultry and egg inspection or plant sanitation.

c. Processing Inspector (PI): A person who has been issued a license by the Secretary of the Department of Food and Agriculture to inspect the processing of meat/poultry meat products for conditions that affect adulteration, misbranding, and wholesomeness. To perform other duties connected with the sanitary meat and poultry processing procedures and sanitation of facilities, equipment used in retail meat processing establishments.

d. Clean: Free, to sight and feel, of dust, dirt, grease, soil or other foreign matter.

e. Sanitation: The science and work of bringing about healthful and hygienic conditions

f. Sanitary: Clean, hygienic (principals of preventing disease)

f. Sanitized: Clean and treated for the destruction of bacteria.

General:

Purpose of Inspection: The primary purpose of processing inspection is the protection of the health of the public. A secondary purpose is to ensure products are formulated in compliance with published standards of identity, not economical adulterated and properly labeled.

Duties and Responsibilities of Inspectors: In general, Processing Inspectors (P.I.) are responsible for ensuring that all provisions of the regulations and manuals that pertain to the processing of State inspected meat and poultry product are complied with in plants in which they are employed as inspectors. The inspector is responsible for the following:

a. Inspections of the plant and its equipment prior to operations to insure that they are maintained in a sanitary condition and acceptable for use prior to start of operations.

b. Inspections during operations to insure that sanitary processing procedures are followed.

c. Inspections to insure that all processed meat/poultry products are properly formulated and labeled with an approved label in accordance with the provisions of the regulations.

d. Reporting all violations, if not corrected by plant management, to the Branch. This responsibility is discharged when the PI reports such violations to a Branch employee.

e. The preparation and maintenance of such reports as may be required by the regulations.

f. Inspections to insure that all meat/poultry products have been packed in clean containers that will adequately protect them from damage and possible contamination during shipment and storage.

g. Assuring that all condemned and inedible products are denatured in a manner that will render them unusable for human food.

Conduct and Dress of Inspectors: The licensed Processing Inspector is to set the example for other employees in the plant:

a. The inspector's head shall be covered with a protective head covering that will prevent falling hair and dandruff from contaminating products.

b. The inspector will never use, or permit others to use tobacco in any form in rooms where edible products are prepared, stored, or otherwise handled.

c. The inspector will make a point of washing hands upon entering production areas and will wash hands frequently throughout the workday.

d. The inspector will wear clean plant clothing (outer garment) over street clothing when handling exposed edible product.

This same standard of cleanliness is required of all employees in a food processing establishment.

An inspector and any other worker involved in any part of the processing of edible products in the plant who attempts to work in an unacceptable condition, that does not wash their hands upon entering the production area, fails to clean his/her personal equipment (e.g. knives, apron and boots) prior to start of operations and in general, ignores the rules of good personal sanitary habits that encourages others to behave in a like manner **will not be allowed to work**.

Inspectors are reminded of the provision of Section 1241(a) of the California Processing Inspection Regulations which state, "Failure in effort on the part of the inspector to properly enforce meat/poultry meat inspection regulations shall be sufficient cause for the director to revoke the license of such inspector."

House Duties: Processing Inspectors may be required to perform duties other than inspection, but only if such duties do not interfere with their duties as inspectors. Any violation of this requirement by plant management will be reported to a Branch employee as soon as possible.

Licenses: Inspectors must have readily available, at all times while engaged in inspection duties, a valid Processing Inspector's license.

Processing Inspector's licenses are renewable at the end of each calendar year. Applications for renewal must be postmarked prior to midnight, December 31, of the year in which they expire. In the event an application for renewal is submitted late, a penalty fee must be paid in addition to the renewal fee. License must be renewed within 90 days of its expiration and after that time it shall be revoked.

18981. (a) Application for renewal of a license accompanied by a fee of one hundred dollars ($100) shall be made on or before its expiration. Applicants for renewal of a license who have not paid the renewal fee by the expiration date of the license shall be assessed a twenty-five dollar ($25) penalty. Failure to pay the renewal fee plus the penalty within 90 days of expiration shall cause a revocation of a license. - ***California Meat and Poultry Supplemental Inspection Act, Sec. 18981***

3 CCR § 901
Cal. Admin. Code tit. 3, § 901

Barclays Official California Code of Regulations Currentness
Title 3. Food and Agriculture
Division 2. Animal Industry
Chapter 4. Meat Inspection
Subchapter 1.
Article 2. Supplemental Requirements, Licensing and Inspection (Refs & Annos)

§ 901. Authority of Livestock Meat Inspectors, Processing Inspectors, and Persons Responsible for Operation of Custom Livestock Slaughterhouses and Meat Processing Establishments.

(a) No person licensed as a livestock meat inspector or processing inspector and no person responsible for the operation of a custom livestock slaughterhouse or meat processing establishment shall exercise the authority of the license:

(1) To perform or allow the performance of any operation not in accordance with the requirements in this subchapter: or

(2) Contrary to instructions of a Department inspector, including instructions relating to proper procedures, wholesomeness inspection, condemnation, or other disposition of diseased animals, carcasses, parts and adulterated or mislabeled meat and poultry products; sanitation inspection; and the maintenance of accurate records.

(b) No person licensed as a livestock meat inspector or processing inspector and no person responsible for the operation of a custom livestock slaughterhouse or meat processing establishment shall allow establishment duties to interfere with livestock meat inspector and processing inspector official inspection duties.

Subchapter 1.
Article 2. Supplemental Requirements, Licensing and Inspection (Refs & Annos)
§ 901.2. Grounds for Disciplinary Action.

Violation of any provisions of Chapter 4 (commencing with section 18650) or of Chapter 4.1 (commencing with section 18940) of Part 3, Division 9 of the Food and Agricultural Code, or the requirements of this subchapter, shall be grounds for disciplinary action against the license or firm involved. Continued violation shall be grounds for permanent withdrawal of plant inspection.

Subchapter 1.
Article 2. Supplemental Requirements, Licensing and Inspection (Refs & Annos)
§ 901.7. Presence of Inspector on Premises.

(b) A processing inspector shall be present on the premises of a meat processing establishment when product is being formulated and when monitoring of weights or temperatures is required.

Subchapter 1.
Article 2. Supplemental Requirements, Licensing and Inspection (Refs & Annos)
§ 901.8. Inspector Responsibilities.

(a) Livestock meat inspectors and processing inspectors shall inspect slaughter and processing operations in official establishments to ensure that meat and poultry products are produced in compliance with applicable requirements of Chapter 4 (commencing with section 18650) or Chapter 4.1 (commencing with section 18940) of Part 3, Division 9, of the Food and Agricultural Code, and this subchapter.

(b) Livestock meat inspectors and processing inspectors shall inspect official establishments to ensure they conduct operations that require state inspection on days and during hours specified on each establishment's current MPES Form 79-038 (Rev. 10/11), Schedule of Operations, unless different days or hours are approved in advance by the Department.

(c) A processing inspector shall complete, at least once a year, an in-depth review, on MPES Form 79-082 (Rev.10/11), In-Depth Review of Cooked Sausage, for each cooked sausage product and an in-depth review, on MPES Form 79-085 (Rev. 10/11), In-Depth Review of Cured, Cooked and Smoked Meats, for each cured, cooked, and smoked meat product produced in the meat processing establishment where the inspector is employed. The in-depth review forms shall be presented, upon completion, to a Department inspector for approval and signature.

(d) When, during an in-depth review for a product, the processing inspector finds any deviation(s) from the requirements of Chapter 4 (commencing with section 18650) or Chapter 4.1 (commencing with section 18940) of Part 3, Division 9, of the Food and Agricultural Code, this subchapter, and the approved MPES Form 79-080 (Rev. 10/11), Label and Formulation Approval, for the product, the inspector shall place a California Retained tag on the involved lot of product and immediately contact the Department. A program employee shall determine the disposition of the product and shall require the official establishment to take corrective measures, if necessary, to assure that the product conforms to its standard of identity and is wholesome and unadulterated before it is presented for sale. If the official establishment does not or cannot correct the deviation(s), the product shall be condemned and disposed of in accordance with section 907 of this subchapter.

(e) The processing inspector shall review all labels and product formulations with the Department inspector before sending them, with a completed MPES Form 79-080 (Rev. 10/11), Label and Formulation Approval, to the Department for approval.

(f) A processing inspector shall record the temperature of each lot of smoked product on MPES Form 79-086 (Rev. 10/11), Smokehouse Chart, and shall complete all items on a line on the smokehouse chart at least once a month.

(g) A processing inspector shall notify the Department when the official establishment makes a change in product formulation or in product manufacturing procedures.

(h) A processing inspector shall inspect the processing of each cured pork or cured beef product produced by the establishment at least once a month, using the following procedure:

(1) Mark one or more pieces of uncured meat with its weight. This is called the green weight of the product.

(2) Determine the weight of the cured product before it is cooked/smoked. This is called the pumped weight of the product. Check the pumped weight against the green weight to determine compliance with procedures in the approved MPES Form 79-080 (Rev. 10/11), Label and Formulation Approval, for the product.

Subchapter 1.
Article 2. Supplemental Requirements, Licensing and Inspection (Refs & Annos)

§ 901.9. Custom Livestock Slaughterhouse or Meat Processing Establishment: Approval of Plans, Notice of Approval, and Granting of a License.

(a) Each applicant for a license to operate a custom livestock slaughterhouse or a meat processing establishment shall submit copies of plans, in triplicate, drawn to scale, not necessarily blueprints, and with specifications detailing the finish of all walls, floors, ceilings, doors, and door casings; ceiling heights; dimensions of doorways; diameter of floor drains and principal drainage lines; and slope of window sills. The plans shall show the locations of features such as walls, windows, doorways, principal pieces of equipment, floor drains, principal drainage lines, lavatories, hand washing basins, hose connections for cleanup purposes, and conveyor rails. The plans shall indicate the use of each room of the establishment. There shall also be a plot plan, drawn to scale, showing features such as the limits of the establishment's premises, locations in outline of buildings on the premises, cardinal points of the compass, locations of wells, locations of septic tanks and lagoons, and roadways and railroads serving the establishment.

(b) Each applicant for a license to operate a custom livestock slaughterhouse or a meat processing establishment shall submit, along with the plans described in subsection (a) of this section, a completed MPES Form 79-039 (Rev. 10/11), General Facility Notes. The applicant shall also submit a completed MPES Form 79-002A (Rev. 09/11), Custom Livestock Slaughter or Meat Processing Plant License Application. Applicants for licensure and renewal shall submit the fees required by sections 19010 and 19011 of the Food and Agricultural Code.

(c) Each applicant for a license to operate a custom livestock slaughterhouse or a meat processing establishment shall submit official results of tests for potability of the establishment's water supply provided by the California Department of Health Services, from an agency or laboratory approved by the California Department of Health Services, or laboratory of the Department.

(d) Persons intending new construction or major reconstruction may request information about plans, construction, and equipment from the Branch before submitting plans. Upon request, the Branch will provide the Meat Processing Establishment Plan Guidelines (Rev. 9/04), the Custom Livestock Slaughterhouse Plan Guidelines (Rev. 9/04), the Meat Processing Establishment Construction and Equipment Guidelines (Rev. 9/04), or the Custom Livestock Slaughterhouse Construction Guidelines (Rev. 9/04).

(e) The Department shall provide a written notice to each applicant granted approval and licensure, specifying the establishment to which the same applies.

(f) Each applicant shall provide written acknowledgement, such as a use permit, from the local zoning authority, that shows the zoning authority is aware of and approves the operation of a custom livestock slaughterhouse or a meat processing establishment at the proposed location.

(3) Plant management shall notify the processing inspector of the time the establishment plans to cure or pump product. This is to provide opportunity for the inspector to record the green weight of the meat and the amount of curing solution uptake during processing.

Subchapter 1.
Article 2. Supplemental Requirements, Licensing and Inspection (Refs & Annos)
§ 901.11. Schedule of Operations

(a) Each licensed custom livestock slaughterhouse and each licensed meat processing establishment shall complete and submit to the Department an MPES Form 79-038 (Rev. 10/11), Schedule of Operations, specifying the days and weeks of the month and the hours of the day that the plant operates.

(b) Each licensed custom livestock slaughterhouse and each licensed meat processing establishment shall complete and submit to the Department a new MPES Form 79-038 (Rev. 10/11), Schedule of Operations, whenever the establishment makes a permanent change in the frequency or times of its operations.

(c) If a licensed custom livestock slaughterhouse or a licensed meat processing establishment plans to temporarily operate on days and/or at times other than those listed on its current MPES Form 79-038 (Rev. 10/11), the establishment management shall contact the area supervisor by telephone at least 24 hours in advance of such unscheduled operations to inform him of its intent.

Subchapter 1.
Article 14. Records and Reports (Refs & Annos)
§ 913.1. Meat Processing Reports.

(a) Plant management at each meat processing establishment shall complete the following reports:

(1) MPES Form 79-070 (Rev. 10/11) Daily and Monthly Processing Report.

(2) Under the headings Meat Products, Poultry Products, Custom Products, and Re-Inspection, a column shall be completed for each day the establishment conducts processing operations.

(3) The weight, in pounds, for all products produced and/or condemned on re-inspection shall be entered in the appropriate space.

(4) MPES Form 79-071 (Rev. 10/11) Monthly Report Processing Operations at State Inspected Meat and Poultry Official Establishments. This form shall be completed for the preceding month, using data from all MPES Forms 79-070 (Rev. 10/11) Daily and Monthly Processing Report completed that month. The completed form shall be sent to the Sacramento headquarters office by the tenth day of the month.

Meeting the Requirements for State Meat Inspection:

Cal. Admin. Code tit. 3, § 902.4 Title 3. Food and Agriculture Division 2. Animal Industry Chapter 4. Meat Inspection Subchapter 1.

➡§ 902.4. Official Establishment Grounds and Facilities.

Official establishment grounds and facilities shall be constructed and maintained in accordance with 9 CFR section 416.2 (2006).

CFR section 416.2

Sec. 416.2 Establishment grounds and facilities.

(a) **Grounds and pest control**.

The grounds about an establishment must be maintained to prevent conditions that could lead to insanitary conditions, adulteration of product, or interfere with inspection by FSIS program employees. Establishments must have in place a pest management program to prevent the harborage and breeding of pests on the grounds and within establishment facilities. Pest control substances used must be safe and effective under the conditions of use and not be applied or stored in a manner that will result in the adulteration of product or the creation of insanitary conditions.

Do pest control programs have to be written documents?

No. Pest control programs addressed in 9 CFR 416.2(a) are not required by regulation to be written programs. However, they must be implemented and maintained to prevent or eliminate pest harborage and breeding within the limits of the official premises.

Although such programs are not required to be written, a written program is beneficial to the establishment because it describes what actions are to be taken, when the actions are to be taken, and what is done to provide evidence that the actions were taken. A prudent establishment would focus on documenting as many aspects of its operation to demonstrate that its overall food safety system is working properly.

(b) **Construction**.

(1) Establishment buildings, including their structures, rooms, and compartments must be of sound construction, be kept in good repair, and be of sufficient size to allow for processing, handling, and storage of product in a manner that does not result in product adulteration or the creation of insanitary conditions.
(2) Walls, floors, and ceilings within establishments must be built of durable materials impervious to moisture and be cleaned and sanitized as necessary to prevent adulteration of product or the creation of insanitary conditions.
(3) Walls, floors, ceilings, doors, windows, and other outside openings must be constructed and maintained to prevent the entrance of vermin, such as flies, rats, and mice.

(4) Rooms or compartments in which edible product is processed, handled, or stored must be separate and distinct from rooms or compartments in which inedible product is processed, handled, or stored, to the extent necessary to prevent product adulteration and the creation of insanitary conditions.

(c) **Light**.

Lighting of good quality and sufficient intensity to ensure that sanitary conditions are maintained and that product is not adulterated must be provided in areas where food is processed, handled, stored, or examined; where equipment and utensils are cleaned; and in hand-washing areas, dressing and locker rooms, and toilets.

(d) **Ventilation**.

Ventilation adequate to control odors, vapors, and condensation to the extent necessary to prevent adulteration of product and the creation of insanitary conditions must be provided.

(e) **Plumbing**. Plumbing systems must be installed and maintained to:

(1) Carry sufficient quantities of water to required locations throughout the establishment;
(2) Properly convey sewage and liquid disposable waste from the establishment;
(3) Prevent adulteration of product, water supplies, equipment, and utensils and prevent the creation of insanitary conditions throughout the establishment;
(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) Prevent back-flow conditions in and cross-connection between piping systems that discharge waste water or sewage and piping systems that carry water for product manufacturing; and
(6) Prevent the backup of sewer gases.

(f) **Sewage disposal**.

Sewage must be disposed into a sewage system separate from all other drainage lines or disposed of through other means sufficient to prevent backup of sewage into areas where product is processed, handled, or stored. When the sewage disposal system is a private system requiring approval by a State or local health authority, the establishment must furnish FSIS **(MPESB**) with the letter of approval from that authority upon request.

(g) **Water supply and water**, ice, and solution reuse.

(1) A supply of running water that complies with the National Primary Drinking Water regulations (40 CFR part 141), at a suitable temperature and under pressure as needed, must be provided in all areas where required (for processing product, for cleaning rooms and equipment, utensils, and packaging materials, for employee sanitary facilities, etc.).

(2) If an establishment uses a municipal water supply, it must make available to FSIS (MPESB), upon request, a water report, issued under the authority of the State or local health agency, certifying or testing to the potability of the water supply.
(3) If an establishment uses a private well for its water supply, it must make available to FSIS (MPESB), upon request, documentation certifying the potability of the water supply that has been renewed at least semi-annually.

Water, ice, and solutions (such as **brine**, liquid smoke, or propylene glycol) used to chill or cook ready-to-eat product **may be reused** for the same purpose, **provided that they are maintained free of pathogenic organisms** and fecal coliform organisms and that other physical, chemical, and microbiological contamination have been reduced to prevent adulteration of product.

(h) **Dressing rooms, lavatories, and toilets**.

(1) Dressing rooms, toilet rooms, and urinals must be sufficient in number, ample in size, conveniently located, and maintained in a sanitary condition and in good repair at all times to ensure cleanliness of all persons handling any product. They must be separate from the rooms and compartments in which products are processed, stored, or handled.
(2) Lavatories with running hot and cold water, soap, and towels, must be placed in or near toilet and urinal rooms and at such other places in the establishment as necessary to ensure cleanliness of all persons handling any product.

Do hand wash sinks have to have foot-operated on/off pedals ?

No. The regulation 9 CFR 416.2(h)(2) requires that hand wash sinks:

- Have running hot and cold water, soap, and towels (or other means of drying hands)
- Be placed in or near toilet and urinal rooms, and
- Be placed at any other places in the establishment necessary to ensure cleanliness of all persons handling any product.

The regulation is not prescriptive; however, inspection program personnel will verify that the use of hand wash sinks does not result in an insanitary condition or lead to contamination or adulteration of product.

(3) **Refuse receptacles** must be constructed and maintained in a manner that protects against the creation of insanitary conditions and the adulteration of product.

➡§ 902.5. Equipment and Utensils.

Equipment and utensils in official establishments shall be constructed and maintained in accordance with 9 CFR section 416.3 (2006).

Sec. 416.3 **Equipment and utensils**.

(a) Equipment and utensils used for processing or otherwise handling edible product or ingredients must be of such material and construction to facilitate thorough cleaning and to ensure that their use will not cause the adulteration of product during processing, handling, or storage. Equipment and utensils must be maintained in sanitary condition so as not to adulterate product.

(b) Equipment and utensils **must not** be constructed, located, or operated in a manner that **prevents FSIS (MPESB) inspection program employees from inspecting** the equipment or utensils to determine whether they are in sanitary condition.

(c) Receptacles used for storing **inedible material** must be of such material and construction that their use will not result in the adulteration of any edible product or in the creation of insanitary conditions. Such receptacles must not be used for storing any edible product and **must bear conspicuous and distinctive marking to identify** permitted uses.

➡§ 902.6. Sanitary Operations.

Operations in official establishments shall be conducted in a sanitary manner in accordance with 9 CFR section 416.4 (2006).

Sec. 416.4 **Sanitary operations**.

(a) All food-contact surfaces, including food-contact surfaces of utensils and equipment, must be cleaned and sanitized as frequently as necessary to prevent the creation of insanitary conditions and the adulteration of product.

(b) Non-food-contact surfaces of facilities, equipment, and utensils used in the operation of the establishment must be cleaned and sanitized as frequently as necessary to prevent the creation of insanitary conditions and the adulteration of product.

(c) **Cleaning compounds, sanitizing agents, processing aids, and other chemicals used by an establishment** must be safe and effective under the conditions of use. Such chemicals must be used, handled, and stored in a manner that will not adulterate product or create insanitary conditions. **Documentation substantiating the safety of a chemical's use in a food processing environment must be available to FSIS(MPESB)inspection program employees for review.**

(d) Product must be protected from adulteration during processing, handling, storage, loading, and unloading at and during transportation from official establishments.

➡§ 902.7. Employee Hygiene.

Employee hygiene in official establishments shall be maintained in accordance with 9 CFR section 416.5 (2006).

(a) **Cleanliness**. All persons working in contact with product, food-contact surfaces, and product-packaging materials must adhere to hygienic practices while on duty to prevent adulteration of product and the creation of insanitary conditions.

(b) **Clothing**. Aprons, frocks, and other outer clothing worn by persons who handle product must be of material that is disposable or readily cleaned. Clean garments must be worn at the start of each working day and garments must be changed during the day as often as necessary to prevent adulteration of product and the creation of insanitary conditions.

(c) **Disease control**. Any person who has or appears to have an infectious disease, open lesion, including boils, sores, or infected wounds, or any other abnormal source of microbial contamination, must be excluded from any operations which could result in product adulteration and the creation of insanitary conditions until the condition is corrected.

§ 902.8. Tagging Insanitary Equipment, Utensils, Rooms, or Compartments.

(a) Red and green “California Rejected” tags are utilized by inspectors and program employees for rejecting equipment, utensils, rooms, or compartments or for retaining a product.

(b) When an inspector finds that any equipment, utensil, room, or compartment at an official establishment is insanitary, or that its use could cause adulteration of product, the inspector will attach a red or green “California Rejected” tag as appropriate.

(c) Equipment, utensils, rooms, or compartments so tagged shall not be used until made acceptable and released for use upon re-inspection by an inspector.

(d) Only a program employee may remove a red “California Rejected” tag. Livestock meat inspectors, processing inspectors, and program employees may remove a green “California Rejected” tag.

Publications: Processing Inspectors should have available or internet access to for reference, copies of the following publications:

a. Extracts of the Food and Agricultural Code pertaining to Processing Inspection.
b. Processing Inspector’s Training Manual.
c. A guide to Federal Food Labeling Requirements for Meat and Poultry Products
d. USDA Food Standards and Labeling Policy Book
c. All written instructions pertaining to processing inspection that may be issued by the Branch from time to time.

SECTION II – MICROBIOLOGY

This chapter provides basic microbiology information that can be useful to all meat processors. However, chapter does not cover all needed information to produce safe and unadulterated product.

Definitions:

a. **Bacteria;** Bacteria are tiny, single cell, **living organisms**; so small that they can only be seen with the use of a microscope. One tiny speck of dust can carry thousands of them. Bacteria are responsible for most of the food borne diseases in man. They cost the meat/poultry industry millions of dollars each year through spoilage of products, lost sales and through lost time by employees.

b. **Spores**: Some bacteria, in order to survive, have the ability to form a protective coating around themselves when some unfavorable condition is encountered, such as loss of one of the elements which they need to grow in; loss of moisture, extremes of heat or cold, etc. While in this state they are called "spores." Bacteria in the spore state have been known to **survive freezing** temperatures indefinitely and **boiling temperatures** for several hours. While in the spore state they stop all activity, they do not feed or multiply. When conditions are again right for their growth they again start their cycle of reproduction. Bacteria with this ability to form a protective coating are known as "Spore Formers." Examples are bacteria from Clostridia group.

c. **Toxins:** During the process of growing and multiplying some bacteria give off a **poisonous** substance called "toxins." Some toxins cause food poisoning in man. While normal cooking temperatures will destroy bacteria organisms in food, such **temperatures may not destroy the toxins produced by e.g. Staphylococcus aureus.**

d. **Lag Phase:** Bacteria have another unique characteristic. When they are transferred from one environment to another, such as from a meat surfaces to a table, they will stop their cycle of reproduction for a period of from one and one half to two hours. This period of inactivity is known as the "lag phase." The recommendation that some equipment in a processing plant be sanitized every two hours is to take advantage of the lag phase.

e. **Growth Phase**: During this phase bacteria undergo their maximum growth rate and it is during this period that the incredible increase in bacterial numbers appear. In this phase meat will develop grossly detectable signs of spoilage and may actually be decomposed.

e. **Resting phase**: At this time bacteria are dying about as fast as they are being reproduced.

f. **Death phase**: There is an acceleration of the downward trend that begun in the resting phase.

Bacteria are found in most environments; the air we breathe the food we eat, the water we drink, in our hair, on our clothing and hands, and are present in large numbers in the intestinal tract of

all animals. In fact, bacteria are found almost everywhere.

Shape;
Bacteria are grouped according to shape: spherical forms know as cocci, straight rods called bacilli, and curved or spiral rods know as spirilla.

Reproduction: Bacteria **reproduce** themselves **by dividing**. Under favorable conditions, multiplication and growth of bacteria is a simple process involving cell enlargement, follow by formation of a cell wall across the middle and, finally separation into two cells. This process is know as **binary fission**. Thus one bacteria becomes two, two become four, four become eight, eight become sixteen, sixteen become thirty two, thirty two become sixty four, and so on. Under ideal conditions this division of each cell can take place in as short a time as fifteen minutes. If we started with a standard plate count of 10,000 bacteria per centimeter, which is the allowable count for certified, grade A, raw milk and far below the count we would expect to find on most poultry carcasses, the 10,000 could become 2,565,000 bacteria in two hours.

1. **Temperature:** Majority of bacteria reproduce at temperatures between 40^{o} and 140^{o} Fahrenheit. Their most rapid multiplication takes place at temperatures of between 80^{o} and 110^{o} Fahrenheit. As temperatures are reduced to 40^{o} F. and below, their growth is slowed significantly. At freezing temperatures their growth has stopped altogether. Freezing does not usually destroy bacteria but it does completely halt their cycle of feeding and reproduction. As soon as a product that has been frozen is thawed, bacterial growth and reproduction will be renewed. Hence the regulations governing thawing of frozen poultry. As temperatures approach 140^{o} F. bacterial growth is again significantly slowed and as temperatures of 160^{o} F. or above are reached, and depending on the length of time they remain at this temperature, most of them will be destroyed. For all practical purposes a temperature of 180^{o} F and above will destroy instantly most of the bacteria of concern in the processing field except some spore formers.

2. **Food:** Any organic matter will provide sufficient food for bacteria to grow and multiply, providing that all three of the needed elements are present for significant period of time; proper temperature, moisture and food. A thin film of organic matter left on a boning table or grinder as a result of inadequate (insufficient) cleaning process will support millions of bacteria.

3. **Moisture:** Bacteria absorb food through their cell walls through a process called osmosis. The food must be in a liquid or semi-liquid state. Pans that have been cleaned and then nested while wet will not dry, hence the requirement that pans "shall not be nested", but stored in a manner that will allow for the free circulation of air around them.

GASEOUS ATMOSPHERE AND BACTERIAL GROWTH

- ***Aerobic bacterium (aerobe)*** – Grows in the presence of air.
- ***Anaerobic bacterium (anaerobe)*** – Grows in absence of air.
- ***Facultative anaerobe*** – Grows in the presence or absence of air.
- ***Microaerophilic bacterium*** – Grows in an atmosphere of less oxygen than in air.

TEMPERATURE AND BACTERIA GROWTH OR SURVIAL

On the surface of meat exposed to the air in chill rooms we expect the growth **psychrotrophic** aerobic bacteria. However, on vacuum packaged meats, other bacteria, many psychrotrophic facultative anaerobes such as the lactic acid bacteria, will grow.

- ***Psychrotrophic bacteria*** – Capable of growth at commercial refrigerated storage temperatures.
- Most psychrotrophic bacteria grow best at 15 - 25°C (59- 77°F), but continue growth at a slower rate under refrigerated temperature. That is way these bacteria's are common meat and poultry spoilage bacteria.
- These characteristics are of great significance in newer packaging technology applied in the meat industry.

GROUPING OF BACTERIA ACCORDING TO THEIR ACTIVITIES IN FOODS AND SIGNIFICANCE TO PUBLIC HEALTH

Certain bacteria are useful as they can produce the desirable body, texture, and flavor in foods. For example, fermented sausage, pickles, cheese, yogurt, sauerkraut, olives, sourdough bread, and vinegars.

Spoilage bacteria – Bacteria which during growth cause quality deterioration and, ultimately, spoilage of food and in most cases are not considered a serious threat to human health. The consumption of spoiled food normally causes only mild alimentary symptoms.

Pathogenic bacteria – Bacteria that are capable of causing serious condition/disease in humans. They may be **present** on meat in sufficient numbers to cause food poisoning in man **without** the meat showing/being in a decayed or spoiled **condition** that is not **noticeable** to the inspector's senses of sight, feel and smell.

FOODBORNE DISEASE OR FOODBORNE ILLNESS

- *Foodborne **disease** or foodborne **illness**:* Infection or intoxication caused by microbial or chemical contaminants in foods.
- Some foodborne illness, such as **salmonellosis** and **staphylococcal food poisoning** can be caused by consumption of a food that contains only a few microorganisms or toxin.
- Other foodborne illnesses result from eating compounds, such as naturally occurring aflatoxin in foods over long period of time.

WHICH BACTERIA ARE RESPONSIBLE FOR FOODBORNE ILLNESS?

Some bacteria cause more serious illness than others, but only a few are responsible for the majority of cases.

The nine prominent bacteria that each processor should know:

- ***CAMPYLOBACTER***
- ***CLOSTRIDIUM BOTULINUM***
- ***CLOSTRIDIUM PERFRINGENS***
- ***ESCHERICHIA COLI O157:H7***
- ***SALMONELLA (over 1600 types)***
- ***STREPTOCOCCUS A***
- ***LISTERIA MONCYTOGENS***
- ***SHIGELLA (over 30 types)***
- ***STAPHYLOCOCCUS AUREUS***

CAMPYLOBACTER

- Found: Intestinal tracts of animals, birds, raw milk, untreated water, and sewage sludge.
- Transmission: Contaminated water, raw milk, and raw or under-cooked meat, poultry, or shellfish.
- Symptoms: Fever, headache, and muscle pain followed by diarrhea (sometimes bloody), abdominal pain and nausea that appear 2 to 5 days after eating; may last 7 to 10 days.

CLOSTRIDIUM BOTULINUM

- Found: Widely distributed in nature: in soil and water, on plants, and in intestinal tracts of animals and fish. Grows only in little or no oxygen.
- Transmission: Bacteria produce a toxin that causes illness. Improperly canned foods, garlic in oil, and vacuum-packaged and tightly wrapped food.
- Symptoms: Clostridium can produce under certain conditions the strongest toxin known to humans that affects the nervous system and in most cases is deadly. Symptoms usually appear with 18 to 36 hours, but can sometimes appear within as few as 4 hours or as many as 8 days after eating; double vision, droopy eyelids, trouble speaking and swallowing, and difficulty breathing. Fatal in 3 to 10 days if not treated.
- Using the allowable amount of a curing agent in a meat or poultry product will reduce the risk of botulism developing in a meat product

CLOSTRIDIUM PERFRINGENS

- Found: Soil, dust, sewage, and intestinal tracts of animals and humans. Grows only in little or no oxygen.
- Transmission: Called “the cafeteria germ” because many outbreaks result from food left for long periods in steam tables or at room temperature. Bacteria destroyed by cooking, but some toxin-producing spores may survive.
- Symptoms: Diarrhea and gas pains may appear 8 to 24 hours after eating; usually last about 1 day, but less severe symptoms may persist for 1 to 2 weeks.

ESCHERICHIA COLI - O157:H7

- Found: Intestinal tracts of some mammals, raw milk, unchlorinated water; one of several strains of *E. coli* that can cause human illness.
- Transmission: Contaminated water, raw milk, raw ground beef, unpasteurized apple juice or cider, uncooked fruits and vegetables; person-to-person.
- Symptoms: Diarrhea or bloody diarrhea, abdominal cramps, nausea, and malaise; can begin 2 to 5 days after food is eaten, lasting about 8 days. Some, especially the very young, have developed Hemolytic Uremic Syndrome (HUS) that causes acute kidney failure. A similar illness, thrombotic thrombocytopenic purpura (TTP), may occur in older adults**.**

SALMONELLA (OVER 1600 TYPES)

- Found: Intestinal tract and feces of animals; *Salmonella enteritidis* in raw eggs.
- Transmission: Raw or undercooked eggs, poultry and red meat, raw milk and dairy products; seafood.
- Symptoms: Stomach pain, diarrhea, nausea, chills, fever, and headache usually appear 6 to 48 hours after eating; may last 1 to 2 days.

STREPTOCOCCUS

- Found: Noses, throats, pus, sputum, blood, and stools of humans.
- Transmission: People-to-food from poor hygiene, ill food handlers, or improper food handling; outbreaks from raw milk, ice cream, eggs, lobster, salads, custard, and pudding allowed to stand at room temperature for several hours between preparation and eating.
- Symptoms: Sore throat, painful swallowing, tonsillitis, high fever, headache, nausea, vomiting, malaise; occurs 1 to 3 days after eating, lasting a few days to about a week.

LISTERIA MONOCYTOGENES

- Found: Intestinal tracts of humans and animals, milk, soil, leaf vegetables, and processed foods; Since this organism can grow slowly at refrigerator temperatures special attention should be given to the prevention of listeria contamination of ready to eat product.
- Transmission: Soft cheese, raw milk, improperly processed ice cream, raw leafy vegetables, meat, and poultry. Illness caused by bacteria that do not produce toxin.
- Symptoms: Fever, chills, headache, backache, sometimes abdominal pain and diarrhea; 12 hours to 3 weeks after ingestion; may later develop more serious illness (meningitis or spontaneous abortion in pregnant women); sometimes just fatigue. It is one of the most virulent foodborne pathogen and is responsible for @ 500 deaths in USA annually.

SHIGELLA (OVER 30 TYPES)

- Found: Human intestinal tract; rarely found in other animals.
- Transmission: Person-to-person by fecal-oral route; fecal contamination of food and water. Most outbreaks result from food, especially salads, prepared and handled by workers using poor personal hygiene.
- Symptoms: Disease referred to as “Shigellosis” or bacillary dysentery. Diarrhea containing blood and mucus, fever, abdominal cramps, chills, vomiting; 12 to 50 hours from ingestion of bacteria; can last a few days to 2 weeks. Sometimes, no symptoms.

STAPHYLOCOCCUS AUREUS

- Found: On humans (skin, infected cuts, pimples, noses, and throats).
- Transmission: People-to-food through improper handling. Multiply rapidly at room temperature to produce a toxin that causes illness.
- Symptoms: Severe nausea, abdominal cramps, vomiting, and diarrhea occur 1 to 6 hours after eating; recovery within 2 to 3 days-longer if severe dehydration occurs.

There are many other pathogens that are transmissible from meat and poultry to man. Since thorough cooking destroys most of them, people can become a victim of these diseases causing organisms through handling of the raw products. **Bacteria** are considered **hitchhikers,** riding from place to place on specks of dust, moisture droplets in the air (such as in a sneeze or cough) by the hands of workers equipment surfaces, etc. For this reason, personal hygiene and sanitary practices are of special concern to all meat/poultry processing plant employees who should also remember that the consumer handles packaged meat/poultry RTE products without sanitizing before opening.

Control: The very nature of meat/poultry products, with the exception of some canned meat/poultry products, makes it impossible to eliminate or destroy all bacteria. However, through careful handling, sanitary processing procedures, use of sanitary equipment, and proper temperature control and/or cooking, their numbers can be reduced and their reproduction can be controlled. In order to control bacteria, a few simple facts concerning their growth must be understood and utilized. Control can be said to fall within three main areas: exclusion, inhibition, and destruction.

a. **Exclusion**: Bacteria are excluded through many means: through keeping bacterial ridden dust, dirt, flies, rodents and other vermin out of the plant and off the product; through the use of sanitary equipment and careful sanitary processing procedures. The trimming off of all contaminated surfaces is the recommended method of removing visible contamination from the product.

b. **Inhibition**: The growth of bacteria is inhibited (slowed or stopped) by proper chilling, cooking, curing, handling and storage. There is an old saying among food handlers, *"Keep food below forty degrees or above one-hundred-forty degrees Fahrenheit."* This temperature range is called the Danger Zone.

c. **Destruction**: Bacteria are destroyed through the use of hot water, sanitizing chemicals such as chlorine or lactic acid solution and through proper cooking temperatures when this type of processing is used.

pH (ACIDITY – ALKALINITY)

pH is used to express the intensity of acidity or alkalinity (acid – base). The pH values range from 0 to 14 with the value **7 representing neutrality**. Values above 7 indicate alkalinity and those below 7 indicate acidity.

NOTE:
It must be noted that pH values are **logarithmic expression** and this means a product with a pH of 5 is 10 times as acid as one with a pH of 6 and 100 times more acid than a pH of 7. The same is true on the alkalinity side, a pH of 8 is ten times more alkaline that a pH of 7 etc.

Another observation of importance is that the further away from a pH is from 7, the greater significance there is to the fractional variations. For example, there is only minor practical difference between pH 6.9 and pH 7, but a large difference can occur between pH 4.5 and pH 4.6.

Usually most bacteria prefer a near neutral pH (6.8 to 7.2). Each species of organisms has an optimum preferred ph and a definite ph range in which it will survive. **Altering the pH** has long been an excellent method of **food preservation**.

Botulism spores are unable to germinate into vegetative cells and product toxins in a high acid environment.

A pH 4.5 is considered safe for shelf-stable meats and is a requirement on certain items such as pickled pig feet which are canned with retorting.

The acid produced in dry fermented sausage is on of the factors accounting for its excellent keeping qualities even without refrigeration.

Yeast and Molds;
Yeast and molds are both fungi and contain no chlorophyll. They are not in the same classification as bacteria but have many characteristics in common. Yeasts and molds are generally **not considered harmful** but some molds may create a health hazard.

Here are few tips how to stay healthy and make a safe and healthy product

- Wash your hands thoroughly before and after all food preparation.
- Thoroughly wash food preparation implements/equipment before using them on other foods.
- Refrigerate meats and leftovers promptly.
- Don't work at the same time with raw and R-T-E product at the same room as food can became contaminated by juices from raw poultry and other meats.
- Don't eat while working.
- Wash your hands thoroughly when re-enter processing room.
- Wear clean garment and head cover when in the processing room.

Bacteria are always present around us and on the raw meat/poultry products being processed, the sanitary quality of which the inspector is monitoring. Mostly bacteria and their toxins cause disease in man and they cause meat/poultry products to spoil.

While many text books have been written covering the subject, and a degree in the science of

bacteriology requires a four-year course of study in a school of higher learning, for all practical purposes it can be said that the law and regulations that regulate the meat/poultry processing industry are based on the facts concerning bacteria as stated above.

If inspectors will always keep in mind these few facts concerning bacteria, they will be successful in carrying out their primary mission of "Protecting the Health of the Public." The reader who needs more detailed information is referred to any public library.

MICROBIOLOGY OF SHELF-STABLE DRIED MEATS

Dried meat and poultry products can be classified as either fermented or non-fermented. If they are fermented, generally they are dry and semi-dry sausages. Semi-dried meats are simply dried to a different level (15% weight loss during drying, compared to 30% for dried products). Non-fermented dried sausages, and, more commonly, jerky and dried whole muscle meats (such as dried ham), are also shelf-stable.
This section discusses two important aspects of the microbiology of shelf-stable dried meat and poultry products – pathogens and spoilage organisms of concern and starter cultures utilized in fermented dried meat and poultry products.
This module will

1. Review the types of microorganisms associated with these products, including pathogens of concern and microorganisms used to control the pathogens.
2. Distinguish pathogens of concern from spoilage organisms associated with shelf-stable meat products.
3. Describe the role starter cultures play in fermentation.
4. Identify the factors that control the safety of these products.
5. Identify factors that impact the fermentation process.

The objectives of this section are for you to be able to

1. Recognize pathogens of concern specific to dry and acidified/fermented products and distinguish them from spoilage organisms.
2. Describe the functions of starter cultures and their use.

Meat Microbiology

Although unaware of the process, early sausage makers knew that once the animal was killed, it was a race between external preservation techniques and the decomposition of the raw meats to decide the ultimate fate of the tissue. We now realize that once the inherent defense mechanisms of the live animal are destroyed, the meat tissue is subjected to rapid decay. The slaughtering process affords extensive contamination of the sterile tissue with primarily Gram-negative microorganisms. This includes enteric bacteria from animal intestines (*Enterobacteriaceae*, including *E. coli* and *Salmonella*), as well as contaminants such as *Pseudomonas* and Gram-positive lactic acid bacteria and staphylococci associated with humans, animals and the environment. As a result, fresh meat spoilage is usually associated with Gram-negative, proteolytic bacteria which literally decompose the protein with the production of offensive odors (putrid, rotten egg) and flavors. Salting, curing and drying of the fresh meat have proven to be effective means to control the fresh meat

microflora and thus preserve the tissue for later consumption. This is possible since the microbiology of salted meats is entirely different from that of fresh meats. The curing salts (sodium chloride, sodium nitrite, sodium nitrate) and subsequent proper handling methods favor the growth of Gram-positive bacteria while inhibiting the proliferation of Gram-negative bacteria. This "microbial inversion," occurring during the salting and curing process, provided the "accidental" origin of fermentation cultures for all salted meats and fermented sausages.

Once the raw meat was salted and spiced, the mixture was stuffed tightly into sausage casings or skins, which excluded air and held the sausage during aging. The casing also provided a convenient medium to hang the mixture for smoking and drying. Excluding air also prevented mold growth, except on the casing surface.

Consequently, a microenvironment was provided for those microorganisms that were not only salt tolerant, but which also could grow in the absence of air. These Gram-positive, fermentative types of microorganisms included the lactic acid bacteria, staphylococci, micrococci, and yeasts.

As the product dried, a fermentation ensued whereby residual meat sugar, or added carbohydrates, was fermented to a variety of end products, including various organic acids, carbon dioxide, alcohols, etc., that contributed to a variety of flavors and textural properties. The primary fermentation product, lactic acid, served to lower the pH and contributed to the stability of these sausages against food-borne pathogens and other undesirable microorganisms. The lower pH also aids in drying since the meat proteins are less able to bind water under acidic conditions (as will be discussed later). Although actually a spoilage condition, the "souring" of the product could be tolerated to a much greater extent than the fresh meat type of proteolytic spoilage, and this served to preserve the meat. If properly controlled, the resulting flavor could make the meat more acceptable to the palate, through a "tangy" sensation in combination with the salt, spices, smoke, and other imparted formulation and processing characteristics. Lactic acid resulting from fermentation has a tendency to enhance the "salty" and "smoky" flavors. Lactic acid is non-toxic to man and moderately pleasant to the palate, but it is inhibitory to most undesirable microorganisms, including most pathogenic microorganisms, which tend to die off in the final product during storage. Similar lactic-acid fermented foods include cheeses, sauerkraut, yogurt and pickles.

►Lactic Acid Bacteria (LAB)

The most common lactic acid microorganisms found in fermented meats are various strains of lactobacilli, leuconostocs, pediococci, and streptococci. *Lactobacillus plantarum* is mostly found in sausages fermented at higher temperatures (86°F, 30°C) and *L. sake* and *L. curvatus* dominate the flora at mild temperatures (68-75°F, 20-24°C) more typical of European processes. Pediococci involved include *P. acidilactici* at higher temperatures (>85°F, 29°C) and *P. pentosaceus* at lower temperatures (<85°F, 29°C). These harmless, beneficial types of microbes are ubiquitous in the environment and are highly competitive. They are fastidious microorganisms, requiring many nutrients for growth (which meats can provide). They primarily convert various sugars to lactic acid and other end products. They can grow with or without air, but are very rapid acid producers in the absence of air, since the fermentation process is very inefficient for energy production and large quantities of acid must be produced for growth. This anaerobic (no air) environment is the characteristic condition within the internal portion of the sausage. The lactic acid microorganisms are also very salt tolerant and thrive within the typical sausage formulation.

Typically, the initial counts of LAB in raw meat mixes, depending upon the raw materials and the environment, are around 1,000-10,000 cells/g. During fermentation, those numbers increase to 10,000,000-100,000,000 cells/g.

Lactic acid type microorganisms are commonly used commercially today as starter cultures to produce a variety of fermented food products, including cheese, yogurt, sour cream, pickles, and olives, as well as dry salami, pepperoni, summer sausage, and fermented meat snacks. They are also used for human and animal nutrition, establishing a beneficial intestinal microflora (i.e., probiotic cultures).

►*Micrococcaceae* and *Staphylococcaceae*

Other types of common microbes in salted meats are members of the *Micrococcaceae* and *Staphylococcaceae* families, including *Kocuria* and *Staphylococcus*, respectively. The predominant types are coagulase-negative staphylococci that are very salt tolerant and can also grow with or without oxygen. By far, the most common strains belong to the species *Staphylococcus carnosus*, *S. xylosus*, and *K. varians*. Previously, many of these strains were classified as *Micrococcus* species. These bacteria generally are harmless and do not represent a microbial hazard. However, *Staphylococcus aureus* is a known food pathogen (as will be discussed later). The *Kocuria* and staphylococci are more salt tolerant than the lactic acid microorganisms, and thus survive and grow in much lower water activity environments, as is the case with highly salted products and as the sausage loses water. Fortunately, these microorganisms are not very acid tolerant and tend to die off at lower pH during and after the fermentation process. They produce catalase, which reduces hydrogen peroxide, and some strains contribute to flavors as a result of lipolytic and proteolytic activity. A characteristic of the micrococci and staphylococci is that they can reduce nitrate (NO_3) to nitrite (NO_2), which provides the active component (nitric oxide, NO) that initiates the typical meat curing reactions. This characteristic was very important in the early days of meat processing before the availability of commercial cures, since the nitrate was found as a natural contaminant in the salt and/or saltpeter (KNO_3) that was added. Without this nitrate reduction to nitrite, the meat will not show the characteristics of cured meat. Since the staphylococci are sensitive to acid, this conversion would occur early in the process (prior to fermentation) before the lactic acid microorganisms became the dominant microflora of the meat mix. With "microbial succession," the staphylococci would gradually die off as the lactic acid microorganisms produced lactic acid. Today, most processors, particularly in the United States, just add the nitrite directly to the meat mix, thus eliminating the need for nitrate reduction by these microbial types. Initially, these strains are present at 100-1000 cells per gram, increasing to 1-10 million cells per gram in some fermentations.

►Undesirable Microorganisms

Not all the lactic acid bacteria that can occur in meat are desirable. For example, *L. viridescens* can cause greening of the meat due to the production of hydrogen peroxide. *L. brevis* and *L. mesenteroides* can cause gas production and unacceptable souring. *Brochrothrix* can cause souring, off flavors and odors.

Yeasts and molds can also be present in salted meats and can survive and grow at lower pH. Both prefer to grow under aerobic conditions at the outer edge and external surface of the meat product (although yeast can grow anaerobically). Yeast can result in

gas production and fruity flavors. Some molds can attack proteins and produce ammonia, which raises the pH on the sausage surface. Others may be lipolytic, attacking fats, or cellulytic, attacking casings. There is also the potential for production of mycotoxins, although this has not yet been shown to be a problem in sausage production. Although these microorganisms are often undesirable, they can be controlled via fermentation and proper drying.

Many pathogenic microorganisms can also be present in the raw sausage mix, including *S. aureus, E. coli* O157:H7*, Listeria monocytogenes*, *Salmonella*, and clostridia. Fortunately these pathogens also are not very competitive with the lactic acid microorganisms and are inhibited by low pH, nitrite and lower water activity. The parasite *Trichinella spiralis* may also be present in pork.

Staphylococcus aureus

Staphylococcus aureus is associated with mucous membranes (nose and throat) and is commonly found on the skin and hair of healthy humans and animals. It is also present in infected wounds, lesions and boils from both humans and animals. It is easily spread though the air via coughing and sneezing, and can contaminate meat from the animal skin or tissue during slaughter. After slaughter and after cooking, the meat can be contaminated from handling by individuals carrying the organism.

Staphylococcus aureus is not a good competitor with other microorganisms and, thus, usually is not a problem in raw foods. This organism becomes a problem when competitive microbes are removed by cooking or inhibited by high salt levels. In salted meats, where many microorganisms are inhibited, *S. aureus* can flourish without the proper controls. Even though *S. aureus* can grow with or without the presence of air, it prefers to grow aerobically; thus its presence in sausage usually occurs at the product surface and outer 1/8". Staphylococcal food poisoning is caused by the consumption of a heat stable enterotoxin produced as a byproduct during the growth of certain strains of *S. aureus*. Toxin production requires considerable growth by the microbe and is normally not present until the total cell numbers reach 1 million per gram of meat. Since the microorganism is readily destroyed by heat but the toxin is heat stable, total counts of *S. aureus* may not indicate if the toxin is present. Proper control is required in the early stages of the sausage production when the pH is high. Proper sanitation and personnel practices reduce product contamination, while temperature control reduces potential growth prior to fermentation. Using a commercial starter culture assures microbial dominance of fermentation strains over any potential pathogens and a controlled reduction of pH to 5.3 to inhibit potential *S. aureus* growth during fermentation. Most companies monitor the rate of pH drop to determine that fermentation is proceeding as expected.

Some companies may test batches for *S. aureus*. This may be done routinely for all products, for certain products known to be more prone to contamination with *S. aureus,* or when a batch does not ferment properly. Monitoring any *S. aureus* numbers should be done immediately after fermentation and before any cooking. If a product has received a heat treatment that could have reduced the number of *S. aureus*, then the lot should be tested for enterotoxin. Thus analyses of final product should be for enterotoxin and not *S. aureus*. All analyzes should be done on the outer 1/8" of the product.

There have been no reported cases of staphylococcal foodborne illness from fermented meats produced in the U.S. for over 20 years. This is due in large part to the widespread used of commercial starter cultures and education of producers by starter culture suppliers and trade associations in best practices for production of fermented meats.

***Escherichia coli* O157:H7**

Escherichia coli O157:H7 is associated with the cheeks, mouth, hide and intestinal tract of animals, particularly cattle, providing opportunity for contamination of the meat at slaughter. The pathogen is shed in the saliva and feces of infected animals, resulting in contamination on the hides of animals that come in contact with the saliva and feces. *E. coli* O157:H7 can be transferred from contaminated hides or the intestines of infected animals during the slaughter process. Although not a good competitor, *E. coli* O157:H7 can survive under refrigerated and frozen conditions. It is acid resistant, and thus it presents a potential problem by its survival in fermented meats.

Even very low numbers of *E coli* O157:H7 are capable of causing infection, thus the microorganism must be completely destroyed during the process.

Control principles for *E. coli* O157:H7 include minimizing the presence of the organism in the raw meats and proper fermentation and heating of final product. In most fermented sausages, a combination of low pH and intermediate heat treatment can effectively eliminate high numbers of *E. coli* O157:H7. For non-heated meat products, reduced water activity (combined with other factors such as salt level, time, and temperature) has been an effective means to reduce numbers of *E. coli* O157:H7.

Following an outbreak of illness from *E. coli* O157:H7 in dry fermented salami, FSIS and industry agreed that processors would validate the manufacturing process for dry and semi-dry fermented sausages to demonstrate an effective 5-log or greater reduction in *E. coli* O157:H7 and prevent recontamination. Ultimately five options were developed -

- Use a heating step in 9 CFR 318.17 or 9 CFR 318.23.
- Apply a validated heat treatment equivalent to at least a 5-log inactivation.
- Hold and test finished products using standard sampling plan protocols (e.g., ICMSF (International Commission on Microbiological Specifications for Foods) lot acceptance criteria; 15 or 30 samples tested, depending on use of product).
- Apply a validated minimum 5-log reduction or process that results in <1 *E. coli* O157:H7/100g (treatments shown to be effective in combination).
- Sample raw ingredients (mix) to demonstrate there is <1 *E. coli* O157:H7/g and apply a 2-log lethality treatment.

A Blue Ribbon Task Force of the National Cattlemen's Beef Association developed option 5 above. The task force also developed several processing procedures that achieved the 5-log reduction, which FSIS considers to be validated processes meeting option 2. These processes involve various combinations of fermentation temperature, pH at the end of fermentation, holding times and temperatures, drying, and cooking.

Salmonella

Salmonella is an enteric microorganism associated with the intestinal tract of many animals and thus is potentially present in most raw meats. *Salmonella* is recognized as a potential problem in salted, dried meats. Illness is usually caused by ingestion of sufficient microorganisms to survive digestion and reproduce in the human intestinal tract.

Fortunately, salmonellae are heat sensitive and easily destroyed with the mild heat treatments for cooking meat. Also, salmonellae are acid sensitive, not surviving well in fermented meats, and are not good competitors, being inhibited by the lactic starter cultures. They are also sensitive to meat curing practices. Salmonellae have not been a problem with fermented sausages if the product is properly fermented using an appropriate

starter culture. *Salmonella* not only survives drying but also becomes more heat resistant with drying and is more of an issue in non-fermented dried meats, such as jerky, and whole meat cuts, such as dried hams. Control mechanisms include proper temperature and sanitation prior to processing, and the use of wet heat early in the heat process to avoid pre-drying. In non-heated meats, the proper use of high salt and proper curing techniques are most effective.

Listeria monocytogenes

Listeria monocytogenes is a common bacterium found in the environment and can be carried by humans and animals. It has been isolated at every level of the meat processing chain, including slaughter and processing plant environments. *L. monocytogenes* can cause an infection after the ingestion of virulent strains.

Certain population segments are at high risk of contracting listeriosis, including pregnant women, the elderly and immunocompromised individuals (e.g., transplant patients, persons with cancer), which can result in serious illness and even death. This pathogen is of concern in the production of dried meats, since it is able to grow under both aerobic and anaerobic conditions and can survive dry conditions. It is also salt tolerant and can grow over a wide temperature range (31.3-113°F, -0.4-45°C), which includes refrigeration. It does not grow well in acid conditions, but can survive.

In addition to good sanitation and avoiding cross contamination, *Listeria* can be controlled by a combination of lower pH, high brine concentration, and competitive exclusion (and in some cases bacteriocin production) with lactic acid starter cultures, varying degrees of heat processing, and the drying process.

Trichinella spiralis

Trichinella sprialis (sometimes referred to as trichina) is a parasitic nematode (roundworm) associated with pork and wild game. It goes through various stages of its life cycle in a single host. Ingestion of cysts in the muscles of infected animals results in release of larvae from the cysts in the intestine; maturation of the larvae into adult worms in the epithelial cells of the small intestine; mating of the worms to produce new larvae; migration of the larvae to the circulatory system, which carries the larvae to muscle where the larvae form cysts. Recent cases have been attributed to the consumption of improperly cooked wild game, such as bear.

There are a number of effective ways to kill trichinae. These may include heating pork products to a minimum time/temperature combination, freezing for a specified time at a specified temperature, or curing according to specified methods.

Other pathogens

Campylobacter is the most common bacterial cause of diarrheal illness in the U.S. It lives in the intestines of healthy birds and is associated mainly with raw poultry and contaminated water sources. It is a fragile bacterium and is killed with oxygen, freezing, or drying. Control measures taken for *Salmonella, Listeria*, and *E. coli* O157:H7 will take care of other pathogens such as *Campylobacter* and *Yersinia enterocolitica*, a pathogen associated with pork.

Dried Meat Curing and Microbial Fermentation - general rules and potential problems

Traditionally, dried meat microbiology involves a natural development or "wild" fermentation in which a "microbial succession" occurs. Without a starter culture, initially all types of microorganisms increase. The total microbial count, which is primarily LAB (when starter cultures are used), rises to a high level (between 10^6 and 10^7 CFU/g) and then remains fairly constant. Enterobacteriaceae and psychrotrophs decrease once LAB reach high levels. Micrococcaceae increase more slowly and eventually decrease. As noted previously, Micrococcaceae (Kocuria) and Staphylococcaceae (Staphylococcus) produce nitrate reductases that convert nitrate to nitrite. Lactic acid microorganisms ferment the product and lower pH. The fermentation of the sugars results in lactic acid formation and the acidity of the meat increases.

In whole cuts of meat, the salting process also favors the same types of microorganisms, but the greater amount of surface area and the exposure to oxygen resulted in less fermentation activity and lactic acid production. In these types of dried meats (e.g., prosciutto, basturma), uniform salting over the entire surface is most critical to inhibit pathogens and spoilage microorganisms. Since the internal meat tissue is sterile, the high salt levels applied to the surface retard most microbes as the salt gradually penetrates the tissue, which should be kept cool during penetration/equilibration. These products have higher pH and greater risk of causing illness if the brine content is not sufficient.

Historically, some dry and semi-dry sausage processors would add the salt (and possibly saltpeter), sugars and spices to the meat and hold the resulting meat mix refrigerated for 1-2 weeks in shallow pans. This process was called "pan curing" or "panning." The salt inhibited Gram-negative bacteria and allowed the lactic acid bacteria, and some micrococci and staphylococci to develop and reduce the naturally occurring nitrate to nitrite. Although rare today, some processors still use a straight "nitrate cure" containing only nitrate – a process that is generally not effective without the presence of the nitrate-reducing microorganisms.

A "mixed cure" of added nitrate and nitrite is very common for dried meats that use a combined starter culture (nitrate-reducing micrococci and LAB) and that are not fully cooked. Nitrate reduction to nitrite provides additional cure color development and the nitrate provides a reservoir for the production of nitrite during the shelf-life of the product.
In the U.S., many processors have converted to a "nitrite cure" containing only added nitrite if they are cooking the product and use a single LAB starter culture.

Starter Cultures

Use of starter cultures resulted from an understanding of the natural development or "wild" fermentation. Gram-negative bacteria yield to Gram-positive bacteria (micrococci, staphylococci and LAB), resulting in microbial inversion. Micrococci and staphylococci convert nitrates to nitrites and yield to LAB (microbial succession). Fermentation results in lower pH. However, relying on indigenous microorganisms to properly ferment products was a risky business. Thus the "backslop," "back inoculation" or "mother batch" method evolved, which depended on using the batter from a previous batch to inoculate the next one – a potentially uncontrolled starter culture where undesirable, as well as desirable, microorganisms are recycled. However, this method has been successfully used by some processors who have implemented appropriate controls to prevent contamination or loss of the effective fermentation culture. Ultimately this process evolved into controlled development with prepared starter cultures. These cultures resulted in controlled "spoilage" through addition of staphylococci and LAB, if nitrate is added to the batch, or LAB only if nitrite is added. Today, most fermented meat processors either add lactic acid starter cultures and/or harmless staphylococci (mostly outside the U.S.) to the raw meat mix.

The microbial basis for fermentation was first determined about 1900, but the first starter cultures were only patented in the 1940's. Meat starter cultures were first commercialized in 1958, but by 1973 only about 33% of all fermented meat processors in North America used commercial starter cultures. Today, over 95% of all processors of these products use meat starter cultures.

Commercial meat starter cultures are selected microorganisms that have been isolated from the meat, purified, grown to large numbers under controlled conditions, concentrated, and then preserved by freezing or drying prior to use.

Eventually, the level of bacteria in many meat products is the same, whether a culture has been added or not. However, when a bacterial culture is added to meat, the microbial growth is controlled by bacteria with well-known characteristics. The addition of high levels (1-10 million bacterial cells per gram) of appropriate microorganisms such as in an LAB starter culture to the initial fermented sausage mix assures microbial dominance over the potential pathogenic and other undesirable microorganisms that might be present. The lactic acid microbes reduce product pH via fermentation while the staphylococci assure more efficient curing through nitrate/nitrite reduction and oxygen scavenging ability. There are two primary reasons to add such an overpowering population of the desired starter culture. One, this large number instantly becomes the dominant microflora, inhibiting all other microorganisms; and, two, the large number of microbial cells provides a tremendous amount of surface area, which results in high metabolic performance (e.g., desired end products such as lactic acid and/or nitrate reduction to nitrite).

Commercial meat starter cultures are not all the same. They differ in form, strain, purity, activity, and consistency, depending on the manufacturer.

The functions of commercial meat starter cultures are to allow fermentation with acid development and reduced pH, which has preservative effects for safety and shelf-life, and to produce more drying efficiency. Commercial meat starter cultures are also used for flavor development (proteolytic, lipolytic), and for color development and stability (nitrate reduction, oxygen scavenger). There are cultures of molds and yeasts that are used on the surface. Starter cultures can also show antioxidant characteristics.

The commercial cultures used in the U.S. differ from those used internationally. Those that are most common in the U.S. (and the fermentation temperatures used) are *Pediococcus acidilactici* (90-115°F, 32-46°C), *P. pentosaceus* (70-100°F, 21-38°C), *Lactobacillus plantarum* (70-100°F, 21-38°C), and *Staphylococcus carnosus* (formerly classified as *Micrococcus varians or M. halobius*; 70-100°F, 21-38°C). Internationally, the most common are *Staphylococcus carnosus*, *Lactobacillus curvatus*, *L. sake*, *S. xylosus*, *L. plantarum*, *Penicillium* spp. (mold), *P. pentosaceus, P. acidilactici*, and *Debaryomyces* spp. (yeast).

The specific starter cultures used in meat processing and whether a manufacturer uses a single culture or a combination of cultures will depend on the product, process conditions, desired fermentation temperature, final product characteristics desired, and regulatory requirements.

- Traditional fermented sausages – European-style, lower temperature, slower fermentations with enhanced color and flavor development
- Fast fermented products – U.S. style, higher temperature, rapid fermentations with emphasis on acid development
- Flavor and color enhancing cultures – strictly for flavor and color development with less emphasis on acid development
- Surface treatment cultures – mold and yeast cultures for surface appearance and flavor
- Whole muscle cultures – whole muscle products with emphasis on color and bioprotection
- Bioprotection cultures – food safety and shelf-life function
- Probiotic cultures – for nutritional purposes

There are different forms of cultures as well. They can consist of frozen liquid or pellets, dry (freeze-dried) cultures, or frozen "syrup." Frozen pellet cultures are the same as frozen liquid, but are easier to handle. They are a measurable culture, but they must be kept at -40°F (-40°C) or below before use (culture freezer). They are easily customized for specific culture blends. Dry meat cultures are used more worldwide. They are easy to distribute and are used primarily by smaller processors. Their primary use is for slower fermentations at lower temperatures (70-80°F, 21-27°C). These cultures should be kept frozen prior to use and added directly to sausage mix or diluted in water and then added. Cans of frozen liquid culture have been most common in the U.S., but this is changing. Frozen pellets and dry cultures, which are more common worldwide, are becoming more popular in the U.S. Regardless of the specific starter culture, detailed product specifications should accompany the cultures. These specifications should include:

- Specific microbial strain
- Function of the starter culture
- Purity of the product, including absence of pathogenic microorganisms and maximum number of "non-type" harmless strains
- Minimum number of specific microbial strain per gram in culture
- Minimum activity of the culture in terms of pH reduction and/or color development

Meat cultures are alive and need to be handled appropriately to ensure they do not lose viability and activity. Proper receipt, storage, and stock rotation according to the manufacturer's instructions are essential to maintain optimal performance.

►Fermentation Process

Fermentation results in an increase in acid along with a concomitant decrease in pH due to the fermentation of sugar (usually dextrose). Acid development is monitored by the drop

in pH. This phase of the process has historically been referred to as the "holding," "greening," or "dripping of the product." In all cases, this "fermentation phase" is where the conditions are established to effect the most efficient fermentation of added sugars to lactic acid.

In this phase of the process, it is critical to measure product pH. Product pH is the negative logarithm of the hydrogen ion concentration and is indicative of the acid concentration. The product pH can be affected by many factors, including the "buffering capacity" (the resistance to change in pH) of the meat mix. Being a logarithmic measurement, pH is not linear and may not be directly proportional to the acid concentration. Total acidity is a linear measurement (titration) and is directly indicative of the acid concentration (taste or "tang"), but is more difficult to measure in the processing environment. Generally, measuring pH is sufficient as an indicator of the progress of the fermentation phase.

When measuring pH with the direct probe method (i.e., insertion directly in the meat mix), it is very important to routinely clean the probe of protein and fat residue, both of which can result in a false pH reading. Additionally, the pH reading from a direct probe should be routinely correlated with the standard water dilution method (i.e., meat slurry) to assure accuracy. The water used for the dilution should be distilled water of neutral pH and not contain any buffering agents.

Appropriate fermentation rate and final pH in the meat reflect that starter cultures are viable and have been handled correctly. The fermentation rate depends on meat type and condition: pork, beef, poultry, temperature, percentage of fat and moisture, meat age, dominant microflora, and pH.

A salt level >3.0% slows down growth of the starter culture, but can be overcome with higher temperatures and the use of an appropriate culture. The usual added salt for dried sausages is 3.3%. Fermentation depends on the sugar types and levels. In general, dextrose is universally the most fermented carbohydrate, followed by corn syrup, sucrose, lactose, maltodextrins, starches and other more complicated carbohydrates.

In general, increasing sugar levels up to 1% decreases pH proportionately. In specific fermented meat products (e.g., pepperoni), limiting the added sugar to 0.5-0.75% achieves adequate fermentation with no residual carbohydrate present after fermentation. This prevents the "charring" of the product due to the reaction of reducing sugars with protein (i.e., Maillard reaction) during heating. A lower pH is obtained with increasing temperature at the same sugar level.

Spice types can increase or decrease culture activity. This usually is dependent upon the manganese content of the respective spice. For example, black and white pepper increase fermentation rate while the antimicrobial properties of mustard and garlic inhibit fermentation. The following additives can adversely affect the fermentation rate due to microbial inhibition: curing ingredients, antioxidants, phosphates, smoke, liquid smoke, non-fat dry milk, starch, and soy products.

Obviously, the starter culture type, activity, handling, and age will affect the culture's performance. It is critical that the optimum starter culture be used for the desired meat product and process.

The casing diameter will also affect the fermentation rate and final pH by affecting heat penetration and moisture migration in, and then out. Generally, large diameter products ferment slower due to slower heat penetration, but they result in a lower final pH for the same reason and/or slower drying.

As expected, the specific process affects the fermentation rate and final pH. In general, the higher the fermentation process temperature and humidity, the faster the fermentation; however, the fermentation temperature should be at the optimum growth temperature of the added starter culture. Added smoke will sometimes inhibit fermentation at the product surface, but the significance will depend upon the product diameter. The final pH will be affected by the added carbohydrate, the heating temperature after fermentation, and the drying conditions.

Fermentation temperature affects the time to reach pH 5.3, which is critical for control of *S. aureus* in fermented products. At 64.4°F (18°C), it takes 36 hours; at 75.2°F (24°C), it takes 19 hours; at 82.4°F (28°C), it takes 13 hours; and at 100.4°F (38°C), it takes only 7 hours to reach pH 5.3. The importance of reaching pH 5.3 within the appropriate degree-hours will be covered under "Principles of Preservation of Shelf-Stable Dried Meat Products."

Fermentation Failures

If the fermentation to a desired pH does not occur within the normal time period, it can be due to a variety of reasons. Generally, if a fermentation problem does occur, it is the result of a total lack of fermentation (the pH does not change from its initial value of 5.6-6.0), a partial fermentation (the pH drops slightly to 5.4-5.6), and/or inconsistent fermentation (variation in fermentation activity from piece to piece or from location to location). The following lists some typical causes for inadequate and/or inconsistent meat fermentations.

No fermentation

- No starter culture added
- No fermentable sugars added
- Excessive salt added
- Starter culture mishandled
    - thawed and refrozen
    - culture premixed with cure, salt, chemicals
- Antimicrobial agents added to formulation
- Antibiotic residues in raw meat

Inconsistent or partial fermentation

- Inadequate distribution of starter culture
- Insufficient fermentable sugars added
- Inconsistent internal product temperature and/or processing temperature and/or humidity
- Reduced fermentative activity of the starter culture
    - out of code product/improper stock rotation
    - mishandled culture
- Antimicrobial agents added to formulation
- Antibiotic residues in raw meat

►New Developments

The sausage manufacturing industry continues to develop new processes and products. High speed fermenting cultures are being developed that result in 4-8 hour processes, compared to multiple-day fermentations in the past. Chemical acidulants are being combined with cultures in new processes. Color enhancing cultures, including

oxygen/peroxide scavengers, are sometimes added to enhance cure color development and stability. New mold and yeast cultures are being used to affect appearance, flavor, and oxidative stability of finished products.

There are also developments with respect to *L. monocytogenes* control, such as a culture blend that "kills" and inhibits via competitive inhibition, bacteriocin production, and reduced pH. This type of culture would generally be used in non-heat-processed products or after cooking.

►Non-fermented products

For whole muscle products, high salt tolerance starter cultures are being developed to provide consistent flavor, *Listeria* control, and improved color. These are added directly to the brine or dry rub. There is more attention on whole muscle products because they generally are not fermented, and thus a large pH decrease with a lot of acid development is not desirable. Starter cultures are used more often to control nitrate reduction/color, flavor, and *L. monocytogenes* in non-cooked items, and to develop a little acid to enhance drying.
Starter cultures are generally not used in the production of jerky. Microbial hazards include *Salmonella*, *L. monocytogenes*, *S. aureus*, and, for beef and venison jerky, *E. coli* O157:H7. The product is heat treated and derives its stability from its cooking (lethality) process and drying to low water activity. If the product receives inadequate lethality treatment and is insufficiently dried, *S. aureus* is a potential hazard, since it can grow at lower water activities than most pathogens.

►Application of Bioprotective Cultures

Bioprotection is the application of lactic acid bacteria to a product in order to control the indigenous flora (i.e., starter cultures to control microflora), without significantly altering the sensory properties of the product. (Traditional fermentation can also be considered a type of bioprotection.) The LAB improve quality by delaying growth of spoilage bacteria and increase safety by inhibiting and reducing growth of pathogens. In addition to traditionally dried fermented products, bioprotection is being applied to a variety of traditionally non-fermented products including raw sausages, cooked ham, sliced meats, dried meats, etc. The added starter culture always controls the product microflora (competitive exclusion) and retards pathogen growth, but the specific affect on product quality depends upon the specific culture used and the formulation and final characteristic of the product.
For not- fully-cooked products such as raw sausages, fermented sausages and whole muscle products, the cultures can be added to the raw meat mix, to the added curing mix (if dry cultures are used) or the liquid brine. For cooked meat products such as frankfurters and cooked ham, the bioprotective cultures are added after the lethality process via spraying onto the product surface.

►Hurdle Concept

The safety and storage stability of processed meat products depends on a combination of several hurdles. The hurdles concept involves combining sub-inhibitory levels of factors that limit microbial growth in a manner that effectively inhibits the microorganisms of concern. Biological competition can be considered a hurdle. Competitive exclusion involves use of desirable competitive microorganisms to inhibit undesirable microorganisms. End-product metabolites (e.g., bacteriocins, lactic acid) from specific microorganisms can inhibit and/or kill competitors. Inhibition can also occur through fermentation (lowering pH to a level inhibitory to other microorganisms).

Bacteriocins are produced by some bacteria as a defense mechanism against competitive flora. These proteins, produced during growth, specifically attack competitors. Low concentrations are needed to produce an effect. For example bacteriocin-producing starter cultures can provide a more effective reduction in *L. monocytogenes* than a normal starter culture. Bacteriocin-producing cultures may also be effective in production of non-acidified products such as dry hams.

Generally competitive exclusion is viewed as a means of controlling growth of another organism; however, use of competitive exclusion cultures that produce bacteriocins can actually reduce the number of the undesirable microorganism, not just control its growth.

SECTION III – BASIC SANITATION OF EQUIPMENT AND FACILITIES

Agreement

Per regulation, when State inspection is granted to an establishment, a responsible plant official agrees to conform to Federal and State regulations and orders pertaining to inspection. The plant official thereby-agrees to produce a wholesome product in a plant that will be maintained in a sanitary condition. **(Food and Agricultural Code, Chapter 4.1. California Meat and Poultry Supplemental Inspection Act, §18970-18977, California Code of Regulations § 927-934, and Article 5, § 1204 Poultry Inspection). California Meat Inspection Regulations, California Code of Regulations and Referenced Federal Regulations, Subchapter 1 of Chapter 4, Division 2, of Title 3, 9 CFR (2006)**

This statement emphatically establishes that plant management has the responsibility to produce clean product in a clean plant under good hygienic conditions. This also includes cooperation with MPESB personnel and providing information necessary for him/her to do a proper inspection job.

This chapter references applicable laws and regulations that obligate each establishment under state inspection to comply with sanitary requirements that should lead to production of wholesome products. Furthermore, this chapter provides only general information and some examples how to create and maintain sanitary environment in state establishment and it is not an intention of this chapter to provide detailed prescription that fits all plants how to accomplish goal of good plant sanitation. MPES Branch employees can offer assistance and better explanation how to create plant cleaning procedures or mandated plant SSOP but it is still plant management responsibility to create and implement SSOP.

Inspected establishments must meet two sets of regulations concerning sanitation: The ***Sanitation Standard Operating Procedures (SSOP)*** requirements and the *Sanitation Performance Standards (SPS).* Compliance with both is necessary if an establishment is to prevent the creation of insanitary conditions that can cause the adulteration of product. Under the SSOP requirements, each establishment must develop, implement, and maintain written cleaning procedures that are conducting daily, before and during operations, to prevent product from **direct** contamination and adulteration. More information about plant SSOP creation and SSOP samples are in the separate chapter of this manual. Each establishment is so unique and requires individual approach to meet these sanitary requirements.

Most of the SPS address conditions within and around the establishment (e.g., ventilation, lighting, facility and equipment construction, and maintenance of the grounds). A few address plant operations and **may** be met through the establishment's SSOP (e.g., cleaning and sanitizing food contact surfaces) or its HACCP plan (e.g., water reuse). SPS are an integral part of the overall public health picture of a facility or a plant. They are used in conjunction with SSOP requirements to ensure that wholesome products are produced in a sanitary environment.

SPS carry as much regulatory weight and enforceability as any other part of MPESB/FSIS's regulatory food safety system. The enforcement strategy, however, is different.

The SPS rule requires the following businesses to operate in a sanitary environment.

- Federal and State inspected meat and poultry establishments
- Import/Export facilities
- Identification (ID) warehouses
- Custom-exempt operations

Each official establishment must have a competent Processing Inspector assigned to be responsible for sanitation requirements. His/her responsibilities include activities as described in the **Sanitation Standard Operating Procedures (SSOP)** and Sanitation Performance Standards (SPS) including but not limited to pre-operational inspection of the plant and equipment prior to the start of operations and inspection activities during operations.

Training

Plant management has the responsibility to train plant supervisors and employees in the hygienic handling of product and other sanitary requirements to ensure cleanliness in the preparation and handling of edible product. **(Food and Agricultural Code §18983)**

Sanitation Performance Standard

Performance standards set the results to be achieved, but they don't prescribe the step-by-step procedures to produce safe meat and poultry products. Simply put, the expected result is defined in the regulation, but the methods to achieve that result are not specified. The performance standards allow establishments the flexibility to develop and employ innovative and unique sanitation procedures to achieve the desired results. Although plants can use varying means to meet the performance standards, the required results are always the same.

Plants must:

(1) Operate under sanitary conditions,

(2) Ensure product is not adulterated, and

(3) Operate in a manner that does not interfere with MPESB inspection and enforcement of the standards.

Sanitation Standard Operating Procedures

SSOPs are written descriptions of the procedures that a meat or poultry processor uses to prevent contamination or adulteration of their product. These include the actual procedures they perform to clean their equipment, utensils and facilities and other procedures they use to insure their product is not contaminated. Meat and poultry processors under Federal or State inspection must meet the specific requirements for SSOP's outlined in Federal Law. These requirements can be found in the Code of Federal Regulations at 9 CFR 416.11 through 416.17.

1. Need for a Plant Sanitation Program.

Experience has shown that without a planned program, plant sanitation is apt to be inconsistent. Regardless of the shift or supervisors involved in cleanup activities, sanitation should be ongoing and consistent. Therefore, a good sanitation program is recommended and should be developed by plant management as a guideline for plant employees to follow. The plant may submit the sanitation program to the IIC for review to determine whether it complies with all applicable rules and regulations.

2. Establishing and Maintaining a Sanitation Standard Operating Procedures (SSOP's) Plant Program.

To develop a good program; the plant should determine what is to be done, how it is to be done, and who is to do it. Most problems can be avoided by proper training of supervisors and employees in effective cleaning techniques and by proper selection and use of cleaning agents, disinfectants, and sanitizers. A good maintenance program keeps gradual deterioration in check, prolongs facilities and equipment life, and makes sanitation easier.

Authority

Proper sanitation is a fundamental requirement of the federal meat and poultry inspection laws that the Agency enforces. The Federal Meat Inspection Act (FMIA) and Poultry Products Inspection Act (PPIA) provide authority, requirements, policies, and standards related to sanitation. The law is quite clear: **Meat and poultry products produced, packed, or held under insanitary conditions where they may have become contaminated with filth or may have been rendered injurious to health are deemed adulterated, without any further showing required by MPIB/FSIS.**

Title 3. Food and Agriculture Division 2. Animal Industry Chapter 4. Meat Inspection Subchapter 1.
Article 3. Facilities for Inspection and Sanitation

§ 902.10. Implementation of Sanitation SOP's.

Each official establishment shall implement Sanitation SOP's in accordance with 9 CFR section 416.13 (2006).

§ 902.11. Maintenance of Sanitation SOP's.

Each official establishment shall maintain its Sanitation SOP's in accordance with 9 CFR section 416.14 (2006).

§ 902.12. Corrective Actions.

Each official establishment shall take corrective actions in accordance with 9 CFR section 416.15 (2006).

§ 902.13. Records Retention.

Each official establishment shall keep and retain records in accordance with 9 CFR section 416.16 (2006).

§ 902.14. Department Verification.

The Department shall verify the adequacy and effectiveness of each official establishment's Sanitation SOP's in accordance with 9 CFR section 416.17 (2006).

SANITATION STANDARD OPERATING PROCEDURES

Reference: 9 CFR 416.11 through 416.17

§416.11 General Rules

Each official establishment shall develop, implement, and maintain written standard operating procedures for sanitation (Sanitation SOPs) in accordance with the requirements of this part.

Sanitation Standard Operating Procedures (SSOPs) are written procedures that an establishment develops and implements to prevent direct contamination or adulteration of product. The establishment must also maintain daily records sufficient to document the implementation and monitoring of the SSOPs and any corrective action taken. The establishment is required to maintain these written procedures on file, and they must be available to FSIS upon request. It is the establishment's responsibility to implement the procedures as they are written in the SSOPs. If the establishment or MPESB determines that the SSOPs fail to prevent direct contamination or adulteration of product, the establishment must implement corrective actions that include the appropriate disposition of product, restoration of sanitary conditions, and measures to prevent recurrence.

§416.12 Development of SSOPs

(a) *The Sanitation SOPs shall describe all procedures an official establishment will conduct daily, before and during operations, sufficient to prevent direct contamination or adulteration of product(s).*
(b) *The Sanitation SOPs shall be signed and dated by the individual with overall authority on-site or a higher level official of the establishment. This signature shall signify that the establishment will implement the Sanitation SOPs as specified and will maintain the Sanitation SOPs in accordance with the requirements of this part. The Sanitation SOPs shall be signed and dated upon initially implementing the Sanitation SOPs and upon any modification to the Sanitation SOPs.*
(c) *Procedures in the Sanitation SOPs that are to be conducted prior to operations shall be identified as such, and shall address, at a minimum, the cleaning of food contact surfaces of facilities, equipment, and utensils.*
(d) *The Sanitation SOPs shall specify the frequency with which each procedure in the Sanitation SOPs is to be conducted and identify the establishment employee(s) responsible for the implementation and maintenance of such procedure(s).*

Establishment Responsibilities

The establishment has the responsibility to develop written SSOPs that contain procedures that the establishment will implement to prevent direct contamination or adulteration of product. It is also required that SSOPs describe the procedures that the establishment will take to prevent direct contamination or adulteration of product. The establishment and inspection personnel should understand that there are not separate SSOPs for different operations or different shifts. The SSOPs cover the entire establishment and all shifts of operation.

These written procedures must:

1. Contain all the procedures the establishment will conduct daily, before and during operation.

2. Identify the procedures to be conducted prior to operations (pre-op) and address, at a minimum, the cleaning of food contact surfaces of facilities, equipment, and utensils.

3. Specify the frequency with which each procedure in the SSOPs is to be conducted and identify the establishment employee or position responsible for the implementation and maintenance of the procedures.

4. Be signed and dated by the individual with overall authority on-site or a higher-level official of the establishment. This signature signifies that the establishment will implement the SSOPs as written and will maintain the SSOPs in accordance with the requirements of this part.

MONITORING

§416.13 Implementation (Monitoring) Requirement

a) Each official establishment shall conduct the pre-operational procedures in the Sanitation SOPs before the start of operations.

b) Each official establishment shall conduct all other procedures in the Sanitation SOPs at the frequencies specified.

c) Each official establishment shall monitor daily the implementation of the procedures in the Sanitation SOPs.

1. Establishment Responsibilities

The establishment is responsible for developing written procedures that are sufficient to prevent direct contamination or adulteration of product. The establishment also has the responsibility for implementing the procedures in the written SSOPs. If the establishment writes a procedure in its SSOP, it must implement that procedure and monitor it daily. In other words, the establishment is responsible for doing what it said it would do.

MAINTENANCE

§416.14 Maintenance Requirement

Each official establishment shall routinely evaluate the effectiveness of the Sanitation SOPs and the procedures therein in preventing direct contamination or adulteration of product(s) and shall revise both as necessary to keep them effective and current with respect to changes in facilities, equipment, utensils, operations, or personnel.

1. Establishment Responsibilities

Before State inspected meat or poultry establishments are permitted to operate, they must develop SSOPs that prescribe sanitation measures to prevent product adulteration or contamination. This means establishments can only speculate about which sanitation measures should be included in their SSOPs to prevent the occurrence of insanitary conditions in their production process. The effectiveness of these measures is unknown initially. Therefore, it is necessary for establishments to evaluate the effectiveness of their SSOPs once they are implemented.

Each establishment has two primary obligations it must meet to comply with the requirements for the SSOP maintenance regulation.
The first responsibility requires establishments to evaluate the effectiveness of all SSOPs that have been implemented in their production operations and the second requires that the company revise the SSOP as needed in order to ensure that it is reflective of the operation and that the SSOP is effective. This regulatory requirement encourages establishments to develop a system for the evaluation of their written SSOPs in order to prevent direct contamination or adulteration of product.
Although establishments must identify the members of their management team who will be responsible for implementation and evaluation of their SSOPs, they are not required to identify the method the individuals employ to perform the evaluations. The methods used within the establishment's evaluation system will vary from one plant to the next. The regulation only requires that establishments perform an evaluation of the effectiveness of their SSOPs; it does not dictate how establishments should perform this evaluation. The establishment must sign and date the SSOPs any time modifications are made. However, there is no regulatory requirement that the plant personnel notify MPESB inspection personnel of the change.

CORRECTIVE ACTION

§416.15 Corrective Action Requirement

(a) *Each official establishment shall take appropriate corrective action(s) when either the establishment or MPESB determines that the establishment's Sanitation SOPs or the procedures specified therein, or the implementation or maintenance of the Sanitation SOPs, may have failed to prevent direct contamination or adulteration of product(s).*
(b) Corrective actions include procedures to ensure appropriate disposition of product(s) that may be contaminated, restore sanitary conditions, and prevent the recurrence of direct contamination or adulteration of product(s), including appropriate reevaluation and modification of the Sanitation SOPs and the procedures specified therein or appropriate improvements in the execution of the Sanitation SOPs or the procedures specified therein.

1. Establishment Responsibilities

These regulations require the establishment to take corrective actions when either the establishment or MPESB determines the **SSOP failed to prevent direct product contamination or adulteration.** Regardless of the type or cause of the failure, corrective actions must be taken. There are three parts to corrective action and all three of these requirements must be met and recorded each time product contamination occurs. The corrective actions include appropriate disposition of product.

NOTE: Most of the time product will not be involved during pre-operational sanitation monitoring. When the establishment finds direct food contact surfaces that are unclean during its monitoring of pre-operational sanitation and cleans the surfaces before product passes over that surface, there is no noncompliance. In these situations, FSIS believes the establishment's SSOP has worked as intended.

The establishment is not required to notify inspection personnel when product contamination occurs, but has the responsibility to implement corrective actions that will meet the requirements of §416.15.

The establishment should take full responsibility for the corrective actions meeting the three requirements of the regulation.

Those three regulatory requirements are:

Appropriate **Disposition** of products that may be contaminated;

Restoration of sanitary conditions;

Prevention of recurrence of direct contamination or adulteration of products.

RECORDKEEPING

§416.16 Recordkeeping Requirement

(a) *Each official establishment shall maintain daily records sufficient to document the implementation and monitoring of the Sanitation SOPs and any corrective actions taken. The establishment employee(s) specified in the Sanitation SOPs as being responsible for the implementation and monitoring of the procedure(s) specified in the Sanitation SOPs shall authenticate these records with his or her initials and the date.*

(b) Records required by this part may be maintained on computers provided the establishment implements appropriate controls to ensure the integrity of the electronic data.

(c) Records required by this part shall be maintained for at least 6 months and made accessible available to FSIS. All such records shall be maintained at the official establishment for 48 hours following completion, after which they may be maintained off-site provided such records can be made available to MPESB within 24 hours of request.

1. Establishment Responsibilities

§416.16 require the establishment to maintain **daily** records sufficient to document the implementation and monitoring of the SSOPs and any corrective actions taken. The establishment must have records documenting that monitoring has been conducted daily for each of the procedures specified in the SSOPs. If the establishment has specified a monitoring frequency in the SSOP that is more frequent than daily, the documentation would have to reflect that the monitoring activities had been conducted at the specified frequencies. The establishment employee specified in the SSOPs as being responsible for the implementation and monitoring of the procedures shall authenticate these records with initials or signature and the date.

There must also be a written record of any corrective actions required by §416.15. These records must be maintained daily. **The establishment has until the beginning of the same shift the following business day to complete these records.**

§416.16(b) provides the establishment the flexibility to maintain these records on a computer system provided the establishment implements appropriate controls to ensure the integrity of the electronic data.

The records must be kept on-site for 48 hours and must be maintained for at least 6 months. After the initial 48 hours, the records may be kept off-site as long as they can be retrieved for a program employee within 24 hours of the request.

Functions of Inspectors: **Processing Inspectors** must function as **sanitarians**, in addition to their other duties, in plants in which they are employed as inspectors. The importance of the part that good plant sanitation plays in the production of **clean wholesome meat/poultry products** in a **sanitary environment** cannot be overemphasized. In order for inspectors to function adequately in the field of sanitation, they must understand and use the information concerning bacteriology contained in section II of this handbook. They must have a thorough knowledge of the plant, its equipment, methods of operation, and approved tools, methods used in the cleaning process and proper sanitation inspection procedures.

a. **Frequency** of Sanitary Inspections: The **PI** inspecting plant sanitation is required to make a thorough **pre-operational sanitary** inspection of the plant **prior to start of operations** (when processing State inspected products those--products that have approved formulations/labels) and its **operational sanitation** at a minimum once **daily.**

b. **Technique** of Inspection: The **PI** should have a flashlight, green "Reject"/"Retained" tags and the Monthly Sanitation Report. Processing inspector performs **organoleptic** inspection making use of his/her sense of **sight, feel and smell**. Surfaces of equipment should **feel clean** to the touch. Even though a slight film left on equipment is not readily seen, it is quickly detected by the sense of feel when the hand is passed over it. The inspector's sense of sight quickly tells him whether the plant is in order (**looks clean).** The sense of smell **(smells clean)** will also quickly inform the inspector if there is any spoiled product stored on the premises or some organic residue such as blood being left on equipment due to insufficient cleaning. The inspector's sense of smell as well as sight will quickly lead him to the source of trouble.

c. **Preoperational** inspection should be planned to start at the point where the plant operations begin and should follow the path of the flow of product. This often permits the cleaning or re-cleaning of items of equipment or rooms found to be in an unsanitary condition without undue delay of the plant's operations. The inspector should be thorough and follow the same routine each day in making sanitary inspections. Plant personnel and cleanup crews soon come to know the inspector that is lax and consequently will slight areas of cleanup where they know the inspector seldom looks.

d. **Operational** - Processing Inspector must perform an operational sanitary inspection of the plant as described in the plant's **SSOP**, as well as being alert for any insanitary condition that may develop during operations. These inspections must be **performed at a minimum of once** daily. Most processing in the state inspected establishments is done under room temperatures and due to that all equipment on which edible products are handled, or come in contact with, is recommended to be cleaned and sanitized every 5 ½ hours of operations. The importance of providing sanitary surroundings and sanitary processing equipment in processing plants cannot be over emphasized. Remember the growth and feeding habits of bacteria.

Essentially, the meat processing plant is an extension of the consumer's kitchen. The consumer is inclined to judge each product by the portion they buy. A product that is clean, well preserved, and free of visible defects will keep them going back to the store and asking for the same brand. Obviously, consumers do not have available to them the knowledge of processing conditions to determine the **sanitary quality** of the meat/poultry products purchased and must rely on plant management and employees, licensed **Processing Inspectors (PI)** and the Meat, Poultry and Egg Safety Branch.

Plant management is responsible for cleaning and sanitizing, of all meat plant equipment(s), tools and parts of the premises that are integral parts of good plant sanitation plan. Cleaning and sanitizing should take place on daily basis to assure that only cleaned and sanitized plant is in operation. Plant cleaning can even be considered as **one of the most important activities in the meat plant**, as these measures provide the necessary environment for proper meat handling and processing. It is highly recommended that manager or designated person will regularly check if cleaning and sanitizing procedures are conducted as described in SSOP using the chemicals in the way recommended by manufacture to accomplish the desirable sanitary result.

Efficient meat plant cleaning and sanitizing is often neglected as it requires extra work and the positive effects are not immediately visible. However, failures in meat plant hygiene can cause high financial losses in the long run. **Unhygienic** conditions in a meat plant result in;

- **unattractive, tasteless products**
- **spoilage of valuable food** and/or
- **food-borne diseases**

Proper cleaning and sanitizing is becoming increasingly important in modern meat processing as more **perishable and hygienically sensitive meat products** come on the market, particularly convenience foods such as pre-packed portioned chilled meat, vacuum-packed sliced sausage and ham products, meat products in controlled atmosphere packages etc. The microbial load of such products must be low to guarantee adequate shelf life and to avoid spoilage during distribution.

Facilities and equipment have closely associated requirements: Both **require prior approval** by the *MPIB*, both *must* be constructed of approved materials, and both *Must* be susceptible of being readily and thoroughly cleaned and maintained in a sanitary manner.

Any problem with facilities or equipment will very quickly affect the ability of the establishment to maintain a sanitary plant environment. One method of ensuring the proper design and construction of the establishment is the requirement that **blueprints be approved** by the *MPIB Prior* to construction of or significant modification of a facility.

Cleaning is a process of **removal all visible dirt, rust, lubricating compounds and all organic substances**, such as fat, blood and other protein particles from surfaces of walls, floors, tools and equipment. Through the cleaning procedures, high numbers of microorganisms (90% and more) present on the mentioned objects will be removed. A piece of equipment that is “clean” - looks clean, smells clean, and feel clean.

However, many microorganisms stick very firmly to surfaces, in particular in tiny almost invisible layers of organic materials, so called *biofilms*, and will not entirely be removed even by profound cleaning but persist and continue multiplying.

It is very important that cleaning chemicals are strictly used according to the specifications given by the manufacture.

Sanitizing is followed cleaning. It is a process of applying a sanitizer on cleaned surfaces of plant equipment or other parts of the establishment (walls, floor, personal tools etc.) with the purpose to inactivate (**kill or reduce)** the number of **microorganisms that survived cleaning.** Inactivation of those microorganisms requires antimicrobial treatments, carried out in food industries through *hot water* or *chlorine solution* or through the application of other *sanitizers*. These sanitizers are chemical substances, strictly used according to the specifications given by the manufacture to kill/reduce microorganisms and should not affect human health through hazardous residues.

When starting **cleaning** and **sanitizing measures** all **food products, ingredients and packaging material** must be ***removed*** from the area because:

- Physical cleaning with pressurized water may stir up dirt or produce contaminated water droplets (aerosol), which could contaminate meat, present in such rooms.
- Chemical cleaning/sanitizing may produce toxic residues when in contact with remaining meat or meat products.

Cleaning Tools, Detergents and Sanitizing Agents:

a. **Steel Wool:** Steel wool is NOT **approved** for use in food processing plants. Small bits of the steel wool are prone to break off and contaminate the equipment and may find their way into the product. If these bits of metal should be ingested by the consumer, severe gastric disorder could result. In addition, steel wool often rusts and cannot be completely cleaned of the organic material it picks up during use.

b. **Metal Sponges**: These scrubbing tools are fabricated from large strips of metal and if broken off the pieces are readily seen and removed from the equipment. Therefore, there is little danger that they may contaminate the product and be ingested by the consumer.

c. **Cloth Towels and Rags**: The use of cloth towels and rags **is prohibited** in any cleaning process. They pick up and retain bacterial laden organic matter, bacteria and do little more than distribute them evenly around the equipment. They are seldom cleaned after use and become a source of off odors in the plant as well as a source of contaminants.

d. **Disposable paper:** towels may be used when desired, provided they are discarded after each use.

e. **Brushes**: of either fiber or synthetic bristles should be used for scrubbing equipment. They should be of such quality that they hold their bristles under hard usage. The use of nylon bristled brushes with hot water is not recommended due to the heat softening the bristles until they are of little use.

f. **Scratch/scouring (green) pads:** acceptable provided they do not fragment, leaving pieces on equipment, they should be readily cleansed of organic material or be disposed after each use**.**

Cleaning tools can be an important source of bacterial contamination of equipment and product. They must be kept clean and sanitized frequently and must be replaced when they become so worn out that they are not effective and cannot be properly maintained.

Detergents are used to "clean" facilities and equipment. An effective detergent should have the following properties:

1. Be noncorrosive to surfaces on which they will be used.
2. Have good wetting ability.
3. Have the power to emulsify and suspend soils such as grease or oils in solution.
4. Be able to dissolve organic and inorganic solids.
5. Be easily rinsed from surfaces.
6. They should **not** contain any masking **odor or perfume**

Detergent Classification:

1. **Strongly Alkaline**: These detergents are highly effective in dissolving fats, oils, protein residue and other organic deposits, and are moderately effective in removing burned or dried on material. They have the disadvantage of being corrosive to tin, aluminum, and oil based painted surfaces. They cause deterioration of wood and many fabrics. In addition, they are difficult to rinse from surfaces. Examples: lime, sodium phosphates

2. **Mildly Alkaline**: Mildly alkaline detergents are effective in removing many deposits and have the advantage of being either noncorrosive or only slightly corrosive to painted surfaces and most metal encountered in food plants. At concentrations employed for ordinary cleaning, they do not constitute a hazard to personnel using them. Examples: most soaps and general-purpose detergents.

3. **Strongly Acid:** Strong acid cleaners are highly effective on both organic and inorganic matter, but their use is recommended for very difficult cleaning jobs only Strong acid cleaners are dangerous to both personnel and equipment. Examples: Phosphoric acid, hydrochloric acid, sodium bisulfate.

4. **Mildly Acid**: Mild acid cleaners are usually satisfactory for removing deposits left by hard water and are relatively noncorrosive to most metal surfaces.

**All detergents used in State inspected establishments must be used strictly for the purpose they were made for and according to manufacture recommendations and specifications.*

Sanitizers

Sanitizing Agents are used to reduce in number/kill or remove bacteria remaining on facility and equipment after cleaning. A "sanitized" piece of equipment is one that has been cleaned and that treated with a sanitizer to kill/reduce bacteria.

1. **Hot Water** must be at least **180 degree F**. at the point of contact with the surface you wish to sanitize to be effective **sanitizer.** Used as a rinse after cleaning, it has the advantage of effectively removing soils taken into solution in the cleaning process and destroying any bacteria on the surface through heat. In most cases hot water dries rapidly from surfaces, thus removing one of the elements which bacteria need to multiply. However hot water can easy create steam leading to unwanted condensation on walls, ceiling, equipment etc.

2. **Chlorine:** Clear solutions of 50 to 200 parts per million of available chlorine are very effective as sanitizers. Many detergents have chlorine combined with them in one form or another to clear solutions of available chlorine in proper strengths. Since **organic matter and heat inactivate chlorine,** the chlorine solution must be made always with cold water and applied to clean cool surfaces to be effective.

*Even when **in-plant chlorination** of the water supply is available, this should **never be used** as a **substitute** for a good sanitation program. There is no substitute for thorough cleaning and rinsing with clear hot water. In-plant chlorination is highly effective in reducing the number of bacteria present during processing and its use for this purpose is recommended.*

3. **Steam**: ***NOT recommended as a sanitizer***. Steam is often used in the **mistaken** belief that it is a **good sanitizing agent.** While steam is an effective sanitizer as it issues from the nozzle of the steam hose, it loses its effectiveness just a few inches from the nozzle. Steam under pressure is also useful in the removal of heavy deposits of organic matter from equipment before cleaning and sanitizing.

4. **Other Sanitizing Agents**: There are many other chemical sanitizing agents, such as e.g. those derived from **iodine** and **quaternary ammonium** products. Some of them required to be rinsed off the equipment after being used and others don't require rinsing.

***In general all sanitizers should be approved prior to use.** To accomplish the purpose of sanitizing they must be applied only on cleaned surfaces and must be applied according to the manufacture's recommendations. It is advisable to contact Branch to insure any chemicals (cleaners and sanitizers) to be used in the plant are acceptable.*

Storage of Cleaning Tools, Detergents and Sanitizing Agents: A special **storage** place in the plant, **away from** contact with **edible products**, is to be provided for these items. All cleaning tools, brushes, etc., should be cleaned and sanitized and hung on racks to dry after use. Detergents and other chemicals used in the cleaning of the plant should be stored in tightly covered, properly labeled containers. There should be no possible contact between these items and the edible products or the raw products used in the manufacturing processes. All hoses should be stored on hose racks off the floor.

Good plant **sanitation** is essential in the production of wholesome meat/poultry products. It also results in more efficient operations, better workmanship, fewer accidents, and in greatly improved consumer/industry relations.

How to carry out plant cleaning and sanitizing;

Please note that more detailed information about after work cleaning procedures (plant cleaning and sanitizing) is provided in the SSOP Requirements chapter.

General

a. Outside premises: All refuse/inedible material to be picked up daily and placed in refuse containers or be burned in an incinerator. There should be no used cardboard boxes piled outside. These boxes and liners of these boxes contain organic matter and provide food for flies and other vermin. Outside premises should be kept reasonably free of clutter to promoted frequent cleaning. Unused equipment stored outside should be stored on racks or pallets in a manner that will permit the circulation of air around and under it. Tall grass and weeds to be eliminated. This prevents it from becoming a harborage for rodents and other vermin.

b. Cleaning of Plant and Equipment: It is required that the plant and equipment be **cleaned prior to start** of each day's operations in the way described in the establishment's **written** Sanitation Standard Operating Procedure (**SSOP).**
Most establishments conduct plant cleaning and sanitizing right after processing in the plant is finished for a day. It is an easiest way to clean plant and highly recommended by the Branch. However, the cleaning also can take place just before operation starts as long as it produces cleaned and sanitized plant to operate. Cleaning is a plant management responsibility but must be verified and checked for accuracy (findings must be recorded) before each day of operation by the licensed PI.

Preconditions for efficient cleaning and sanitation are:

- Premises and equipment must be "cleaning-friendly", which means
  - easy and practicable access to all contaminated areas,
  - smooth surfaces and adequate materials for building structures and equipment to be cleaned.
- Proven methods for meat plant cleaning and sanitizing must be available.
- Acceptable cleaning and sanitizing chemicals used
- Personnel must be regularly instructed and trained how to properly clean, sanitize and keep good sanitary conditions.

When to use the REJECT/RETAINED tag

When the **Processing Inspector** notes some piece of equipment that is unsanitary, he should attach a **green** "Reject" tag until it has been properly cleaned. This prevents its use before cleaning. The use of "Reject" tags is particularly important on pieces of equipment that are not needed for immediate plant operations and are shunted aside for later cleaning. During the inspection, if the inspector notes any product that may need some further attention to place it in an acceptable condition, such as that packed in inadequate containers, the green "Retained" tag should be attached until it is placed in an acceptable condition. Of course, any spoiled or contaminated products should be immediately condemned and denatured. The use of a "Reject" / "Retained" tags is not intended as punishment of plant management, but it is simply one of the tools an inspector uses to make sure that the plant and equipment are sanitary when used and that the products processed therein are clean and wholesome when offered for sale.

A. Rejected/Retained Tag **(Red in color**) (79-107)

1. Used to tag unsanitary or otherwise unsatisfactory equipment or facilities **(Rejected**), or to hold product, packaging material, non-meat product ingredients, etc., pending re-inspection and/or disposition (**Retained**).

2. Applied and removed, following re-inspection and disposition, **only by Branch employee.**

B. Rejected/Retained Tag (**Green in color**) (79-107A)

1. Used to tag unsanitary or otherwise unsatisfactory equipment or facilities (**Rejected**) or to hold product, packaging material, non-meat product ingredients, etc, pending re-inspection and disposition (**Retained**).

2. Applied and removed, following re-inspection and disposition, by **Branch employee or Processing Inspector (PI).**

THE ACCEPTABLE STANDARDS

CLEAN—an article that is free of dust, dirt, grease, and any other foreign matter and is clean to the sight, touch and smell. Organoleptically clean.

SANITARY—free from dirt, filth and contamination, and free from any other substance or organisms (e.g. bacteria), which are, know to be injurious to human health or which would render the product adulterated.
The failure of most written Sanitation Standard Operation Procedures (SSOP) is that they are not written with sufficient detail or specifics to completely explain and reflect the establishment's actions or activities as related to sanitation. The written (narrative) Sanitation Standard Operating Procedure (SSOP) describes the what, when, where, and how often directed/detailed actions, activities, observations and recordings are taken by specified personnel.

The written SSOP plan must describe the PROCEDURES the establishment will conduct before and during operations and the FREQUENCY at which they will be conducted to prevent direct contamination or adulteration of products(s).

PROCEDURE; is a particular way of doing or going about the accomplishment of something.

FREQUENCY; is the number of repetition of a periodic process (procedure) in a unit of time.

The statement of "All equipments are disassembled as necessary", IS NOT A PROCEDURE. It must be explained what is the procedure. For example "complex equipment requiring disassembly is disassembled to facilitate cleaning/sanitizing and to exposed product contact surfaces for pre-operational sanitation inspection.

The statements of "clean as necessary", "if necessary", "as needed" and "when needed" ARE NOT FREQUENCIES.
The procedures and frequency of the SSOP are a combined proactive approach to eliminate the "necessary" and "needed", therefore the procedures must be defined and the frequencies stated to be valid operational procedures.

"If needed" or "as necessary" are not preventive procedures as the increased potential for product contamination or adulteration directs the "needed/necessary" actions/activities due to inadequate procedures or insufficient frequencies.

The narrative must be as detailed as reasonably possible to fully dictate actions or activities to be taken necessary to ensure expected results and compliance with regulatory requirements.

In summary write procedures, actions/activities in detail that the establishment takes to prevent product contamination/adulteration before and after the start of operations and state the frequencies at which they will occur and by whom the will be accomplished, monitored and documented. Simply stated the narrative says what is to be done and checklists prove it was done. These are the basic elements of a procedure/program.

DOCUMENTATION (checklist) is the sole supportive presentable evidence of acceptability of the intentions of the narrative.

Documentation is the quantitative validation and verification of the results of any action or activity taken. It is of the utmost necessity for all programs and procedures to ensure stated expectations are achieved.
The documentation must reflect the narrative's detail to ensure the directed actions and activities are sufficient to achieve the expected results. One size does not fit all.

A checklist with detail allows for one person to begin and if interrupted for another person to take up where the first person left off and finish with assurance that nothing was overlooked.

The primary function of a checklist is to assure that the stated results of the narrative are achieved. It also insures that the actions and the activities of the narrative are implemented, maintained and are sufficient to achieve acceptable results.

An additional function of a checklist is that it provides an opportunity for discovery of trends and patterns through historical (periodical) reviews of the documentation that may result in changes in the narrative to correct the repetitive deficiency.

ACCEPTABLE means to have achieved stated goals it does not mean perfect.

UNACCEPTABLE means stated goals have not been achieved it does not mean failure. There is always room for improvement.

The inherent mission statement of an SSOP is "to produce a clean and wholesome product, in a sanitary environment".

The "decision tree" for any action/activity related to producing a meat/poultry product is simply does this action/activity contributes to the mission statement?

If the answer is yes,(acceptable), continue !
If the answer is no, (unacceptable) cease and desist, take corrective action!

CORRECTIVE ACTIONS normally mimic action or activity already stated in the narrative and they remain over time repetitively the same without, if possible, preventive measures being implemented.

PREVENTIVE MEASURES are usually initiated because of documented failures discovered while using a checklist and they have the possibility of being implemented and incorporated into the written procedures

In summary if it is not documented as acceptable it is to be considered unacceptable and any unacceptable, documented or undocumented are to result in corrective actions and if possible preventative measures being taken.

When corrective actions are taken due to the contamination/adulteration of product as a result of inadequate procedures or insufficient frequencies the written SSOP must be modified to prevent the reoccurrence of contaminated/adulterated product. This modification results in new procedures or increased frequencies.

Establishments are required to take all possible preventive measures (that are reasonable and prudent) to prevent product contamination and/or adulteration.

REASONABLE; being in agreement with right thinking, not absurd, not ridiculous, not extreme nor excessive

PRUDENT; to foresee, to provide, the use and development of resources

The intent of the SSOP is to maintain acceptable sanitation standards as related to all aspects of meat/poultry food products and production at official establishments.

NOTE;

SEE SAMPLE SSOP

Cleaning and sanitizing procedures in the meat industries are complex processes depending on the **surfaces to be treated** and the kind of **contamination to be removed**. More complicated pieces of equipment must be disassembled for cleaning. Selection of suitable **chemicals** may require some knowledge as efficient cleaning and sanitizing is of utmost importance for product quality and safety.

CLEANING TECHNIQUES

Physically removal; The first step in floor and equipment cleaning is to physically remove scrap, i.e. coarse solid particles (inedible material)), with a brush or broom and shovel and stored it in clearly marked as INEDIBLE enclosed containers under refrigeration if kept over 24 hours prior to removal from the premises to rendering plant. These containers shall be cleaned after each use or before being brought back into the plant.

Rinse or high pressure rinse; High pressure water is efficient for surface cleaning. It serves for the removal of remaining small solid parts, blood and dirt from the entire floors and walls of processing sections as well as for the removal of meat and fat particles and layers of protein from tools and equipment.

Manual cleaning; More profound clean-up procedures require **water** in sufficient quantities. Manual cleaning using brushes or scrapers is widely applied in small-scale operations although labor and time-intensive. **It is absolutely essential that this cleaning step as well as the previous one is not done with hot water that could easy cooked all organic matter on the equipment and make it difficult to clean.**

Higher pressure cleaning; It is method commonly used in the meat industries. The pressurized water is applied by high pressure units and special spraying lances. If warm water is used, the temperature should be 120°C at the nozzle in order to achieve sufficiently high temperatures at the surfaces, in particular for fat removal. Cleaning with equipment producing a **pressurized steam/water-mix** is even more efficient. The **disadvantage** of this method is the intense fog and aerosol formation, which may not only cause unwanted **microbial spreading** by water droplets (aerosol) but also affect installations and equipment through high humidity and excessive condensation. For these reasons a steam/water-mix is not suitable for meat processing facilities and cold or hot pressurized water cleaning is preferred. Please note that usage of the high pressure water in cleaning if not done properly may create additional problems therefore it is not recommended for all plants.

Chemical cleaning; The removal of loose dirt and meat/fat residues by water does not mean that the cleaning was complete. Sticky or encrusted layers of fat or protein will still exist and must be removed. For this purpose chemical cleaning solutions can be very effective. Application can be by hand using brushes for dismantled equipment or in general for smaller surfaces to be cleaned. Mechanical cleaning with high pressure equipment together with cleaning solutions is used for larger floor and wall areas as well as working tables, containers and equipment.

Traditional cleaning substances for manual use are **alkaline**, such as sodium carbonates (Na_2CO_3, washing soda). These substances are efficient in dissolving proteins and fats, but may cause corrosion in tools and equipment, if their **pH** is 11 and above.

Chemical cleaning; Commercially available cleaning agents in modern cleaning practices are complex compositions of **alkaline, acid or neutral** chemical substances. In order to improve their dirt loosening properties, surface-active agents, also called **surfactants** or **detergents** are added. Detergents decrease the superficial tension of water. Water can then penetrate into the small spaces between dirt particles and surfaces, where those particles are attached, thus facilitating their removal. For fat removal by pressurized hot water, cleaning detergents are important as they keep the fat dissolved and prevent fats settling down after the water temperature has decreased. It is important that manufacturers indicate the type of the substance, an alkaline, acidic or neutral on the product label.

General Sanitation:

The plant and plant premises must be cleaned as stated in the plant's SSOP. The cleaning of production areas floors, floor drains, walls, and ceilings must be identified. Overhead fixtures such as lights, pipes and overhead conveyors must be cleaned. There is a separate chapter that deals with SSOP. SSOP should be specific to each facility where meat or poultry products are produced or processed. Various cleaning schedules, including daily, weekly, monthly and annual duties, should be integrated to provide a well - rounded sanitation plan.

Remember, one grain of dust sifting down from these fixtures can carry thousands of bacteria.

1. **Utensils** must be cleaned and sanitized and stored on racks in a manner that will permit them to dry. Employees should not be permitted to take favorite knives, scissors, etc. home with them. If this practice is permitted, some of these utensils will not be properly cleaned or will often be re-contaminated in transit.

2. **Containers,** pans, etc., must be cleaned and sanitized and stored in a manner that will permit them to dry. Any bacteria that may remain on such equipment cannot multiply without moisture. It is for this reason that regulations forbid the nesting of pans.

3. **Equipment** over which edible products pass or come in contact (product contact surfaces) must be cleaned and sanitized every four hours and be rinsed with hot water every two hours during processing. This is usually accomplished during break periods. This takes advantage of the "lag phase" in the growth of bacteria. All equipment should be rinsed with hot water prior to resumptions of operations to remove any dust, dirt that may have collected on it during the night.

General Sanitation non-production areas:

1. **Toilets and dressing rooms** must be cleaned and kept clean. Aprons, boots, etc., must be cleaned before storing and stored in a manner that will permit them to dry. Hand washing basins, both in toilets and in processing rooms, must be cleaned and kept clean. Employees will seldom use a dirty hand wash basin or one in which unused utensils are stored. Clean toilets, dressing rooms, and hand washing basins encourage employees to practice sanitary personal habits. Garments and hats shall not be worn outside the production area. All processing workers upon immediately entering the production area from outside areas of the plant must wash and sanitize their hand before resuming product handling.

2. **Dry storage areas;** must be clean and dry. Any spilled grains, flour, cornmeal, rice, etc., must be swept up and disposed of. Spilled cereal grains are an open invitation for rats, mice and other vermin to enter the plant. Cereal grains that have become wet and left to sour will draw flies in large numbers. **Product ingredients** stored in these rooms must be stored in a manner that will permit cleaning, if on pallets they must be frequently moved or if on **racks 12 inches off the floor. Labeling and packaging materials** must be stored in a manner that will protect them from dust, dirt, any vermin that may gain access to the plant, and from contamination from cleanup activities. It is recommended that all product ingredients are stored in tightly closed containers.

3. **Coolers** must be clean and free from mold and objectionable odors. Products stored on pallets must be frequently moved if on **racks** or shelving **12 inches off the floor** to protect them from water that may collect on the floor or which may back up into coolers from clogged drains. (Inspectors who note standing water on cooler floors or clogged drains should immediately notify the proper supervisory personnel and require that the condition be corrected.).

Cooler temperatures must be maintained at 40^{o} Fahrenheit or below with free air circulation around stored products. As the keeping of perishable product constantly under the right temperature inside the cooler is important, it is recommended that temperature measuring devices be checked regularly for accuracy

Freezers; must be clean and free from excessive ice buildup. Products stored on pallets must be frequently moved if on **racks** or shelving **12 inches off the floor.** All products to be stored in secondary containers **no exposed product**.

SECTION IV – SANITARY PRODUCT HANDLING

General: Further processing is defined as any process that changes the conformation or characteristics of meat/poultry. **Processing plants** must exceed sanitary requirements of those for slaughter plants due to the nature of the finished product. In addition, processing plants, depending on the type of operations and products produced [generally **Ready-To-Eat (RTE)],** present some special problems to the inspector, some of which are dealt with in this section.

a. The sanitary handling and processing of processed meat/poultry products is an absolute must if the Branch is to accomplish its primary purpose of "Protecting the Health of the Public." Every effort must be made by each plant employee and Branch Inspectors to eliminate bacterial contamination of the products produced and to prevent the growth of those bacteria that are unavoidably present in or on the product. **Note**: Recommended cooking temperatures destroy bacteria but won't destroy their toxins.

b. Each plant is an individual problem. Due to the wide variety of products produced and the production methods utilized, and different layouts of each plant no set rules can be formulated to cover every situation which the inspector may encounter. **Processing Inspectors** must use their ingenuity, keeping in mind those facts concerning bacteria as set forth in section II of this manual, how they affect the product, and the possible effect on the consumer.

c. In order for the **Processing Inspector** to effectively carry out his duties, he must familiarize himself with every aspect of the operation under his jurisdiction: the physical layout of the plant; equipment in use and how it operates; processing methods and formulas in use; any quality control methods in use; sources and methods of handling raw materials; methods in use for storage and distribution of finished products; in fact, anything and everything that may have some effect on the sanitary quality of the final product.

   The **Processing Inspector is responsible** for inspecting every aspect of production and to set an example for other coworkers to follow, from the receipt of raw materials, sanitation and sanitary operating procedures, on through manufacturing processes until the final product is produced, stored and sold from the plant. Regular food safety and sanitation training is highly recommended for all production workers.

d. The major factors contributing to filth and poor sanitation in a food plant are:
   - Human behavior
   - Personal hygiene
   - Improper dress
   - Worker health
   - Inadequate supervision of personnel (work habits)
   - Flies, rodents and other vermin
   - Dirty equipment and utensils
   - Condition of raw materials used in the product and their storage and handling
   - Insanitary processing procedures

Improper storage, chilling, handling, and shipment of finished product
Insanitary toilets and dressing rooms

e. After a study of this section on processing, keeping in mind the few basic facts concerning bacteriology contained in section II of this manual, **Processing Inspectors** can readily see the necessity for constant vigilance in processing plants. In order to maintain effective inspection in further processing, **P.I.'s** are to give attention to the following:

1. Inspection of all materials received.
   a. meat product ingredients
   b. non-meat product ingredients
   c. packaging and labeling material

2. Sanitary handling and storage of raw materials.

3. The maintenance of sanitation and temperature controls throughout product storage, processing and distribution.
   a. Chilling should begin within 90 minutes after the cooking cycle is completed. All product should be chilled from 120°F (48°C) to 55°F (12.7°C) in no more than 6 hours. Chilling should then continue until the product reaches 40°F (4.4°C).
   b. The product should not be shipped until it reaches 40°F (4.4°C).

4. Exercising control over personnel regarding personal hygiene, sanitary work habits, and cleanliness of dress.

5. Detection and elimination of possible sources of contamination of raw and finished product, in addition to cross contamination between raw and cooked products.

POST-PROCESSING HANDLING AND SANITATION

Establishments need to control their processes to prevent contamination of product with pathogens from product handling after the lethality step.

Cross-contamination of product can occur from situations such as the following:

1. Use of the same equipment (e.g., grinders or mixers) for both raw and cooked products without complete cleaning and sanitizing of the equipment between production lots.

2. Placing cooked product on the same surface (e.g., cutting table) as raw product without complete cleaning and sanitizing of the surface before reuse.

3. Using the same utensils or containers (e.g., scoops or buckets) for both raw and cooked product.

4. Condensation, aerosolization, or dusting of dry ingredients into the processing environment.

It is the establishment‘s responsibility to maintain sanitation in the RTE area to ensure that food contact surfaces are free of contamination from pathogens such as *Lm* and *Salmonella*.

In addition to equipment sanitation, the establishment should address the following sanitation issues:

1. Employee hygiene
Washing hands upon resuming duties after breaks and before putting on gloves.

2. Wearing separate or color-coded frocks in RTE areas of the establishment and controlling employee traffic between raw and RTE production areas.

3. Training employees in proper hygiene practices, and monitoring their practices.

4. Separation of raw and RTE production areas.

5. Completely separating the processing areas by time or space (e.g., scheduling raw and RTE processing on different days).

6. Installing separate air ventilation systems that are designed to prevent or minimize condensation and other potential air contaminants. If separate ventilation systems are not feasible, then ensure that air flow is directed from the RTE areas to the raw areas.

7. Using separate equipment for RTE and raw processing. If this is not possible, schedule use of equipment first for RTE processing and then for raw processing.

8. Restricting movement of personnel to and from the non-RTE area during RTE processing.

9. Establishing procedures for moving equipment from a non-processing area to an RTE processing area to prevent product contamination from the equipment during operation.

10. Avoiding passing raw product through RTE areas and passing RTE product through raw production areas.

11. Not allowing RTE product to come into contact with raw products or surfaces that may be contaminated in coolers.

A cabinet used for the storage of food ingredients, or a cabinet that is used to store cleaned and sanitized equipment, utensils, laundered linens, and single-service and single-use articles may not be located:

(1) In locker rooms;

(2) In toilet rooms;

(3) In garbage rooms;

(4) In mechanical rooms;

(5) Under sewer lines that are not shielded to intercept potential drips;

(6) Under leaking water lines including leaking automatic fire sprinkler heads or under lines on which water has condensed;

(7) Under open stairwells; or

(8) Under other sources of contamination.

Product must be protected from adulteration during processing, handling, storage, loading, and unloading at and during transportation from official establishments.

EMPLOYEE PRACTICES

1. Employees with diagnosed communicable disease (like tuberculosis, which is transmissible from person to person or by indirect means), shall be excluded from the food facility/preparation of food.

2. Gloves shall be worn if an employee has cuts, sores, rashes.

3. No employee shall commit any act that may contaminate or adulterate food, food contact surfaces, or utensils.

4. No employee shall eat, drink, or smoke in any work area.

OPERATIONS

1. Hand washing soap and paper towels shall be provided in dispensers, dispensers to be maintained in good repair.

2. All chemical substances such as detergents, bleaches and other cleaning compounds shall be stored separate and far away from food, utensils, packaging materials and food contact surfaces.

3. Food contact surfaces/ utensils shall be cleaned and sanitized each time there is a change in processing, between different animal products, produce and ready-to-eat foods and a least every 4 hours.

4. All processing plant employees are required to wash their hands
   a. Before beginning work
   b. Before handling food/equipment/utensils
   c. As often as necessary, during food preparation to remove soil and contamination
   d. When from switching from working with raw to ready to eat foods
   e. After touching body parts

f. Any time contamination may have occur
g. Upon entering the prior to handling product.

5. All employees preparing, serving or handling food or utensils shall wear clean, washable outer garments or uniforms.

6. All employees in food areas that contain exposed product direct contact surfaces shall wear a hairnet, cap, or other suitable head covering to confine hair.

7. Gloves shall be worn if any employee has artificial nails, nail polish, or fingernails that are not clean and neatly trimmed.

CONSUMABLES

Handling, storage and disposition

1. Consumables (plastic consumer size trays, lids, butcher paper, paper towels, food handling gloves, etc.) stored as not to be directly exposed to environmental influences in dry storage areas.
2. Consumables are to remain in the original shipping containers unless the shipping container is damaged or otherwise rendered unable to protect the consumable form environmental influences.
3. Consumables are to be brought into the processing area in their immediate containers and in sufficient numbers to meet demands for the hours of operations as close as possible.
4. Consumables are not allowed to be stored in the processing area, as the potential for contamination during clean up is possible.
5. Excess consumables are not to be returned to storage until inspected for acceptability (free from blood, fat, meat scraps, or any other objectionable condition).
6. Those consumables that are determined unacceptable are to be discarded.
7. Excess consumables that are determined acceptable for use and that are to be returned to storage will be placed in an immediate container (plastic bags, plastic tubs, totes, etc.) that will protect them from environmental prior to storage.
8. There shall be no handling or storing of materials, which create an objectionable condition in areas where product is prepared, stored or handled.
9. Unnecessary items and other materials not related to productions or product are to be removed, and excessive trash not allowed to accumulate.

PRODUCT RECONDITIONING

The majority of product/products that are accidentally or incidentally soiled (not contaminated) may be reconditioned if acceptable procedures are written, verified and the required facilities are available and properly utilized.

FACILITIES REQUIREMENT

The first requirement for a salvage (reconditioning) operation is a “meat sink”.

The “meat sink” is to be used only for meat reconditioning when identified as such.

The second requirement is that the meat sink must have a false bottom with a minimum height of 2 inches from the bottom of the sink with perforations (holes) to allow the meat to be rinsed with clean water not soaked or bathed.

This sink may be used for other functions but not as a meat sink at the same time.

Each time it is to be used as a “meat sink” it must be cleaned/sanitized and inspected by the Processing Inspector (P.I) prior to use as a meat sink.

The third requirement is that the “meat sink” be identified with a highly visible sign, placed above the sink when being used as a meat reconditioning sink.

Use of hand washing basins for cleaning product is not permitted.

PRODUCT REQUIREMENTS

Raw whole meat parts or intact poultry carcasses that are accidentally soiled are to be retrieved from the point of contact with unacceptable surfaces (floors, racks, shelves, etc.) and reconditioned at an identified location (meat sink).

When product has become unclean by accidental contamination, and can be cleaned with water, care must be taken to see that the product is promptly washed individually under a stream of running water. Trimming is required in all situations where washing is inadequate in removing contaminants.

Containers used for storing inedible material must be of such material and construction that their use will not result in the adulteration of any edible product or in the creation of insanitary conditions. Such containers must not be used for storing any edible product and must bear conspicuous and distinctive marking clearly to identify their restricted use~~s~~.

SECTION V – RECORDS AND RECORDKEEPING

Title 3. Food and Agriculture
Division 2. Animal Industry
Chapter 4. Meat Inspection
Subchapter 1.

Article 2. Supplemental Requirements, Licensing and Inspection (Refs & Annos)
§ 901. Authority of Livestock Meat Inspectors, Processing Inspectors, and Persons Responsible for Operation of Custom Livestock Slaughterhouses Operation of Custom Livestock Slaughterhouses and Meat Processing Establishments.

(a) **No person licensed** as a livestock meat inspector or **processing inspector** and no person responsible for the operation of a custom livestock slaughterhouse or meat processing establishment shall exercise the authority of the license:

(1) To perform or allow the performance of any operation not in accordance with the requirements in this subchapter: or

(2) **Contrary to instructions of a Department inspector**, including instructions relating to proper procedures, wholesomeness inspection, condemnation, or other disposition of diseased animals, carcasses, parts and adulterated or mislabeled meat and poultry products; **sanitation inspection; and the maintenance of accurate records.**

I. Plans

FAC Section 18970. (a) Prior to the issuance of a license to an establishment required to be licensed pursuant to Article 8 (commencing with Section 19010), the establishment shall meet the department's building and equipment standards.

(b) Building plans and specifications shall be submitted to the director for approval prior to any intended construction or major reconstruction for any establishment licensed pursuant to Article 8 (commencing with Section 19010).

II. Licenses (current year)

a. Retail Processor establishment's license to be conspicuously posted
b. Individual Processing Inspector's license to be conspicuously posted

III. Official Forms.

Permits: (retain until superseded)
(1). Inedible Permit - MPES Branch Form 79-016 (Rev. 10/11)

(2). Sewage Letter/Disposal - MPES Branch Form 79-029 (Rev. 10/11) or other official form from applicable governmental agency.

Sewage disposal. Sewage must be disposed into a sewage system separate from all other drainage lines or disposed of through other means sufficient to prevent backup of sewage into areas where product is processed, handled, or stored. When the sewage disposal system is a private system requiring approval by a State or local health authority, the establishment must furnish MPES with the letter of approval from that authority upon request.

Plant Improvement Program
(3) Meat, Poultry and Egg Safety Branch Form 79-032 (Rev. 10/11) Plant Improvement Program. (retain until superseded)

Current Approved Hours of Operation:
(4) Meat, Poultry and Egg Safety Branch Form 70-038 (Rev. 10/11) Approved Hours of Operations (retain until superseded)

General Facility Notes
(5) Meat, Poultry and Egg Safety Branch Form 79-039 (Rev. 10/11) General Facility Notes. (retain until superseded)

Daily and Monthly Processing Report
(6) Meat, Poultry and Egg Safety Branch Form 79-070 (Rev. 10/11) Daily and Monthly Processing Report. (retain for one year)

FAC Section 18857. It is unlawful for any person required by this chapter to file any annual or special report to fail so to do within the time fixed by the director for filing the report.

Guidelines for the Completion and Submitting *Form # 79-070* (Rev. 12/11) is to be filled out daily (for a single month only no "split" months) and at the end of each month totaled from left to right, then each section totaled from the top down to achieve Grand Totals by the designated establishment personnel (Processing Inspector).

The following combinations of the three Grand Totals of this form are to be transcribed onto Form # 79-071 (Rev. 12/11) section #2 Total Pounds of Production this Month.

Part 1 Meat, combined totals of Grand Total 1 and 3 MINUS any Poultry product annotated in Custom Products),

Part 2 Poultry, Grand Total 2, PLUS poultry products only annotated in Custom Products.
Part 3 Condemned Meat, self explanatory.

Part 4 Condemned Poultry, self explanatory.

NOTE: Total Pounds Condemned on form # 79-71 (rev12/11) is for product condemned for **pathological** conditions only.

Monthly Report Processing Operations

(7) Meat, Poultry and Egg Safety Branch Form 79-071 (Rev. 10/11) Monthly Report Processing Operations at State Inspected Meat and Poultry Official Establishments.

a) Plant management at each meat processing establishment shall complete the following reports:

b) Under the headings Meat Products, Poultry Products, Custom Products, and Re-Inspection, a column shall be completed for each day the establishment conducts processing operations.

c) The weight, in pounds, for all products produced and/or condemned on re-inspection shall be entered in the appropriate space.

d) MPES Form 79-071 (Rev. 10/11) Monthly Report Processing Operations at State Inspected Meat and Poultry Official Establishments. This form shall be completed for the preceding month, using data from all MPES Forms 79-070 (Rev. 10/11) Daily and Monthly Processing Report completed that month. The completed form shall be sent/faxed or totals e-mailed to the assigned inspector by the **tenth day of the month.**

(8) Meat, Poultry and Egg Safety Branch Form 79-080 (Rev. 10/11) Label Formulation and Approval.
(retain until superseded)

Guidelines for the Completion and Submitting *Form 79-080 (Rev. 12/04)*

MPI Form 79-080 must be completed by an establishment or its representative to request label formulation approvals from the Meat and Poultry Inspection Branch (MPIB), or from the assigned MPI personnel at individual establishments.

All information required on Form 79-080 must be completed to request an approval for the use of a formula, label, or marking device applicable to state inspected meat or poultry products. All information must be typed or printed. The following information provides instructions for completing Form 79-080.

1. Block 1- Establishment name (name of establishment as stated on retailed processors license
2. Block 2 -Establishment Number (number assigned to the establishment by Branch)

Enter the official plant or establishment number. If the label formulation approval is requested for use at more than one establishment, enter each establishment number where the label is to be used.

3. Block 3- Establishment address (actual location of the processing establishment)

4. Block 4 -Product Name

Enter the common name or generic product name, such as “Frankfurter”, Cereal Added” or “Italian Sausage.” Do not use trade names, brand names, or coined names, such as “Joe’s Sloppy Dogs” or “Joe’s Corn Dogs” unless the brand name is accompanied by the true product name such as “Battered Wrapped Wieners.”

5. Block 5-Approval type requested by for approval.

Note: If a temporary approval is requested enter the number of days requested and the number of labels on hand in the large block under the "Approved By" block.

NOTE: Sketch and final label approvals may be concurrent when the following conditions are met;

a. An approved formulation is on file. (If applicable)
b. The sketch approval submittal is not in need of corrections, deletions, or additions. (The graphic display is in compliance with regulatory requirements).
c. The graphic display accompanying the sketch approval request is the actual label that will be placed on or in the packaged product (e.g. Self-adhesive scale generated labels).

A. If the previously stated conditions exist, the approving/forwarding inspector will apply the following changes from the normal sketch approval process prior to forwarding the Area Supervising Meat Inspector (S.M.I.).

a. Annotated on Form 79-080 (rev. 12/04) in the "Sketch App. Number "box the appropriate sketch approval number.
b. In the FOR OFFICIAL USE ONLY BOX.
    i. Leave the Number (stamped) box blank.
    ii. Leave the Approval Type unchecked
    iii. Mark the Preliminary Approval "Approved" box.
    iv. Sign the "Preliminary Approved By" box.

B. Attach the actual label to the back of Form 79-080 (Rev.12/04)

6. Block 6-Sketch approval number.
   If a final approval is requested, enter the sketch approval number,

7. Block 7- Date of sketch approval
   If a final approval is requested, enter the date the sketch was approved, if applicable.

8. Block 8- Type of Product
   Check the appropriate box for the product as presented to the consumer

9. Block 9- Internal Temperature of product (deg)
   Enter the upper limit of internal product temperature if applicable as described in the method of preparation and remarks block

10. Block 10-Type of material of Label (casing, wrappers, cartons, inserts)
    Complete this block only if the product is to be offered for sale at self-service retail level. State the dimensions of the principal display panel. The principal display panel consists of the entire side of the package where the label is to be placed and is considered as the area most likely to be view by the consumer at the time of sale. Include the type of labels such as "pressure sensitive label".

11. Block 11-Ingredients
    List each ingredient in the product by weight in their order of predominance. If a product consists of several components, list each component separately and list each ingredient of that component. If additional space is required attach a continuation sheet(s).

12. Block 12-Weight (lbs)
    Weights of the individual ingredient or component may be in pounds, ounces, or kilograms, or grams. DO NOT use gallons, pints, cups, teaspoons and the like. DO NOT use fractions. Express fractional amounts in two decimal points, for example 1¼ lbs. would be expressed as 1.25 lbs.

13. Block 13-Method of Preparation and Remarks
    Briefly, but thoroughly, describe the procedures used to formulate the product. Examples of processing procedures include:
    A. Weather the product is sectioned, chopped, ground, reformed or stuffed;
    B. Cooking temperatures
    C. How are liquids injected into the product
    D. Method of curing hams, corned beef, pastrami, and other similar products.

    NOTE: Approval of the label does not necessarily mean approval of the processing procedures.

14. Block 14-Establishment Representative
    The signature of the applicant or applicant's agent must appear here.

15. Block 15-Date
    The date of the signing of the applicant or applicant's agent must appear here.

BLOCKS 16- 21 FOR OFFICIAL USE ONLY (See Block 5 if applicable)

16. Block 16 Number (stamped) block is to be annotated for formulation and sketch approval by the submitting Branch inspector with the establishment specific number.

In addition the submitting inspector will annotate the following

17. Block 17 Mark the Approval Type accordingly

18. Block 18 Mark the Preliminary Approval "Approved" box.

19. Block 19 Sign the "Preliminary Approved By" box.

20. Block 20 Official Approval (no action required)

21. Block 21 Supervising Meat Inspectors will mark the appropriate box after review

22. Block 22 Approved By is to signed by the reviewing Supervising Meat Inspector

23. Block 23 Blank Space
    This space will be used by the approving Branch personnel for comments, correction, deletions, and additions or any other actions or activities to be taken by the establishment prior to re-submittal for final approval and request for temporary approval information.

24. Block 24-Inspector
    The signature of the establishment's assigned inspector receiving the label formulation application.

25. Block 25-Date
    The date the assigned Inspector received the label formulation submittal.

FAC Section 909.14. Rescindment of Labels
Once a year each official establishment shall submit to the Branch Chief, in quadruplicate, a list of approvals for labels that have become obsolete, accompanied by a statement that such approvals are no longer desired. The approvals shall be identified by number, date of approval and name of the product.

IV. Additional Official Forms

(9) In-Depth Review of Cooked Sausage - MPES Branch Form 79-082 (Rev. 10/11) - retain for one year

(10) In-Depth Review of Cured/Cooked and Smoked Meats. - MPES Branch Form 79-085 (Rev. 10/11) (retain for one year)

(11) Smokehouse Chart - MPES Branch Form 79-086 (Rev. 10/11) - retain for one year

(12) Plants Freezing Pork to Destroy Trichina - MPES Branch Form 79-087 (Rev. 11/11) - retain for one year

(13)) Plant Certified Pork Use Record - MPES Branch Form 79-088 (Rev. 11/11 - retain for one year

(14) Processing Inspector Handbook - MPES Branch (Rev. 5/03) California Department of Food and Agriculture - retain until superseded

V. Additional Required Documentation

Laboratory Results**:** (retain until superseded)
a. Water
   1. Private well (every 6 months)
   2. Municipal (one required – can have any date)

Water supply and water, ice,

(1) A supply of running water that complies with the National Primary Drinking Water regulations (40 CFR part 141), at a suitable temperature and under pressure as needed, must be provided in all areas where required (for processing product, for cleaning rooms and equipment, utensils, and packaging materials, for employee sanitary facilities, etc.).

(2) If an establishment uses a **municipal water supply**, it must make available to MPESB, upon request, **a water report**, issued under the authority of the State or local health agency, certifying or attesting to the potability of the water supply.

A potability certificate or report from a State or local health agency or other responsible organization is acceptable. The potability certificate for water from a **municipal source** must be available to MPESB upon request. It **does not** have to be **renewed annually.**

(3) In an establishment uses a **private well** for its water supply, it must make available to MPESB, upon request, **documentation** certifying the potability of the water supply that has been renewed at least **semi-annually**.

When the water supply comes from a **private well**, the establishment must have a water potability certificate or report from a State or local health agency or other responsible entity (an accredited laboratory) certifying or attesting to the water's potability. The potability certificate or report must be **renewed** at least every **six months** and available to MPESB upon request.

When **ice** is being supplied to the establishment from an **outside source**, the establishment must have records showing that the water used to make the ice is potable. The documentation must be available to FSIS upon request.

However, if establishment's manager/operator or PI or Branch Inspector have a reason to suspect that water/ice used in the establishment maybe contaminated another lab testing for potability must be taken.

IV. Additional Required Documentation cont.

Meat/Poultry finished Products Sample Results

1. Establishment (finished product results for compliance with standard of identity and pathogen control)

Sanitation Standard Operating Procedures and Reports

a. Current plant SSOP must be kept at the plant and be available to Branch inspectors upon request
b. Completed Sanitation Inspection Reports - retain for one year
   1. Pre-operational
   2. Operational
   3. Corrective action

Each official establishment shall keep and retain records in accordance with 9 CFR section 416.16 (2006).

Chemical List (retain until superseded)

a. Approved cleaning and sanitizing chemicals (chemicals currently being used)

b. Q1: Do chemical sanitizers used on surfaces in direct contact with food (food contact surface) have to be approved for use in the plant?

A1: MPESB does not approve chemical sanitizers. Sanitizers used on food contact surfaces must meet FDA requirements with the establishment having documentation that the sanitizer is safe for use in a food-processing environment. This documentation must be available to MPESB upon request

Pest Control:

a. Documentation of routine inspection actions taken an/or observations (e.g. - chemicals used, activity if noted, routine rodent trap check reports. This record must be kept for one year.

NOTE: Pest control programs addressed in 9 CFR 416.2(a) are not required by regulation to be written programs. However, they must be implemented and maintained to prevent or eliminate pest harborage and breeding within the limits of the official premises. Pest control programs may be provided by an outside company or self administered.

NOTES:

SECTION VI – RECOGNIZED LOCALIZED DISEASE CONDITIONS

A **disease** is an abnormal condition affecting the body of an organism (livestock). It is often construed to be a **medical condition** associated with specific symptoms and signs. It may be caused by external factors, such as infectious disease, or it may be caused by internal dysfunctions, such as autoimmune diseases.

In animals, "disease" is often used more broadly to refer to any condition that causes pain, dysfunction, distress, or death to the animal afflicted, or similar problems for those in contact with the animal. In this broader sense, it sometimes includes injuries, infections, isolated symptoms, and atypical variations of structure and function. Most diseased animals after slaughter will show some changes in the tissues.

Death due to disease is called death by natural causes. There are four main types of disease: pathogenic disease, deficiency disease, hereditary disease, and physiological disease.

Diseases can also be classified as communicable and non-communicable disease.

A localized disease is one that affects only one part of the body, such as an eye infection.

A localized disease/condition is an infectious (capable of being transmitted) or neoplastic (abnormal new growth of tissue) process that originates in and is confined to one organ or mostly affects one small area in the body, such as a sprained ankle, a boil on the hand, an abscess of finger. In most cases the localized disease/ condition doesn't affect the entire body and after trimming affected parts or affected area the rest of the carcass can pass postmortem inspection as fit for human consumption.

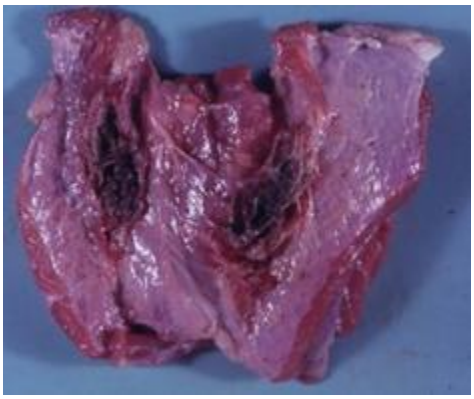
A generalized disease/condition is an infection that affects entire body and produce serious disease symptoms. The animal shows sickness and pathological signs like abnormal discoloration of various tissues, enlargement of internal organs and lymph nodes, imperfect bleeding, various inflammations and other indications of sickness are visible on post mortem. Pneumonia, for example, is generally confined to one or both lungs but can become sepsis, in which the microbe responsible for the pneumonia "seeds" the bloodstream or lymphatic system and is transported to distant sites in the body. When that occurs, the process is no longer described as a localized disease, but rather as a systemic disease when most systems in the body and most internal organs are affected.

Due to the fact that majority of the meat in the retail establishment are from USDA sources and well inspected before distributed you will probably not see any of this localized or generalized conditions in your operation. However, if for any reason you will see any suspicious looking carcass/meat or meat product please stop processing it and immediately contact your assigned Branch inspector.

Please see pictures below of few abnormal meat conditions.

pyogenic bacteria

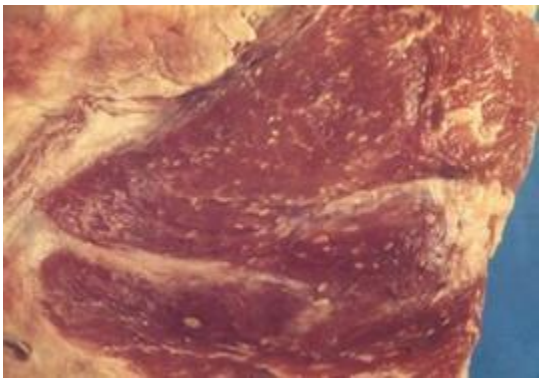
Cattle are prone to developing abscesses caused by pyogenic bacteria, most commonly *Arcanobacterium pyogenes*. Abscesses in the muscle are most commonly seen in the hind limb. The affected limb presents with pain and swelling because of the widespread necrotising cellulitis and myositis.



Myositis from intramuscular injection

Protozoan myopathies

Intracytoplasmic protozoan cysts from Sarcocystis spp. are often found by chance in skeletal and cardiac muscle fibres in cattle.
Massive exposure can cause fever, anorexia and progressive impoverishment, though this is quite rare.
More often, Sarcocystis infection is diagnosed as an incidental finding during necroscopy or during inspection of the meat at the abattoir.



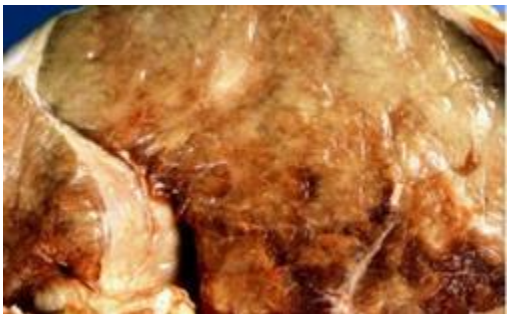
Sarcosporidiosis.

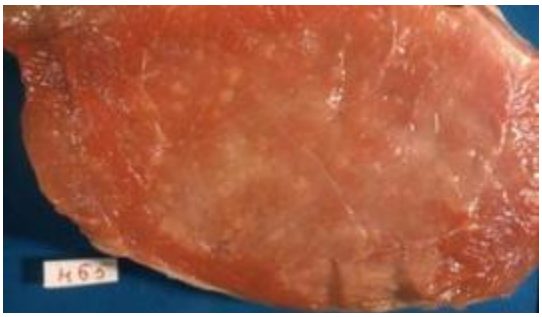
Esinophilic myositis

Eosinophilic myositis (EM) is a collective term used to describe an inflammatory condition grossly characterized by focal, green, muscular lesions in clinically healthy cattle. The most frequently affected tissues are striated skeletal muscle, esophagus and heart. Carcasses of animals exhibiting EM must undergo trimming of affected tissue prior to entering the food chain. Severely affected carcasses are condemned. It has been reported that 5% of carcasses may be condemned in severely affected areas; thus, a high prevalence of EM may account for severe economic losses to producers and processors.

Esinophilic myositis is a disease affecting cattle which is thought to be a rare result of Sarcocystic infection, due to hypersensitivity on the part of the animal.

Affected muscles appear to be green in colour because of the massive infiltration of oesinophils. It is associated with myofibral necrosis and, in chronic cases, fibrosis





Nutritional Myopathies

Cattle and young cows are prone to nutritional myopathies due to selenium and (less commonly) vitamin E deficiency.

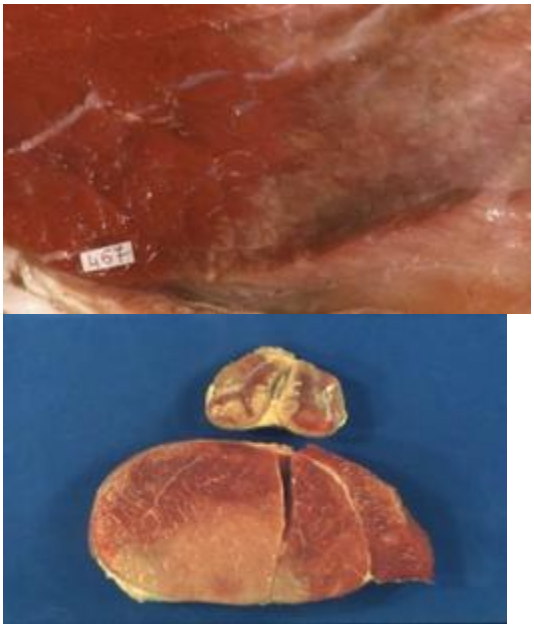
Muscles in affected cattle range from pale pink to white in appearance and often have irregular distribution.

In the early stages of the disease, the muscles present with yellow and white bands and then later the muscles look completely pale and white, to the extent that the disease is known as “white muscle disease”.

Nutritional myopathies

Vitamin E and **selenium** are important for protecting the animal against lypoperoxidation in the cells by free radicals because it prevents the formation of hydroperoxide acids. Free radicals are responsible for the peroxidation of lipids and physical-chemical damage of proteins, especially those in the membranes.

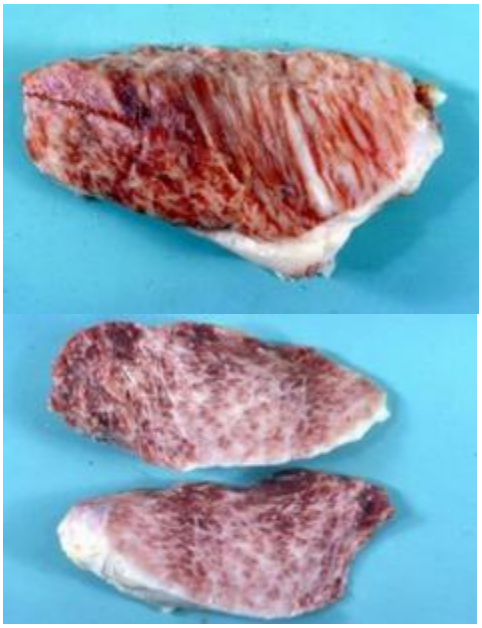
Abnormal retention of Ca_2^+ results.



Congenital or Hereditary disorders

Lipomatosis

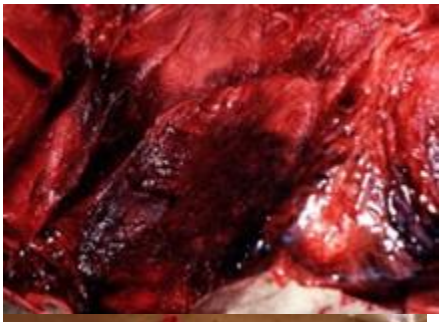
This bovine disease is occasionally discovered on necroscopy or butchering. It is believed to be a defect in muscle development, whereby vast areas of myofibres are replaced by adipocytes.

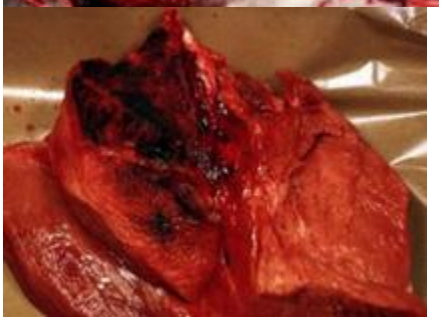


Bacterial and parasitic myopathies

Clostridium Myositis ("blackleg")

This disease, which is due to *Clostridium chauvoei*, is extremely important especially from a financial point of view because it is the most common myositis in beef cattle. The affected muscles, fascia and subcutaneous tissue present with hemorrhages and locally extended edema, often with crepitus due to gas bubbles. The necrotic muscle fibres look dark or black-red.





Inedible Material Control:

The facility must handle and maintain inedible material to prevent the diversion of inedible animal products (including SRM) into human food channels, resulting in the adulteration of human food (9 CFR 303.1(a)(2)(i), 303.1(b)(4), 381.10(a)) (4), 416.2(b)(4), and 416.3(c)).

Sec. 308.13 Inedible operating and storage rooms;

All operating and storage rooms and departments of official establishments used for inedible materials shall be maintained in acceptably clean condition.

FOOD AND AGRICULTURAL CODE SECTION 18650-18677

18655. "Capable of use as human food" means any livestock or poultry carcass, or any part or product of any such carcass, unless it is denatured or otherwise identified as required by the director to prevent its use as human food, or is naturally inedible by humans.

Q4a: Can containers used to store or handle inedible product be used for edible product if they are first cleaned?

A4a: No, "inedible" is defined by regulation as adulterated, uninspected, or not intended for use as human food. When an establishment designates a container for storing or handling of "inedible" product, that container cannot be used to store edible product even if it is cleaned and sanitized. Those containers are to be identified by label, color, or other means as "inedible" **(letters at a minimum 4 inches high)**

Q4b: If product goes off condition in an edible container, does that container holding this product then need to be designated as inedible?

A4b: No, the container does not have to be designated as an inedible container.

Q4c: If an edible product is destined for inedible purposes, e.g., bones; fat, does the container holding this product then need to be designated as inedible?

A4c: No. Establishments may store bones or fat in edible containers even though the bones or fat are destined for inedible use.

All inedible products must be de-natured sufficiently to prevent the diversion of inedible animal products (including SRM) into human food channels with an acceptable denaturant prior to leaving the official establishment's control.

INEDIBLE CONTROL

1. All inedible containers must be legibly identified with the word "INEDIBLE".
2. Large inedible containers (those supplied by outside services) must have tight fitting lids and be marked with letters at least 2 inches high and the lids be on the container at all times.
3. Outside supplied containers are to remain in coolers/freezers until picked up.
4. Outside supplied containers are to be cleaned and sanitized upon being emptied.
5. Small inedible containers that are in the processing room are to emptied as necessary when full, or at the end of each day's production into the outside supplied containers.
6. Inedible containers are not to contain plastic, paper, Styrofoam, etc.
7. All products must be removed from any type of packaging prior to be placed in the inedible container.
8. Establishment will assure that all inedible material/product are denatured thoroughly to preclude it's use for human food. An approved denaturant must be used.
9. No container already containing inedible material will be allowed back into the processing area.
10. Small "inedible" containers used in some processing area are to clean/sanitized as any other equipment used for production prior to the next day's production.
11. Establishment when collecting "inedible" are to comply with current requirements and laws, in addition to following guidelines of rendering companies in the handling and collecting of inedible material. An "Inedible permit" must be obtained by every plant and be available upon a Branch inspector request.

Most "inedible product" generated by retail processing is normally edible product that has been chosen by the establishment to be downgraded to inedible product, mainly because there is no further use for it as an edible product.

True inedible product is that product that has been contaminated or adulterated and therefore is not acceptable as an edible product or as ingredient of an edible product or used to produce and edible product.

An example of true inedible is the fat and meat scraps removed from drains at the end of the processing operations cleaning activities.

SECTION VII – RODENT AND PEST CONTROL

Management is responsible that a Retail Processing establishment has an effective pest control program that is monitored and documented.

RODENTS IN GENERAL

- Rodents have been responsible for more human illnesses and deaths than any other group of mammals.
- They spread diseases, directly by contaminating human food with their urine or feces, or indirectly, by way of rodent fleas and mites.
- Rodents cause enormous economic loss.
- They consume or contaminate vast quantities of food and animal feed.
- They destroy property.

EVIDENCE OF RODENTS

- Rodent droppings in the plant and outside and nests and burrows (outdoor nesting sites, trash dumps, or piles or rubbish).
- Gnaw marks (hole gnawed through a building or in products; old rat holes will be smooth from use, new ones will be rough with splintered edges).
- Urine stains, observed as fluorescing under an ultraviolet light; and characteristic musty odor.

RODENT CONTROL

- MPES Branch has implemented precise regulations and procedures on rodent and pest control.
- The regulations specify that every practical precaution ***shall*** be taken to exclude pests from official establishment. Those pests that do gain entrance ***shall*** be eliminated in a safe manner
- The effective control of pests is by proper exclusion and sanitation (often backed up with appropriate chemical treatments).
- These controls are necessary to ensure a sanitary environment for producing safe and wholesome meat and poultry products.

- *Pest control* means those physical and chemical method used to control pests.

Methods used to **prevent or eliminate** pest infestation.

- The physical or primary controls

  1. ***Construction***

  2. ***Maintenance***

  3. ***Exclusion****, and*

  4. ***Sanitation***

  The chemical or secondary controls refer to pesticide applications and the use of traps and other devices to supplement the primary controls and thus prevent infestation and eliminate or control established ones.

  An integrated pest control program incorporates both the primary controls of pest infestation prevention and the secondary controls of pesticides and pest-controlling devices.

  EPA regulates (through the Federal Insecticide, Fungicide, and Rodenticide Act) the registration of all pesticides.

PRIMARY CONTROLS

- **Sanitation.** A sound sanitation program remove the food and water supply that attracts and supports a pest population. It also eliminates the debris that provides nesting and hiding places.
- **Construction.** A sound construction program creates a barrier that prevents pest entry. It also impedes or stops their movement within the building.
- **Maintenance.** A good maintenance program ensures that breaks in the construction barriers are promptly corrected.
- **Exclusion.** An exclusion program prevents pest entry through the necessary openings in a building.

SECONDARY CONTROLS

- Residual insecticides not only kill when they are applied, they also deposit a residue that has a prolonged lethal effect.
- Baits, pallets, and powders. Sugar baits and tracking powders may also be used in inedible areas and on outer premises.
- They *must* be distinctly colored blue or green to preclude confusion with food ingredients.
- Automatic systems. Automatic insecticide systems may only use non-residual insecticides.
- These systems are allowed in processing and storage areas, provided the dispenser is operated only when products are not being processed or stored in open containers.
- When the system is in use, product in the affected rooms *must* be covered to prevent falling insects or spray residue from contaminating them.
- After dispensers have been used, all utensils and equipment *must* be thoroughly washed with an effective cleaning compound and rinsed with potable water to remove dead or dying insects or residues that may remain on any surface before operations begin
- The automatic system may be in use without time limitations, provided that sufficient precautions are taken to preclude entrance of insecticide mist or affected insects into work areas via open windows, ventilating systems.
- Rodenticides. In general, rodenticides may not be placed in edible product departments until operations have ceased for the day and all uncovered products are removed from the area. These baits come in two forms, liquid and dry.
- Liquid baits may be used in bait fountains provided the solution has a distinct green color. These fountains are housed in bait boxes.
- Dry baits are usually mixed with cereal or other vegetable meal. These baits *must* be an obvious blue or green color.

PEST AND RODENT CONTROL PROGRAM

- If the plant has an integrated pest control program, it should be on file in the inspector files.
- The plants written program should designate a responsible plant employee.
- The program includes sealing all openings or holes where vermin may gain entrance, eliminating harborages, using bait boxes, surveying the premises on a weekly basis.
- A contract with a recognized extermination firm (if applicable) or an effective plant program.
- A map should be on file showing the actual locations of all pest control devices (bait boxes, ketch-alls, sticky boards, fly zappers, etc.) on the official premises.

PEST IN PRODUCTION AND RELATED AREAS

- The production and production-related areas ***shall*** be properly maintained for pest control
- No bait boxes or tracking powder are in evidence during operations. Tracking powder is **illegal** in the state of California.
- No evidence of pest or rodents is noted during an inspection specific to this task.

PESTICIDE/RODENTICIDE LABELS AND USE

- An up-to-date list of pesticides currently being used on the official premises needs to be maintained by the plant and kept on file.
- Pesticide labels should be reviewed to determine if the pesticides are properly identified**,** EPA-approved, used as stipulated on the label, and that this use is in accordance with MPES Branch regulations.

PESTICIDE/RODENTICIDE STORAGE

- Pesticides and rodenticides that are **stored** on the official premises need to be in a **designated area or in locked cabinet.**
- This area is to be properly maintained to ensure good sanitation.
- The poisons ***must*** be in closed containers and properly identified.

SECTION VIII – PROPER FORMULATION OF MEAT FOOD PRODUCTS

When a product is fabricated from **two or more ingredients**, the plant must have submitted the formula for the product to the Branch for **approval** prior to producing the product. The formula must list the various ingredients, giving the percentage/weight of each.
Processing Inspectors must assure themselves that the submitted formula before being used is in compliance with regulatory requirements of the ingredients and it produces a safe product.

WHAT ARE THE ESTABLISHMENT RESPONSIBILITIES?

When Meat Poultry and Egg Safety Branch inspection (MPESB) is granted to an establishment a responsible plant official signs a statement agreeing to conform strictly to all regulations and orders pertaining to inspection.
This statement emphatically establishes that the establishment management has the responsibility to produce a product that is safe, wholesome, unadulterated, and properly labeled.

Establishment management is expected to have process control procedures and checks in place to identify, correct, and prevent any conditions that could lead to violations. For example, the establishment:

! ***Will assign a competent individual(s) to be responsible for product formulation.***

! ***Will use and adhere to specific tested and proven formulas that will produce products in compliance.***

! ***Will accurately measure and identify all ingredients, mixtures, and emulsions through all phases of production.***

! ***Will maintain approved formulation records of meat and poultry products.***

INSPECTION RESPONSIBILITIES

The licensed Processing Inspector and MPESB assigned inspector's are responsible for:

! ***Evaluating formulation records and verifying the weighing and addition of ingredients at the time of formulation.***

! ***Monitoring fat content of various products. If a product has less than its standard of identity fat content or targeted fat content, but the antioxidant calculations were based on the standard of identity fat content or targeted fat content, then the product would be out of compliance for antioxidants.***

! ***Performing calculations for ingredients permitted in meat and poultry products to determine compliance with the product standard, or approved formula, at the time of formulation.***

INTRODUCTION

There are **four** main types of sausage**:**

1. **Fresh sausage —** no cure added for preservation, product not cooked**.**
2. **Cooked sausage and Smoked —** fully cooked and ready-to-eat.
3. **Fermented sausage —** fermented to increase shelf life of product, "tangy summer" sausage is an example of a fermented sausage.
4. **Meat loaves and jellied products —** meat chunks are added to the product

1. FRESH SAUSAGE

Fresh sausage is just what its name says. It is made from raw/uncooked ground meat. It may be flavored with added spices but **no 'curing' agents** - nitrite or nitrate - have been added. **They need to be cooked before consumption.**

Examples are fresh pork sausage, fresh bratwurst and fresh Italian sausage. These products need to be cooked before eating.

2. COOKED AND SMOKED SAUSAGES

These are fully cooked ready-to-eat sausages. They need to be kept **refrigerated** while stored and they don't need to be reheated before consumption.

Some are finely comminuted or emulsified may contain no more than **30% fat** or a combination of 40% fat plus added water.

- ***Examples:*** *Wieners, smoked sausages, bologna and cooked bratwurst, franks, hot dog etc*
  Other are coarsely ground
- have a **10% added water limit** in the finished product
- **no fat limitation** because it is visible to the consumer
- ***Examples:*** *Polish, cotto salami, kielbasa, and bierwurst*

3. FERMENTED SAUSAGES

They are known for a 'tangy' flavor. This type of sausage has gone through a fermentation process by lactic acid producing bacteria or adding encapsulated acids. If properly acidified and dried, fermented sausages can be **shelf-stable**. Semi-dry and dry are two types of fermented sausages.
Examples: Summer sausage and snack sticks are semi-dry. Pepperoni and hard salami fall under the dry category

4. MEAT LOAVES

They are mixtures of chopped meat that are usually "formed" and **cooked in pans** or metal molds for shaping. A cooked mixture of meat chunks placed in gelatin is called a jellied product.
Examples: Jellied roast beef and head cheese. Pickle and pimento loaf and honey loaf are other examples of meat loaves.

Salt

Salt is a necessary ingredient in a sausage recipe.

- Salt is a necessary ingredient for flavor
- It aids in preserving some sausages
- It is essential for extracting the "soluble" meat protein that is responsible for binding the sausage together when the sausage is heated

**Most sausages contain 1-3 % salt*

Flavorings

Flavor is of great concern to the meat and poultry processor. **Spices, sweeteners, and liquid smoke** added to meat and poultry mixtures impart flavor characteristics which make each product unique. Some sweeteners contribute more than just flavor. In cured meat or poultry products, sweeteners not only counteract the harshness of salt, but sweeteners such as corn syrup (CS) and corn syrup solids (CSS--dehydrated form of corn syrup) also increase water holding capacity (water retention) and casing peelability.

Spices

For best flavor and consistency, use fresh spices and seasonings. If using pre-packaged spices, check use-by dates. Store spices and seasoning mixes at 55°F or below in air tight containers. This maintains freshness and prevents insects from hatching out.

SEASONINGS USED IN MEAT PROCESSING

Seasonings are normally parts of plants which flavor food. The trade in and the processing of spices has developed into an important support industry for food processing enterprises in order to meet consumer preferences. Ready to use pre-mixed seasonings/spices are developed by many companies and they are commonly used nowadays by most retailers to provide flavoring for various meat products. Letters of guarantee from each company supplying plant with seasonings/spices mixtures are to be obtained and kept in the plant. *Natural spices, herbs and vegetable* bulbs are the main groups of seasonings and are described hereunder.

Natural spices

The term "natural spices" includes dried rootstocks, barks, flowers or their parts and fruits or seeds of different plants. The most important natural spices used in processed meat products are **pepper**, **paprika**, **nutmeg**, **mace**, **cloves**, **ginger**, **cinnamon**, **cardamom**, **chili**, **coriander**, **cumin** and **pimento**. The most common natural spice in sausage making is pepper. Spices are mainly used in the ground form with particle sizes from 0.1 to 1 mm.

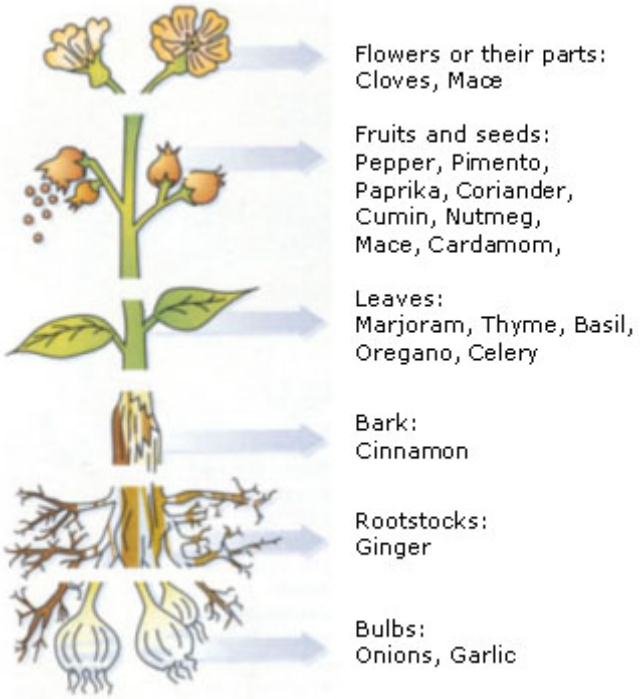


Fig. 113: Origin of natural spices

Herbs

Herbs are dried leaves of plants grown in temperate climates. The major herbs used in processed meat products are **basil**, **celery**, **marjoram**, **oregano**, **rosemary** and **thyme**.

Vegetable bulbs

The main natural seasonings originating from vegetable bulbs and used in processed meat products are **onions** and **garlic**.

Extracts

Natural spices are often **contaminated** with high numbers of microorganisms, in particular spores, due to their production process. This may become a problem for the stability of the meat products. The microbial load of spices can be reduced by **irradiation** or **fumigation**. Such treatments are not allowed everywhere. Another option is the use of spices extracts. **Extracts** are produced by separating the flavor-intensive fractions through physico-chemical procedures (e.g. steam distillation) which results in germ-free flavoring substances. Extracts are preferably used in viscous liquid or oily form. Due to the absence of microorganisms, extracts are specifically recommended for the production of microbiologically sensitive processed meat products, such as cured-cooked hams or cured-cooked beef cuts.

Procession and handling

Most spices used in meat processing are milled or ground. The milling method used affects the quality of the spices. Spices are normally cold-milled at low temperatures. The raw spices are deep-frozen thus avoiding the loss of oleoresins, aqua-resins and essential oils, which are the active flavor components.

- Spices (whole or ground, natural or extractives) should always be kept in a **cool**, **dark** and **dry place**.
- They must be stored in tightly **sealed containers** or bags to avoid loss of flavor.
- For processing purposes, spices should only be removed from the storage container using a **spice spoon**. Under no circumstances should spices be removed by hand as the adhering moisture and germs will lead to contamination, loss of flavor and clotting of the dry mixes.
- For all production, spices should be **added by exact weight** in order to standardize flavor and taste of the product.
- Products, which are consumed heated should be spiced **mildly**, as in the hot product higher amount of flavoring agents (oleoresins, aqua-resins and essential oils) will be released.
- If spices are added to a product mix under high temperature, the seasoning should be **strong**. In case of cold consumption of this product less spice will be released and taste and flavor will be weak if there is not enough seasoning.

Description and origin	**Uses** (in gram per 1 kilo of product)
A. *SPICES*	
Black/white pepper Fruits seed	Used in a variety (almost all) meat products 1–2.5 g / 1 kg.
Paprika (Fruit seed)	Used in frankfurters, minced specialties and other products. Sometimes used as a coloring agent. 1-5 g / 1 kg.
Chili (Fruit seed)	For spicy products
Pimento (Fruit seed)	It has an aroma similar to a mixture of nutmeg, cinnamon and cloves. Used in a variety of sausage products. Sometimes used as a partial replacement for black pepper in frankfurters and some smoked products. 0.3-3.0 g / kg
Mace (Flower)	Used in liver sausages, frankfurters and bologna and similar. 0.4-1.0 g / kg
Ginger (Rhizome) (Root)	Used in frankfurters and similar products. 0.3-0.5 g / kg
Nutmeg (Fruit seed)	Used in bologna and minced ham sausages, frankfurters, liver sausage and gelatinous meat mixes. 0.3-1.0 g / kg
Clove (Flower)	Used in bologna, gelatinous meat mixes and in blood and liver sausage. 0.3-0.5 g / kg

Cinnamon (Bark)	Astringent and sweet, used in some countries in mortadella and bologna sausage. 0.1-0.2 g / kg
B. *AROMATIC SEEDS*	
Cardamom	Rapid loss of aromatic constituents during storage. Used in liver sausage and gelatinous meat mixes. 0.3-5.0 g / kg
Celery seed	Used in fresh pork sausages. 0.3-2.0 g / kg
Coriander seed	Contains about 13% of fatty matter and a trace of tannin. It is used in frankfurters, minced ham, and luncheon meat. 0.3-1.0 g / kg
Cumin	Used for meat specialties with distinct flavor. 0.2-0.3 g / kg
C. *CONDIMENTAL HERBS*	
Marjoram **Thyme**	Used in liver and white raw-cooked sausages and gelatinous meat mixes. 0.5-2.0 g / kg
D. *CONDIMENTAL VEGETAB.*	
Onion (Bulb)	Used in liver sausage, gelatinous meat mixes, meat loaves. Sometimes replace garlic. 2.0-10.0 g / kg
Garlic (Bulb)	Used in many types of raw-cooked sausages. 0.1-0.2 g /kg

Fig. 114: Selected seasonings used in meat processing

White, black and green peppercorns

Ground coriander and coriander seeds

Ground and whole nut med

Ground mace and blades

Ground allspice and allspice berries

Cinnamon stick, quills and ground

Cayenne pepper

Whole and ground cloves

These definitions of natural flavor include specific references to flavors containing ingredients derived from meat and poultry, for the function of their flavor properties, not nutrient purposes:

"The term natural flavor or natural flavoring means the essential oil, oleoresin, essence or extractive, protein hydrolysate, distillate, or any product of roasting, heating or enzymolysis, which contains the flavoring constituents derived from a spice, fruit or fruit juice, vegetable or vegetable juice, edible yeast, herb, bark, bud, root, leaf or similar plant material, meat, seafood, poultry, eggs, dairy products, or fermentation products thereof, whose significant function in food is flavoring rather than nutritional."

What substances or ingredients can be listed as "natural flavor," "flavor," or "flavorings" rather than by a specific common or usual name?

Spices (e.g., black pepper, basil, and ginger), spice extracts, essential oils, oleoresins, onion powder, garlic powder, celery powder, onion juice, and garlic juice are all ingredients that may

be declared on labeling as "natural flavor," "flavor," or "flavoring." Spices, oleoresins, essential oils, and spice extracts are listed in the Food and Drug Administration regulations.

1. **Question:** What commonly used ingredient may be designated as "flavors," "flavorings," "flavoring," or "flavor?"

Answer: Spices, spice extractives, essential oils, oleoresins, onion powder, garlic powder, celery powder, onion juice, and garlic juice. Spices, oleoresin, essential oils, and spice extractives are listed in 21 CFR 172.510, 182.10, 182.20, 182.40, 182.50, and 184.

2. **Question:** What commonly used ingredients, which have been designated as "flavors" prior to March 1990, must be designated by their common or usual name?

Answer: Hydrolyzed (source) proteins (e.g., hydrolyzed corn gluten, hydrolyzed casein, hydrolyzed wheat protein, and hydrolyzed milk protein), gelatin, hydrolyzed meat and meat by-products (i.e., "hydrolyzed [species and tissue of origin]"), autolyzed yeast, and autolyzed yeast extract are some examples.

3. **Question:** Can dry meat or poultry stocks, dried broth, extracts, and dried beef plasma be designated as "flavors?"

Answer: No, because dried stocks, dried broths and extracts, and blood fractions are of animal origin, they must be designated as dried (species) stock, dried (species) broth, (species) extract, or dried (species) plasma.

4. **Question:** Can commonly used organic acids be designated as flavors?

Answer: No, because they have restricted uses and use levels, commonly used acids must be designated by their specific name (e.g., ascorbic, citric, lactic, phosphoric, etc.).

5. **Question:** Can fruit (or vegetable) juices, purees, powders, and similar ingredients be designated as "flavors?"

Answer: No, with very few exceptions, these ingredients are foods that have nutritional value and may not be designated as "flavor" and must be listed by their common or usual name, e.g., tomato powder and lemon juice. However, powdered onion, powdered garlic and powdered celery, as specifically cited in the regulations (9 CFR 317.2 (f) (1) (i) and 381.118 (c) (2)), may be labeled as "flavor," "natural flavors," or similar terms. Onion juice and garlic juice, according to FDA, may also be termed "flavor," etc.

6. **Question:** Must specific ingredients that meet the definition of "flavor," e.g., rosemary, and are not proteinaceous, be identified on the label application form?

Answer: No. Spices, oleoresins, essential oils, and spice extractives may be grouped together and listed as "spices" or "flavor" or similar terms without specific names. If color is imparted, they must be designated as, for example, "spice and coloring" or by their specific name(s), e.g.,

turmeric.

7. **Question:** Can the use of mustard as part of the ingredient mix be designated in the label application as "spice?"

Answer: Yes, mustard may be listed in the ingredient statement on the label of a meat or poultry product as "mustard," "spice," or "flavoring" (see 9 CFR 317.2 (f) (1) (i)).

8. **Question:** Can "deflavored" or "decharacterized" mustard (or other spices) be used as an ingredient in meat or poultry products? If so, how should it be designated in the ingredient statement?

Answer: Deflavored (or decharacterized) mustard is an acceptable ingredient in the preparation of meat or poultry products, under the conditions of use that are acceptable for spices or flavorings, including level of use. When used in a meat or poultry product, deflavored mustard may be designated as "deflavored mustard," "deheated mustard," or "deactivated mustard." According to FDA, deflavored mustard, however, may not be designated as "mustard," "spice," or "flavoring." The same would hold true for other spices.

9. **Question:** If the processor declares spice(s) or spice extractive(s) on the meat or poultry product label, is it necessary to identify the specific spice(s) and spice extractive(s) on the label application form?

Answer: Generally, the processor need not identify each spice or spice extractive and the quantity of each on the label application form. As always, the total quantity of all spices versus all spice extractives will need to be indicated on the label application form to determine order of predominance for the different terms, i.e., spice(s) and spice extractive(s). In addition, if the label is submitted by an establishment in a foreign country, each spice and spice extractive must be identified on the label application form by name because of differences between countries in regulations for these ingredients.

10. **Question:** Can paprika, saffron, and turmeric be designated as "spice" or "flavoring" on meat and poultry product labels?

Answer: No. Paprika, saffron, turmeric, and extractives of these, according to FDA, are both spices and coloring, or flavoring and coloring and should be declared as "spice and coloring" or "flavoring and coloring" unless the specific spice or spice extractive is named in the ingredients statement.

- **Question:** Can annatto be designated as "spice" or "flavoring" on meat and poultry product labels?

Answer: No. Annatto may be called either "annatto" or "artificial color" or "artificial coloring" but may not be labeled as spice or flavoring.

12. **Question:** Does each constituent of ingredients designated, as "artificial flavor(s)" have to be identified on the label application form?

Answer: No. It is not necessary to identify the specific components of artificial flavors when the substances meet the definition in 21 CFR 172.515 and 182.60.

13. **Question:** Do ingredients that are designated as "spice(s)," "flavor," etc., in FDA-regulated foods that are used as components in meat and poultry products need to be identified on the label application form as to the specific spices or flavors used?

Answer: No, foods produced under FDA jurisdiction (e.g., sauces, vegetable mixes, baked beans) that are purchased and used as components of meat or poultry products need not identify the flavors on the label application. The ingredients listed on the label of the FDA regulated product may be listed as such on the label of the meat or poultry product because it is expected they will be in conformance with FDA ingredient labeling rules.

14. **Question:** When does a processor need to provide specific "flavor" component information on purchased products?

Answer: Specific information need only be provided if the product is a seasoning ingredient or if there is reason to suspect that the purchased product contains ingredients that are inappropriately designated as "flavor," etc.

15. **Question:** Does the Agency recognize a de minimis (minimal) level below, which a flavoring ingredient need not be declared?

Answer: No, there is no de minimis level at which a flavoring ingredient need no be declared by its common or usual name.

16. **Question:** How much information must suppliers of natural flavors, such as "tomato flavor" or "egg flavor," provide?

Answer: Suppliers of these types of ingredients must supply FSIS, at the time of label approval, with the identification of all constituents (ingredients) of that flavor.

17. **Question:** Can natural smoke flavoring be listed as natural flavor?

Answer: No, the labeling of natural smoke flavorings is covered by 9 CFR 317.2 (j) (3) and 381.119 (a) and by Policy Memo 117, "Smoke Flavoring." Natural smoke flavoring may not be listed as "natural flavor" or "flavor" in the ingredients statement. It may be declared as "natural smoke flavoring" or "smoke flavoring." Artificial smoke flavoring must be labeled as such.

18. **Question:** Would a distillate of acid, alcohol, or food be considered "flavor?"

Answer: Yes, distillates from acid, alcohol, or food that are the result of a distillation process, can be designated as "flavor," if they contain solely the flavoring constituents that are not of nutritional consequence. That is to say, no components of the substrate are present – only the chemical constituents that provide flavor, e.g., aldehydes, ketones, etc.

19. **Question:** Can cultured, fermented, or enzyme-modified products be designated as "flavorings?"

Answer: No. According to FDA, these ingredients must be designated by their common or usual name, e.g., "cultured whey" and "enzyme modified cheddar cheese (sublisted ingredients)."

20. **Question:** Can flavoring compounds which are separated from fermented products be designated as "flavors" (e.g., aldehydes, ketones, diacetyl, etc.)?

Answer: Yes, provided the mixture contains only the flavoring compounds and does not contain the substrate from which the flavoring compounds were removed.

21. **Question:** How would the "natural" versus "artificial" status of a flavoring compound be verified and by whom?

Answer: FSIS regulations do not provide criteria for differentiating between "natural" and "artificial" flavoring compounds (e.g., "natural" diacetyl). Determination for proper nomenclature can be obtained from the FDA.

22. **Question:** Can sandalwood extract or yellow sandalwood may be designated as "flavor" on labels of meat and poultry products?

Answer: White sandalwood extract or yellow sandalwood may be designated as "flavor" in the ingredients statement. FDA does not permit the use of red sandalwood extract in food, with the exception of alcoholic beverages.

SMOKE FLAVORING

ISSUE: What are the labeling requirements for products containing a component to which smoke flavoring has been added?

POLICY: ***The use of smoke flavoring (natural or artificial) in a component of a meat or poultry food product, e.g., ham in a ham salad, does not require that the product name be qualified to indicate the presence of the smoke flavoring. However, the smoke flavoring must be declared in the ingredients statement on the meat or poultry product labels.***

RATIONALE: The Meat and Poultry Inspection Regulations, 9 CFR 317.2(j)(3) and 381.119, require that when an approved artificial smoke flavoring or an approved smoke flavoring is added as an ingredient in the formula of a meat and/or poultry food product, the presence of the smoke flavoring must be shown contiguous to the product name and listed in the ingredients statement. The Meat and Poultry Inspection Regulations, however, do not explicitly address whether this requirement applies to smoke flavoring which is an ingredient of a component that is used in a meat food product or poultry food product (secondary product). Because of the absence of clarity in the regulations, confusion and inconsistency in the approval of labeling has resulted over the years.

We see no useful purpose in requiring a qualifying statement in the name of the secondary product. The presence of the smoke flavoring in the ingredients statement will provide the necessary information to those consumers who are interested in knowing if a component has been treated with smoke flavoring. We believe this requirement is sufficiently informative and does not in any regard misrepresent the meat and/or poultry food product to consumers.

This policy is consistent with current policy for labeling secondary products and is intended only to clarify the procedures already being implemented.

CLARIFICATION NOTE

If an establishment is only smoking for additional flavor a previously fully cooked meat product the smoking establishment is not required be under state inspection.

Sweeteners

Sugars (sucrose and dextrose) are the primary food source for starter cultures (lactic acid-producing bacteria) that produce the characteristic tangy flavor of fermented sausages. Hence, the primary function of sugar in these products is to drive the fermentation process.

There are several flavorings approved for use in meat and poultry products. They appear in the Tables of Approved Substances for meat and poultry [MPI Regulations, sections 318.7(c)(4) and 381.147(f)(4)].

Because flavorings affect the entire product and not just the meat and poultry portion, all calculations for restricted flavorings are based on the ***finished weight*** of the product. A ***projected finished weight (PFW***) is an acceptable basis for calculation.

FLAVORING LIMITS

Sugars (sucrose and dextrose) are **not limited** because adding excessive amounts would make the product unpalatable (too sweet). **Other sweeteners** such as CS, CSS, malt syrup (MS), glucose syrup (GS) and sorbitol **have restrictions** on their use because they are not as sweet as sucrose or dextrose.

Binders (fillers) and **extenders** are commonly found in a sausage formula. A binder improves flavor and retains natural juices by binding properties (increasing water binding) and prevention of the fat separation during heat treatment. **An extender (if rich with protein) and fillers (if rich with carbohydrates)** can reduce production costs by adding an ingredient to replace some of the meat that is needed. Gelatin , nonfat dry milk, cereal flours and soy protein products are often used. Milk, soy and wheat are common food allergens. You must list these on the ingredient list of the label.

Water

- Added to rehydrate the nonfat dry milk and to replace the expected moisture loss during smoking and cooking
- Up to 10 percent by weight of water may be added to most sausages
- No water is added to sausages that will be dried

The amount of water added to the product is regulated by its *Standard of Identity*

Casings

- Casings are either natural or synthetic
- Natural casings are from sheep, hog, or cattle intestines or manufactured from collagen (an animal protein)
- Synthetic casings are usually made from cellulose
- There must be concern for **potential allergen** exposure with different casing types, as well as, **religious and ethnic preferences**.
- Allergen and Kosher label requirements must be met.
- Beginning Sept. 5, 2001 FSIS regulations require sausage manufacturers to label the source of natural sausage casings if they are derived from a different type of meat or poultry than the meat or poultry encased in the sausage.
- Sausage products encased in regenerated collagen casings will have to have a statement on the label disclosing the use of regenerated collagen.

Product Identity and Standards

Meat Product produced under a registered name must meet the identity standard and contains all necessary ingredients in the amounts specified in the standards.

- Processor must be familiar with the ***Standard of Identity*** for the products produced.
- Federal regulations are very specific in limiting the fat content, the amount of water added, the presence of extenders and variety meats in sausages.

Variety meats include organ meats, glands and other meats that are not part of a dressed carcass. This may include liver, kidneys, brains, heart, tongue, tripe, feet, tail, and cheek meat. Liver and heart may be frozen as well as fresh. Tongue may be fresh, pickled, corned and smoked. Tripe is the lining of a cow's stomach. Pig's feet, or trotters, are available fresh, pickled and smoked.

Cooking and Smoking in a cooked/smoked sausage product is a critical control point. The cook or smoking (with heat) step is critical to kill disease-causing organisms in cooked sausage. ***A minimum temperature of 155°F is considered adequate to produce a safe to eat pork and beef cooked sausages and 165°F is considered adequately to produce a safe to eat cooked sausages containing poultry.***

Curing is a process that usually precedes smoking and can be carried out in various ways: ***by immersion*** in a cure solution containing salt, various flavorings, and sodium nitrate or sodium nitrite; ***by injecting*** the cure solution in the thick part of the muscle tissue; or ***by a combination of injection and immersion.***

(a) Curing processes must be carried out in sanitary noncorrosive - type containers at temperatures of approximately 35 - 40^{o} F. Containers must be emptied of the cure and sanitized after each use.

(b) Curing solutions may not be re-used.

(c) After a meat/poultry product have been removed from the curing solution, washed, drained, and placed in smokehouses, the smoking must be continued until the internal temperature of the product has reached regulatory requirements, regardless of the time and temperatures used in the smoking process.

(d) Nitrates and nitrites are harmful to humans when taken in excessive amounts. For that reason, the use of nitrites must be limited to the following amounts:

1. 2 pounds to 100 gallons of liquid cure
2. 1 ounce to each 100 pounds of poultry in a dry cure procedure
3. 1/4 ounce in 100 pounds of chopped meat and poultry meat

(e) Curing solutions and smoked products, depending on the ingredients used, will support bacterial growth to some degree and will quite readily support molds. For this reason inspectors must maintain good controls over time, temperature, and sanitation.

Cooling is another critical step in a sausage making process. FSIS Compliance Guidelines recommend that cooked meat products be cooled to below 80°F in less than 1.5 hours and below 40°F in less than 5 hours. Sausage products must be cooled properly after

cooking.

Reference: FSIS Appendix B: Compliance Guidelines for Cooling Heat-Treated Meat and Poultry Products, Stabilization

OTHER CRITICAL POINTS IN PROCESSING

In all manufacturing processes that involve the production of heat-and-eat or ready-to-eat products, **Processing Inspectors** must take care to prevent cross contamination between the raw product and the cooked product; **for example**, the slicing and packaging of cooked meat on a table that has been used for deboning raw chicken carcasses can only be done after the table surface has been cleaned and sanitized and confirmed acceptable by a Processing Inspector.

After a study of this section on processing, keeping in mind the few basic facts concerning bacteriology contained in section II of this manual, **Processing Inspectors** can readily see the necessity for constant vigilance in processing plants. In order to maintain effective inspection in further processing, **P.I.'s** are to give attention to the following:

1. Inspection of all materials received.
   a. meat product ingredients
   b. non-meat product ingredients
   c. packaging and labeling material

2. Sanitary handling and storage of raw materials.

3. The maintenance of sanitation and temperature controls throughout product storage processing and distribution.

4. Exercising control over personnel regarding personal hygiene, sanitary work habits,and cleanliness of dress.

5. Detection and elimination of possible sources of contamination of raw and finished product, in addition to cross contamination between raw and cooked products.

The following are some possible sources of cross contamination.

(1) Personnel working in or moving freely between areas in the plant where raw and finished products are handled.

(2) Using the same equipment such as racks, pans, or tubs in both areas without proper cleaning and sanitizing.

(3) Combining equipment used in both areas during cleaning operations.

(4) Moving contaminated material through the final processing area.

(5) Inspectors should remember that the area where raw products are handled is considered a contaminated area and should be isolated from the final processing area

PRODUCING CURED MEAT CUTS

Entire pieces of muscle meat and reconstituted products

Curing is the treatment of muscle meat with **common salt** (NaCl) and **sodium nitrite**[1] ($NaNO_2$). It is applied in the manufacture of sausages or similar products, but also for larger pieces of meat selected for cured meat specialties. In the past, when refrigeration was not commonly available, curing was mainly applied to extend the storage life of entire pieces of muscle meat by using the preserving effects of common salt (in high concentrations) and to a lesser extent sodium nitrite. In modern meat processing, this aspect is less important as more efficient meat preservation methods, in particular cooling and freezing, are available. Curing is now mainly applied to achieve a pink-red color as well as a typical flavor and taste in processed meat products.

Cured-raw pork loin ("coppa"), left, and cured-cooked pork loin ("smoked loin"), right

Cured meat cuts made of **entire** pieces of muscle meat, constitute a specific group of meat products. The opposite are **comminuted** cured meat products, to which sausages and similar preparations belong. In principle, the cured meat cuts can be sub-divided into two groups, **cured-raw meats** and **cured-cooked meats**.

For ***cured-raw meats***, usually entire muscle groups in their anatomical connection are used. Typical examples are whole pork hind legs or parts of hind legs (topside, silverside, and round), pork loins and bellies, beef briskets and/or cuts from beef hindquarter. In some regions mutton legs, ostrich breasts and game meat cuts are also produced as cured meat cuts.

[1)] Sodium or potassium nitrate ($NaNO_3$/KNO_3) are alternative curing substances but generally not needed and not recommended for the usual processing methods, if sodium nitrite is available (see page 35, 119).

For ***cured-cooked*** **meats**, similar meat cuts as mentioned above and smaller meat pieces can be used as raw material. These pieces vary in size and can be much smaller than individual muscles. After curing (in most cases combined with tumbling), the pieces are joined together in special containers (moulds) and/or casings prior to cooking to "reconstituted meat".

The curing for both groups, **cured-raw** and **cured-cooked**, is in principle similar: Small amounts of nitrite, either as dry salt or as salt solution in water, have to be brought in close contact with the muscle tissue in order to effect the curing reaction with the muscle pigment myoglobin.

The decisive difference between the two groups of cured meats is:

- **Cured-raw meats** - *do not undergo any heat treatment* during the manufacturing process and need to be kept in controlled conditions during their entire processing period which comprises curing, fermentation and ripening. During this period a decrease of the moisture content is achieved resulting in a moderate drying effect of the meat. Fermentation and ripening processes take place simultaneously with the drying and make the products palatable.
- **Cured-cooked meats** - after the curing process of the raw muscle meat, *always undergo heat treatment*, either at pasteurization or sterilization temperatures, to achieve the desired palatability. Moisture losses would make the products dry and are therefore not desirable.

Cured-raw meat

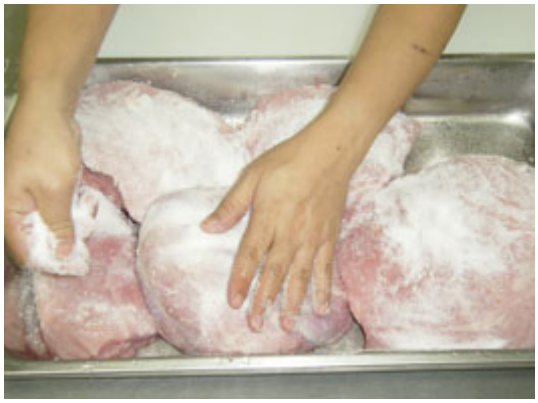
For cured-raw meat, fresh meat of **good hygienic quality** should be used, as this aspect has a crucial impact on the long shelf-life and typical flavor of the final products. The fresh meat selected for cured-raw products should have a low pH, as **lower pH-values** result in lower water binding capacity, thus allowing for adequate release of water (drying) during the fermentation and ripening phase. If the meat remains in the high pH range and retains high moisture content, it would spoil during the prolonged ripening phase. pH-values below 5.6 in the selected fresh lean pork and even lower for beef are recommended. Meat from older animals is equally suitable due to its decreased water holding capacity.

Raw-cured meat cuts are not submitted to any heat treatment and consumed raw. The exception is *Jinhua ham*, which Chinese consumers prefer to boil in soups or similar, but it can equally be eaten raw.

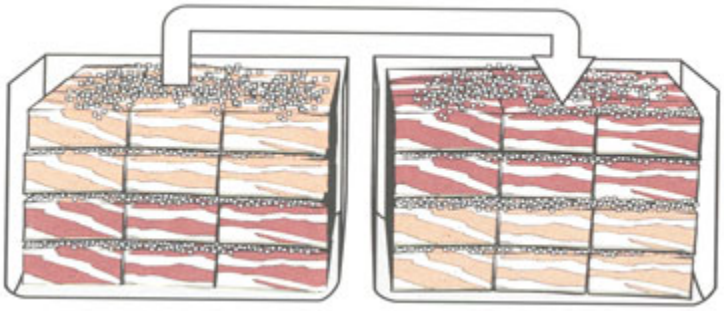
Curing and ripening

Products under this category are manufactured by **applying curing salt** (combination of 99.5% common salt and 0.5% sodium nitrite) either dry or in solution or in a combination of both. After the curing, specific processes of **fermentation**, **drying** and **ripening** take place in the meat. The duration depends on the size of the meat pieces and the type of products, but lasts usually between three to six months. For some raw ham specialties the process can take up to 24 months.

a) Dry curing



Rubbing with salt for dry curing



Dry-salting. Periodic re-arrangement of meat piles

Dry-salting is the traditional favored method for raw-cured meat. Meat cuts (entire pieces of muscle meat) are **rubbed with curing salt**. Thereafter these meat pieces are **packed in curing tanks** and **piled** on top of each other with layers of curing salt between them and stored at low temperatures (0 to +4°C). The curing salt **infiltrates** the meat tissue and at the same time liquid from the meat tissue is **extracted** by the salt surrounding the meat. The liquid accumulates at the bottom of the curing container. Sometimes, this liquid covers the lower piles of meat pieces and contributes an additional curing and flavoring effect, in other cases this liquid is drained out. Due to the weight of the rubbed meat cuts, the pressure within the pile is higher at the

bottom of the container. This results in faster liquid loss and salt infiltration. For equal distribution (uniform exchange process) re-piling and adding of dry curing salt should be carried out every seven days with the lower piles up and the upper ones down.

Depending on the size of the meat cuts, the **curing process** alone can last up to several weeks for equal penetration of the meat cuts with curing salt. At temperatures of about +4°C, a pork shoulder takes about two weeks, a leg of pork about four weeks. The same curing periods apply to beef cuts of comparable size. In all dry-curing methods the meat should be covered to protect it from the air. The liquid, which may develop in the first few days, when the salt extracts the juice from the meat, can be removed, but additional smaller amounts of dry curing mix must then be sprinkled over the meat cuts. If the liquid is left at the bottom of the container, care should be taken that re-piling is done more frequently.

In combination with the dry curing salt, also **spices** and **sugars** for flavoring and **sodium ascorbate** for enhancement of a typical curing color (pickling-red) are used simultaneously. The use of ascorbic acid (instead of sodium ascorbate) in curing mixes and/or brines is discouraged as it could lead to a violent chemical reaction with the nitrite, especially when dissolved in water together with nitrite. The result would be fast nitrite breakdown and loss of its functional property.

As exception to the common technology of using curing salt (containing nitrite or nitrate, or a mixture of both, some well-known traditional cured-raw ham products (e.g. *"Parma Ham"* and *"San Daniele Ham"* in Italy, *"Jinhua Ham"* in China *"Jamon Serrano"* in Spain, *"Jambon Savoie"* in France, or *"Virginia Ham"* in US) are fabricated without nitrite using **common salt** only. For these products carefully selected pork hind legs with bone are used. Although no nitrite is used, a stable red color is achieved in these cured-raw ham products.

This red color derives from the natural meat color intensified by the drying and ripening process, in some instances traces of nitrite and nitrate in salt and spices may also contribute.

b) Dry-Wet curing

This method is also sometimes practiced in order to **facilitate a standardized curing process** in bigger meat cuts of slightly different size in one curing container. The meat cuts are dry-salted as usual and piled up layer by layer in the curing containers. The liquid extracted from the meat tissue by salt

accumulates at the bottom of the curing container and is topped up to reach to upper piles by separately prepared brine, usually with 15-20% curing salt concentration. The brine must be checked periodically for density and salt concentration and replenished as necessary to assure even curing. The curing brine can also contain spices for enhanced flavor and sodium ascorbate to further stabilize the curing color. After 5-7 days the meat cuts are re-piled and covered again by the curing brine. As a rule of the thumb, the curing time for the biggest meat cut is 2 days per kg of its weight at a brine/meat ratio of 1:2. This is followed by a drying/ripening phase.

Fast curing with additional brine injection

For some raw-cured products smaller amounts of curing brine are injected directly into the muscle tissue to accelerate the curing process. This technique significantly shortens curing periods, as curing substances migrate in both directions, from outside to inside and from central to less central parts. But because of the accelerated process, the curing flavor remains less intensive and texture of these products remains softer then in products applying dry or dry-wet curing. The shelf life is also reduced significantly and most products are kept refrigerated. Typical products of this fast-cured type are **cured/smoked pork loin** and **breakfast ham** (low price raw ham). Fast curing with injection of curing brine will therefore remain the method of choice for **rapid turnover cured-cooked meat products** only.

Quick cured-raw breakfast ham Vacuum packed to stop weight loss

c) Ripening and fermentation of cured-raw meat products

After the curing period, a **ripening** (maturing) and **fermentation period** is required for the full development of the typical flavor of raw-cured meat products. At the start of the ripening period, all curing salt is removed from the meat surfaces and the meat cuts are either spread on trays or hung on sticks in refrigerated rooms at initial temperatures between +2 and +5°C (Fig. 217). During this phase the cured meat cuts develop the typical flavor, color

and texture. In the course of the ripening period, temperatures are gradually increased, but should not exceed +12°C. Ripening is a very slow process and can take up to several months for specific products. Throughout the entire process (curing, ripening, fermentation) the meat looses a significant portion of its water content. This process starts during curing, when salt penetrates the meat in exchange for moisture, and is continued during ripening, when moisture from the meat evaporates and dry partially. At the end of the ripening phase the salt concentration should reach ³4.5% (a_W 0.96) as this ensures a microbiologically stable product. Hams dried and fermented in natural or controlled air are called **"air dried hams"**. **Air dried beef** is a very tasty product and attracts high prices.

Fig. 217: Drying and ripening stage of cured-raw hams (suspended in ripening room after completion of curing)

For *"Parma Ham", "San Daniele Ham"* and "*Jamon Serrano"*, the whole process including curing, drying, fermentation and ripening leading to the product ready for consumption can take up to 24 months. Process periods (curing, drying, fermentation and ripening) for *other* raw-cured products see table 9.

d) Smoking

For many of the larger raw-cured meat cuts and depending on the region it is common to apply short sequences of **cold smoke** (around 20°C) during the ripening stage, especially in regions with wet and/or cold climate. The high air humidity in these regions increases the risk of mould growth on the meat surfaces, which can be prevented by the antimicrobial effect of smoke. This category of products is called **"smoked raw hams"** (Fig. 220).

Table 9: Treatment for raw fermented products

	Curing period temp	Post-curing period	Optional cold smoke	Ripening, fermentation, drying
Pork leg (Ham) dry cured	15-30 days 4-8°C	3-5 days 8-12°C	5-30 days 12-18°C	Normally up to 9 months (Parma etc. up to 24 months) (water content in muscle tissue ~62%); +2 to +5°C, later higher
Smaller meat pieces dry cured	4-10 days 4-10°C	1-3 days 8-12°C		Few days to few weeks (water content in muscle tissue 67% and above); +4 to +10°C, later higher

Fig. 218: Well ripened ham, bone-in, air dried

Fig. 220: Raw ham, heavily smoked

Fig. 219: Well ripened ham, bone-in, air-dried

Fig. 221: Beef, dry cured, rectangular shaped through pressure during curing and fermentation, ripening period several months, surface layer edible yeasts

Cured-cooked meat products

Raw meat material used for cured-cooked meat products is mainly pork derived from hind leg, shoulder or loin. In some regions, lean muscle meat from other species (here mainly from beef carcasses, Fig. 231) may also be processed to local cured-cooked specialties. In some regions cured-cooked beef tongue is a delicacy. Meat from younger animals with **higher pH values** is preferred (for pork pH above 5.6, preferably 5.8-6.0). Higher pH values are associated with better water binding capacity. Contrary to cured-raw products, where low pH-values are desirable to boost moisture decrease, high pH-values are desirable for cured-cooked products to retain the full moisture content.

For high quality products and regional delicacies, **entire pieces of muscle meat** (Fig. 226, 230) are cured and cooked. These meat pieces may consist of defined muscle groups, such as ham or large back muscle. Medium quality cured-cooked meat products are normally **reconstituted** (Fig. 228, 231) from smaller size lean muscle parts, which

are cured and tumbled, tightly filled in special containers and cooked (Fig. 413, 414). For the low-cost market so-called **"re-formed"** products have become popular. For these products, small muscle pieces and lean trimmings are mixed with brine (water, salt, binders, extenders, etc. The mixture is tumbled, stuffed into casings or cans and heat treated. The individual processes are described below. The meat temperature should ideally be kept below +4°C during the curing process.

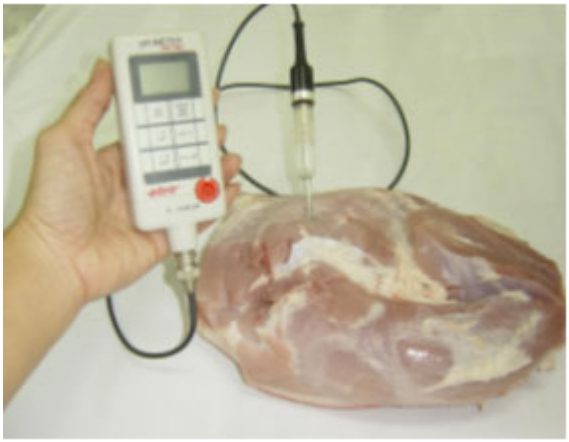


Fig. 222: pH – measurement in ham

Processing Technology

There are slight differences in the processing technology of cured-cooked products, mainly depending on the size of the meat parts used for product manufacture. Curing brine is administered in all products. This is usually done by brine injection.

Even distribution of the injected brine is achieved by treating the injected meat pieces in a meat tumbler (Fig. 28, 228). When no tumbler is available, “resting periods” for the meat pieces are needed.

When meat pieces are too small for brine injection, they are transferred untreated into the tumbler together with an adequate amount of curing brine, which will be absorbed into the meat tissue through the massaging effect of the tumbling.

Preparation and application of curing brines

An essential part of cured-cooked meat processing is the **use of curing brine**. For some products, curing brine is partly injected directly into the meat tissue and partly used in solution in which the injected meat cuts are submerged prior to cooking. In re-constituted cured-cooked meat products, a mixture of meat pieces, trimmings and curing brine (often enriched with additives for increased binding) is subjected to tumbling. All these curing brines have different compositions and salt concentrations.

Table 10: Injection of curing brine

Cooked cured	
Concentration % (curing salt)	Volume % (injected brine)
8-14	15-20

All curing brines contain **nitrite curing salt** dissolved in potable water. The recommended ***salt concentration*** in brines for cured-cooked meat pieces is 8-14%. **Seasonings** are also often added to a brine to impart a uniform flavor in the final product. Here liquid spice extracts are best suited as solid spice particles can cause blockage of injection needles. Other common additives in the curing brine solution are **cure accelerators** and **phosphates**. The common cure accelerator used in cured-cooked meat products is ***sodium ascorbate***.

The use of ascorbic acid must be avoided. Sodium ascorbate (0.1-0.2%) should only be added to the curing brine immediately before application, as otherwise the substance could initiate a premature breakdown of the nitrite.

Other additives used in small amounts include **sugars**. In only mildly pasteurized products sugar might cause undesirable acidity during prolonged product storage, due to active Lactobacillus bacteria. The addition of ***phosphates***, especially in combination with salt, increases the water binding capacity of raw meat and contributes to improved texture in the final product after heat treatment (see Fig. 230). In low-cost products with increased yield (reconstituted hams), additional non-meat additives can be used, such as **isolated soy protein**, and **modified starches**. In these rather complicated curing brines, care must be taken that all additives are completely dissolved and evenly distributed.

Table 11: Approximate addition to curing brines for injection[1] (referring to 15-25% brine injection)

Additives	% in brine
Curing salt	8 - 14
Phosphate	1 - 3
Sodium ascorbate	0.15 - 0.20
Isolated soy protein	4 - 6
Sugar	1 - 4

Gelatin	1 - 2
Carrageenan	0.5 - 2
Modified starches	1.5 - 3
Glutamate	0.2 - 0.3

The following sequence is commonly recommended for the successful preparation of curing brines (Fig. 223, 224, 225):

- Firstly phosphates are dissolved by continuous stirring
- Secondly isolated soy protein is added and dissolved
- Then salt is added and dissolved followed by carbohydrates (sugars), gelatin and carrageenan
- Lastly modified starches and cure accelerators are dissolved

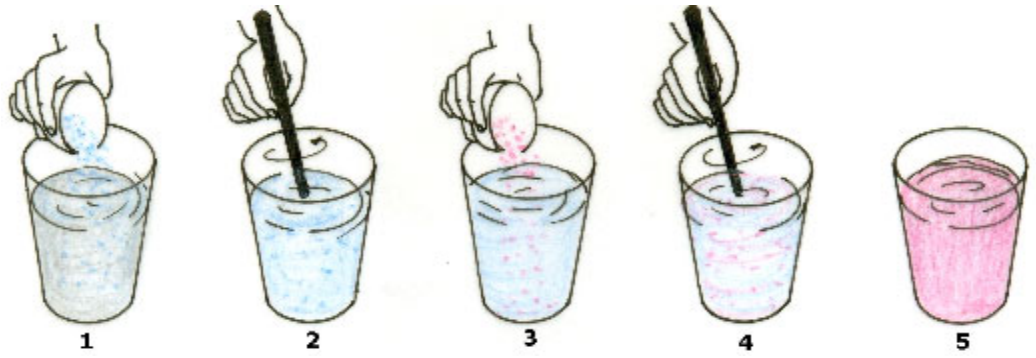


Fig. 223: Preparation of common curing brine (containing curing salt and phosphate)
Correct order of dissolving components
1 = Add phosphates first, 2 = Stir and dissolve, 3 = Add nitrite curing salt, 4 = Stir and dissolve, spice extracts can be added at this stage, 5 = Brine ready for application

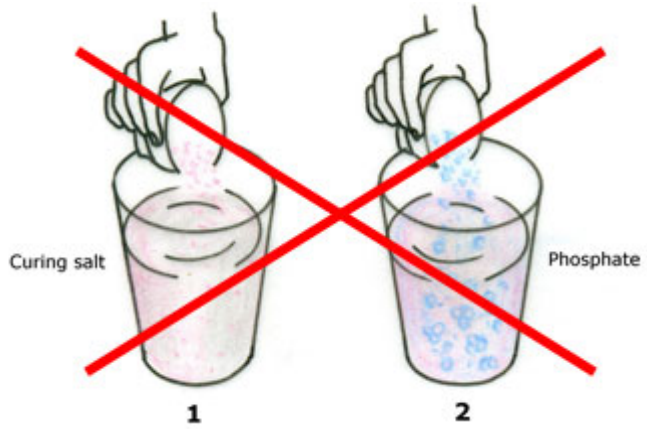


Fig. 224: Wrong order of dissolving components for curing brine (leads to clotted phosphate) (phosphate must be dissolved first!)

[1)] There may be variations involving a wider range than indicated in table 11 depending on local processing techniques and national regulations.

Fig. 225: Correct order of dissolving ingredients in complex brines 1 = phosphate, 2 = isolated soy protein, 3 = curing salt, sugar, gelatin and carrageenan, 4 = modified starches and sodium ascorbate

To reduce bacterial contamination of the cured meat, particularly through injection, curing brines must be **hygienically** prepared and handled. For example in case of poor hygienic water quality, the water used for the curing brines should be boiled and thoroughly chilled again before application. This can be achieved by either cooling the potable water in the cold room, or by direct addition of ice (use of ice water). When using ice, care must be taken that it has completely melted prior to injection of the curing brine. Large portions of remaining solid ice, into which no salt penetrates, would result in too high a salt concentration in the liquid part of the brine. The temperature of meat and brine should not exceed +4°C. One important additional benefit of such low temperatures is the increased amount of protein going into solution,

thus contributing to improved water holding and reduced cooking loss of the final products.

Whole muscle products

Fig. 226: Manual brine injection

Curing brine injection is the method of choice for a fast curing process of large meat cuts (entire pieces of muscle meat) to be processed through curing and subsequent heat treatment. The curing brine solutions are injected into the muscle tissue by using either manually operated **curing brine pumps** with a single or multi-needle device (Fig. 226) or automatic **multi-needle brine injectors**. The curing brine injection should take place in small quantities and repeatedly in various different spots of the muscle tissue. Injection of huge quantities of brine in one or few isolated spots would cause ruptures of the meat tissue and substantial loss of brine. Usually 15-20 % of brine (by volume) having a salt concentration 10-14 % are injected into. Both parameters need to be carefully balanced in order to achieve the desired salt concentration in the final product, which are normally between 1.8% and 2.4%, depending on the product type.

The **equipment used** for the curing brine injection (pump, hoses, needles) must be thoroughly cleaned and periodically disinfected to prevent the transfer of microbial contamination from dirty equipment into the meat.

Excessive pressure during brine injection or the injection of larger quantities of brine into one spot must be avoided, as both would damage the meat tissues. Muscle pumping, even if done properly, may still result in unequal distribution of the brine throughout the meat cuts. For this reason the curing is usually completed by immersing the meat in curing brine of the same composition as the one injected ("resting period"). This method has the advantage that losses of injected curing brine are replenished.

The "**resting time**" for products, which are not tumbled, should be 24-48 hours under refrigeration. This will further enhance the uniform distribution of salt and curing substances and ensure the development of an attractive red curing color throughout the meat cuts prior to cooking.

If tumbling equipment is available, the immersion of the meat in brine ("resting period") is not necessary. In this case, the drip-off of brine lost during injection is added to the tumbler and will be reabsorbed by the muscle tissue during tumbling.

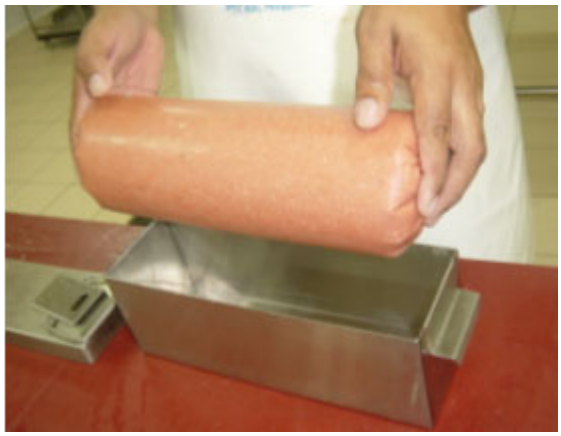


Fig. 227: Filling meat pieces in casing and putting in mould before cooking

The curing color is further stabilized during the first phase of the subsequent heat treatment, while passing through the temperature range of 30-50°C. Large cured meat cuts (e.g. boned pork legs) can be kept in the desired shape by tightly binding them with layers of string. In recent years this labor-intensive method has been increasingly replaced by using **expandable nets**. These more traditional products are often **hot-smoked** prior to cooking in steam. Alternatively, the meat cuts can also be tightly pressed into ham moulds, round or square (Fig. 414), or stuffed into heat resistant plastic bags or casings and cooked (Fig. 227).

Reconstituted meat products of the cured-cooked type

Cured-cooked meat products can also be produced from **smaller muscles or muscle parts** (Fig. 228, 229). These smaller size meat pieces are usually derived from meat cutting and grading operations. The main purpose of these procedures is cost reduction, as carcass parts can be more profitably utilized. The most common source is pork meat; mainly hind legs, shoulders or loins are de-boned and dissected. The dissection enables grading according to lean and fat, dark or bright meat color and even according to the pH of individual muscle tissues.

The selected smaller muscles or muscle parts undergo preparatory **treatments**. Care must be taken that all fat and connective tissue layers are removed from the meat surface. These undesired tissues are either removed manually or by using electrical “skinning” machines. The lean surfaces of the muscle pieces should be **incised** by knife, as this, in combination with the application of curing brine, facilitates the release of liquefied muscle protein, which in turn coagulates during heat treatment and makes the meat pieces stick firmly together.

In the next step, the smaller muscles or muscle parts are injected with curing brine and subjected to a resting phase of 24-48 hours. **Cure accelerators, phosphates**, and **spices** are added to the curing brine as described in sub-chapter “Whole muscle products” (page 182). The cured meat pieces are then tightly pressed into ham moulds and cooked. To facilitate the necessary firm coherence of the meat pieces, some meat processors sprinkle small quantities of gelatin powder onto the meat surfaces to be bonded together.

The release of liquefied muscle protein in particular on the surfaces of meat pieces can be further enhanced by subjecting the brine-injected or brine-infiltrated meat pieces to **tumbling**. Tumbling is the mechanical treatment in special equipment, either in rotating drums with fixed massaging humps or in fixed drums with rotating massaging arms (see also page 28 and Fig. 228). Tumbling takes place at temperatures of <4°C (-5 to -8°C is best) for several hours (up to 24 hours) (Fig. 229). Tumbling or massaging followed by **heat treatment** allows the meat processor to reconstitute larger and uniformly shaped cured-cooked meat products from smaller meat pieces of different sizes and shapes. At the industrial scale large quantities of such products are manufactured.

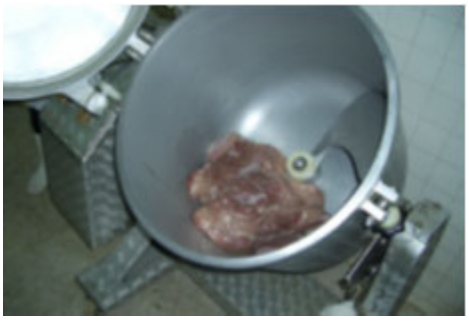


Fig. 228: Tumbling of pork pieces, brine added to tumbler

Fig. 229: Pieces of pork after tumbling

Apart from the above processed goods the use of a tumbler enables production of low-cost cured-cooked products. Lean meat pieces and trimmings from all parts of the carcass are coarsely ground, placed in the tumbler together with the desired quantity of curing brine and tumbled/mixed. Such products very often contain non-meat additives for cost reduction and improvement of the binding and water holding capacity of the mixture, such as **soy protein** (isolate), **hydrocolloids** (carrageenan), **gelatin**, **transglutaminase**, etc.

In general, in order to facilitate a timely and uniform tumbling/curing process, larger meat pieces are **brine-injected** prior to tumbling, while smaller pieces can go uncured directly into the tumbler. Care must be taken that the correct quantity and concentration of **curing brine** is added. Amounts and concentrations of brines must be carefully balanced in order to maintain the targeted salt content of the final product, which should be in the range of 2% (see also table 12).

Table 12: Treatment for cooked cured products

	Brine injection	Treatment after injection	Heat treatment of products in containers (moulds, foils, etc.)
Entire meat pieces	Brine 15-20 % by volume with a salt conc. of 10-14% Temperature 0°C	Resting period for penetration of curing salts (12-26 hours, 0-4°C), with or without tumbling	Water/steam Temperature 70-75°C Internal temp 70 (72) alternatively: hot smoke for bacon, pork chops
Small pieces to be reconstituted	Brine by 15-20 volume % with a salt conc.. of 10-16% Temperature 0°C	Tumbling for equal distribution of all ingredients, 8-12 hours (15 min. tumbling, 15 minutes rest) (0-4°C or below)	Water/steam Temperature 70-75°C Internal temperature 70°C (72)

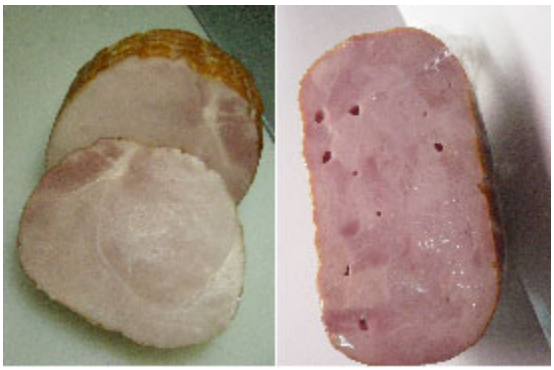


Fig. 230: Entire cooked ham (left) and tumbled reconstituted cooked ham (right)

Fig. 231: Beef ham as a cured-cooked product, made of one entire piece of muscle

NOTES

If equipment that comes in direct contact with either product or product ingredients is prone to rusting---it is constructed of unacceptable material and is to be rejected from use.

SECTION IX – FAT AND MOISTURE CONTROL

Please note that some information at the beginning of this chapter is purposely repeated here for the benefit of the reader and better understanding of that chapter topic.

COOKED AND SMOKED SAUSAGES

Emulsified sausages are cooked sausages that have been finely comminuted (all ingredients reduce to mash/pulp) to consistency of a fine paste.

- Finely comminuted or emulsified sausages may contain **no more than 30% fat** or a **combination of 40% fat plus added water**. This limitation is imposed to protect consumer who due to finished product appearance of this type of sausage ~~is~~ are ~~not~~ unable to visibly (see) determine how much fat the product contains.

Examples: frankfurthers (franks), hot dog, wieners, vienna sausage, bologna, garlic bologna, etc.

Coarsely ground sausages consist of rather large ground meat/poultry elements, not fine or delicate in texture, structure, or form.

- have a **10% added water** limit in the **finished product**
- **have no fat** limitation as the fat content can be **visible** determined by the consumers.

Examples: Polish, cotto salami, kielbasa, and bierwurst

Water

- Added to rehydrate the nonfat dry milk and to replace the expected moisture loss during smoking and cooking
- Up to **10 percent by weight of water** may be added to **most sausages**
- Up to **3 percent for fresh products** to allow for ingredient mixing
- No water is added to sausages that will be dried

Cooking

All meat products must be cooked to the required temperature in order to kill pathogens to be safe for consumption as RTE product. This internal cooking temperatures and cooking times must be carefully monitored and recorded.

- **Temperature of 145°F** is considered adequate for **whole muscle cuts of pork, beef, veal and lamb with an added 3 minute dwell time (rest time).**

- **Temperature of 160°F** is considered adequate for **ground pork, beef, veal and lamb patties.**

- **Temperature of 165°F** is considered adequate for **poultry.**

SHELF- STABLE READY TO EAT (RTE) MEAT/POULTRY PRODUCTS

It is the Meat, Poultry Egg Safety Branch's function to "Ensure a clean, wholesome, unadulterated, properly labeled product, is produced in a sanitary environment" is presented to the consuming public.

Dry and semi-dry meat and poultry product produced under State inspection include but not limited to are; *Jerky, Mexican Style Chorizo, Basterma, salami, summer sausage thuringer, meat sticks, and other various dried sausages.*

It is not unreasonable to expect processors of shelf stable ready-to-eat (RTE) product to have scientific supportive documentation (e.g. finished product sample results, or established guidelines they follow) to ensure the elimination of pathogens of concern and compliance with product standards of identity prior to product being sold or given to the public for consumption.

All establishments producing RTE product under State inspection must implement adequate method to control, reduce, or eliminate the biological hazards known to be associated with production, handling, and packaging of this type of finished products. These most likely will include but it is not limited to microbiological hazards from **Salmonella, Staphylococcus aureus, Listeria monocytogenes, and Escherichia coli 0157:H7.**

Currently there is no requirement for a **lethality step** (Heat application) to be applied to–**Dry shelf stable RTE** meat and poultry products. **However**, in the absence of an acceptable heat treatment the processor of such type products is required to produce supportive documentation that their process produces a safe product.

For United States Department of Agriculture (U.S.D.A.) inspected establishments this issue is addressed in the regulatory required Hazard Analysis Critical Control Points (HACCP) plan.
For U.S.D.A. establishments, the regulatory required Sanitation Standard Operating Procedures (SSOPs) addresses the issue of product (s) post-lethality handling to prevent re-contamination or cross-contamination of the pathogens of concern in regards to shelf stable RTE products.
As the Meat, Poultry and Egg Safety Branch (M.P.E.S.B.) now requires all retail processors to have written implemented Sanitation SOPs the issue of product handling is addressed.
In addition the M.P.E.S.B. requires product that is to be fully labeled to meet the following U.S.D.A. standard of identity in regards to shelf stable RTE product.
The U.S.D.A. does not use Moisture Protein Ratio (M.P.R.) to determine if a sausage product is shelf stable but for labeling purposes only.
A finished product with a M.P.R. of 1.9:1 or less in considered a "dry sausage" and is deemed shelf stable without regards to pH. U.S.D.A. regulations state:

A semidry sausage is shelf stable if it has a M.P.R. of 3.3:1 or less, a pH of 5.0 or less and does not contain more than 3.5 percent binders or 2 percent isolated soy protein .

If a semidry sausage's M.P.R. is greater than 3.1:1 it can still be considered shelf stable if its pH is less than 4.5 (4.6 if the water activity is less than 0.91), has a brine (salt) concentration of greater than 5 percent, has appropriate levels of nitrite or nitrate, is smoked using natural wood smoke, and is intact (whole muscle), or if sliced, vacuum packed.

SALAMI "COOKED"

The product "Salami" must be labeled to include the work "Cooked" regardless of the type and size of its packaging unless one of the following:

1. A salami with a moisture protein ratio of no more than 1.9 to 1;
2. "Genoa salami" with a moisture protein ratio of no more than 2.3:1;
3. "Sicilian salami" with a moisture protein ratio of no more than 2.3:1;
4. Labeled as . . . ,
   a. Kosher Salami,
   b. Kosher Beef Salami,
   c. Beer Salami, and
   e. Salami for Beer.

PRINCIPLES OF PRESERVATION OF SHELF-STABLE DRIED MEAT PRODUCTS

In general, the term "shelf-stable product" refers to those products that do not require refrigeration or freezing for safety and acceptable organoleptic characteristics. Most often, the products are stored at "room temperature" (ambient). This shelf-stability also is often dependent upon the proper packaging to control oxidation and potential mold growth. The shelf-life for these types of products is usually defined for acceptable quality, not safety because the safety has been addressed in the production process. MPESB is concerned with product safety and not quality attributes, which are concerns of the establishment.

The shelf-life of the product is defined as the time the specific product can be stored under specified conditions that retains organoleptic acceptability. Shelf-life is determined by two kinds of deterioration: microbiological (spoilage) and chemical (oxidation and physical).

This chapter describes the principles of food preservation as they relate to dried meat products. It will cover:

1. The interaction of factors that affect shelf-stability;
2. The relationship between drying, acidification, and heating;
3. The minimum $\mathbf{a_w}$ and pH values required for microbial growth;
4. How additives affect shelf-stability;
5. How moisture/protein ratio applies to these products;
6. Process validations for these products; and
7. The critical process parameters for dried meat products.

The objectives of this section are for you to be able to:

1. Identify the relationship between, drying, acidification and heating in the production of shelf-stable products.
2. Recognize how moisture/protein ratio relates to product water activity.
3. Recognize that microbial thermal resistance will vary due to product characteristics.

Shelf-stability and Hurdle Effect

Shelf-stability is due to a combination of factors, otherwise known as the "hurdle effect". The interaction of these factors affects specific microorganisms and chemical reactions. Controlling the various factors and interactions maximizes the total effect and achieves shelf-stability.

Food preservation technologies usually are classified into three types.

1. **Prevention/removal of contamination**
   e.g., decontamination of raw materials (steam treatment and organic acid washes of carcasses, irradiation of spices), aseptic processing

2. **Inactivation of microorganisms**
   e.g., heat (pasteurization, sterilization), high pressure processing

3. **Slowing or complete inhibition of microbial growth**
   e.g., low temp, water activity, redox potential, pH, or preservatives

For dried meat products, preservation is mostly due to the slowing or complete inhibition of growth, although inactivation of pathogens such as *E. coli* O157:H7 is also involved.
The following are the most common factors relating to the safety/shelf-stability in dried meat products.

- water activity (a_w)
- pH
- time/temperature/relative humidity
- salt/brine strength
- microflora types

Other factors, such as the following, can also be important in the safety/stability of certain products.

- titratable acidity (% acid)
- moisture content
- packaging: modified atmosphere/vacuum
- preservatives
- hydrostatic pressure (high pressure processing)

With dried meat products, **water activity probably is the most important factor** contributing to shelf-stability over the total range of products. If pathogens (microorganisms that can cause disease) are still viable, the product is adulterated. For the most common microorganisms associated with these products, the minimum water activity for growth is as follows.

E. coli O157:H7	0.95	*Campylobacter*	*0.98*
Pseudomonas	0.97	*Listeria monocytogenes*	0.92
Clostridium botulinum (non-proteolytic)	0.96	Some LAB	0.92
C. botulinum (proteolytic)	0.93	*Staphylococcus aureus* (anaerobic)	0.90
Clostridium perfringens	0.93	*S. aureus* (aerobic)	0.86
Most LAB	0.95	*Aspergillus flavus*	0.80
Salmonellae	0.94		

The product pH is the second most important factor, particularly considering that many of these dried meat products are fermented to some extent, or exhibit some microbial activity to yield the final product characteristics. Minimum pH values for growth for the relevant microorganisms are as follows.

Clostridium perfringens 5.0
Campylobacter 4.9
Clostridium botulinum (proteolytic) 4.6
E. coli O157:H7 4.0-4.4
Pseudomonas 4.4
Listeria monocytogenes 4.4
Yersinia enterocolitica 4.2
Staphylococcus aureus 4.0
Salmonellae 3.8
Most LAB 3.0-3.5
Aspergillus flavus 2.0

Inhibition of microorganisms by pH depends on many factors, including the type of acid and the temperature. The minimum pH that allows for growth of *E. coli* O157:H7 is generally closer to 4.4, but it will survive well at lower pH values, especially if refrigerated.

Microbiological minimum or maximum limits for growth are primarily due to temperature, water activity, pH and/or the presence of preservatives. The limits of water activity and pH as shown above apply only when all other factors are optimal for growth of the specific microorganism. In food materials, especially dried meats, the environmental conditions are hardly optimal and if more than one preservative effect (i.e., hurdle) is present, the effects may be added together (synergistic), and may even be more effective than the two factors alone. For example, in a dried fermented meat product, the competitiveness of commonly occurring microorganisms varies with storage temperature, water activity, pH, presence of additives (e.g., salt, nitrite) and lack of oxygen.

The hurdle effect occurs when the combination of inhibitors is more restrictive than the individual inhibitors alone – a synergistic effect. Often, the hurdle effect allows the use of lower levels of the individual inhibitors that can result in a more organoleptically acceptable product, e.g., dried meats can have a higher water activity with lower pH. In other words, the meat product is more acceptable at the higher water activity (e.g., more tender), but normally this higher water activity would not give shelf-stability. By lowering the pH, the combination of the final water activity and the pH results in a shelf-stable product.

The most important hurdles in food preservation are.

- high temperature
- low temperature
- reduced water activity
- increased acidity
- reduced redox potential
- preservatives
- competitive microflora

For shelf-stable dried meats, the last five hurdles are of primary importance, since these products are not sterilized, often not pasteurized, and certainly not distributed frozen.
The main objective in the formulation and processing of a shelf-stable, dried meat product is to arrive at a combination of hurdles that favor desirable microorganisms over undesirable microorganisms while also maintaining a consumer acceptable product. There are many combinations of hurdles that can achieve product stability.

Typical fermented sausages have been categorized as either “very perishable” (pH > 5.2; a_w > 0.95), “perishable” (pH 5.2-5.0 or a_w = 0.95-0.91)) or “shelf-stable” (pH 5.2 and a_w < 0.95 or only pH < 5.0 or only a_w < 0.91) according to their respective pH and a_w, assuming typical levels of the other hurdles such as salt, curing agents, etc.

►Fermented Sausages

Fermented sausages demonstrate a lowering of product pH due to fermentation, followed by weight loss and decrease in water activity during drying. These vary in their rate and extent depending upon the specific formulation and process.

►Water Activity

Water activity probably is the most important single factor for shelf-stability (as indicated by microbial stability) in most dried meats. Water activity, expressed as a_w, is the vapor pressure of the product divided by the vapor pressure of pure water. Relative humidity measurement is expressed as a_w x 100%.

Water activity values in foods vary: fresh meats, fruits and vegetables, greater than 0.98; dried sausages and condensed milk, 0.85 – 0.93; honey and chocolate, less than 0.60. For dried meats, semi-dry sausages exhibit a_w values from 0.95-0.97 while dry sausages generally show values of 0.85 – 0.93. Dried hams, coppa and beef jerky generally have a_w values less than 0.88. Pork rinds have a_w values less than 30. When other environmental conditions are optimal, most microorganisms do not exhibit growth below 0.91 water activity, with a few relevant exceptions, notably the staphylococci and fungi. *Staphylococcus aureus*, a common meat pathogen, can grow as low as 0.86 water activity depending upon the other growth conditions, particularly if oxygen is present.

Water activity, also referred to as a_w, is a measure of the concentration of moisture (i.e., water) and its availability in a food. The amount of water available in a food depends on the total concentration of all dissolved substances in the product because they bind water. Thus, if ingredients such as salt or sugar are added to food, they compete with the bacteria. A water activity critical limit of 0.85 or lower should control growth of all bacterial pathogens of concern as well as mold for products stored in an aerobic or oxygen containing environment such as in ambient air; however, if the product is vacuum packaged in an oxygen impervious packaging (creating an anaerobic environment where no oxygen is present), the water activity critical limit could be 0.91 or lower. These limits are based on the growth and toxin production limits for *Staphylococcus aureus* under optimal conditions with and without oxygen present (ICMSF, 1996). Establishments that choose to use these limits as support for the shelf-stability of their product may cite this guideline as supporting documentation for these limits and are not expected to provide additional scientific support.

►Moisture/Protein Ratios

Moisture/protein ratios – MPR – are commonly used in the U.S. to classify dried sausages and other meat products. These ratios express the percent moisture divided by the percent protein. Dried meat MPR values vary from 3.7:1.0 for Thuringer to as low as 0.75:1.0 for beef jerky. These MPR values are currently FSIS labeling standards and are historical in nature, representing average values of a market basket survey of representative products exhibited at the time of initial classification for labeling. Although the MPR values do indicate the degree of product drying, they are not necessarily indicative of microbial safety or stability, as is the case with a_w values. Nevertheless, FSIS, in its Food Standards and Labeling Policy Book, identifies criteria for a shelf-stable product based on MPR. Shelf-stable dry sausage must have an MPR ≤ 1.9:1 and semi-dry sausage must have an MPR ≤ 3.1:1 with a pH ≤ 5.0, or be commercially sterilized (unless another MPR is specified for a product).

Formulation Ingredients Important for Shelf-Stability

►Salt

Salt (sodium chloride) is the most important ingredient used in the manufacture of dried meat products. Salt exhibits many functions including suppressing microbial growth, reducing water activity, releasing salt soluble proteins, penetrating easily into meats enhancing cure penetration, flavor and showing a pro-oxidant effect. Salt plays a more limited role today than in the past in sausage preservation as most sausage recipes contain only 1-3% salt mainly adjusted for taste. The percent salt in a meat product is not as important as the brine strength. The brine strength (sometimes referred to as water-phase salt) is the percent salt divided by the percent salt plus percent moisture in the same product. In dried meats that are manufactured with an injected or immersed brine, the salometer reading expresses the strength or salt content in the brine. A 100 degree brine contains the maximum 26.3% salt and a 50 degree brine contains 13.15% salt.

►Nitrate (NO_3^-)

Potassium nitrate, or saltpeter, was the original curing agent and was generally added to the meat unintentionally as a contaminant in the salt. This chemical is very stable and must be converted to nitrite to effect meat curing. This conversion usually is done by specific microorganisms, including the *Kocuria* and staphylococci. Originally, these microorganisms were also contaminants in the meat, other ingredients, and/or the processing environment. Although today we realize that nitrite is the active curing ingredient and that it can be added directly to the meat, the use of nitrate salts (sodium or potassium) is still somewhat common, mainly in dried meat products. The primary reason for its continued use is that residual nitrate in dried meats can serve as a “nitrite reservoir” in non-cooked products and the conversion of nitrate to nitrite in meat processing is a slower process and can yield a deeper red cure color. For the necessary nitrate reduction to nitrite, the specific microorganisms that produce nitrate reductase always must be present and active. Nitrate is a restricted ingredient and its use is regulated by the relevant government agency in different countries.

►Nitrite (NO2-)

Sodium nitrite is the active curing ingredient for typical meat curing. This is a highly reactive chemical that reacts with meat to produce nitric oxide (NO) which replaces the oxygen molecule in the meat pigment structure (heme) yielding the typical cured “pink” color when the meat product is heated. Nitrite also functions for meat flavor, helps provide microbial stability and acts as a potent antioxidant. Because of the highly reactive nature and toxicity of the nitrite, it is usually first combined with a portion of the salt prior to meat addition and should never be added to anything other than salt prior to the addition to the meat. There is a strict limitation of how much **nitrite** can be used in a meat/poultry product.

►Curing Accelerators

Compounds such as sodium erythorbate, sodium ascorbate, ascorbic acid, sodium acid pyrophosphate, chemical acidulants, etc., are added to dried meats to enhance the curing reaction by either serving as a reducing agent, oxygen scavenger and/or reducing the product pH.

►Meat Starter Cultures

Microorganisms typically are active participants in the processing of dried meats. Specific starter cultures are added in the formulation to control the product microflora and function for safety and preservation, product consistency (fermentation, drying, texture), product color and/or product flavor. Generally, the two types of starter cultures used for dried meats are the lactic acid microorganisms and the staphylococci and *Kocuria* (micrococci). The presence of antibiotic residues in meat may inhibit growth of the starter culture, resulting in inadequate drop in pH.

►Sugars (carbohydrates)

The role of added sugars or carbohydrates in meat curing and drying often is underestimated. Carbohydrates, or "sugars," used in dried meat processing generally consists of dextrose, cane sugar/sucrose, brown sugar, corn syrup, lactose, honey, molasses, maltodextrins, starches, etc. The added sugars function for flavor, reduce harshness of salt, lowering water activity, yield, and as a source of energy for functional and spoilage microorganisms. Added sugar type and amounts are critical for fermented products to control fermentation and final product pH. This is clearly demonstrated in pepperoni, whereby the added dextrose generally is limited to achieve a desired final pH without subsequent charring or burning when the pepperoni is cooked on a pizza.

►Chemical Acidulants

Chemical acidulants are specific acids that are added to some dried meat product formulations to lower pH for various functions, including flavor, shelf-stability, color, and drying enhancement. Typically, chemical acidulants are designed or chosen to "mimic" the action of the lactic acid microorganisms (i.e., biological fermentation), thus the specific chemical acidulant demonstrates a somewhat slower release than just adding the pure acid. The slower release allows for some meat matrix formation prior to acidulation. This is accomplished by either adding a cyclic compound (e.g., glucono-delta-lactone, GDL) and/or adding an encapsulated acid. Chemical acidulants most often are utilized to replace the starter culture in a typical fermented dried product to eliminate the fermentation phase and, thus, shorten the process.

►Preservatives

Certain preservatives, particularly anti-mold agents, are commonly used in dried meats since mold can grow on almost any dried meat product that is not in an anaerobic pack. Typical mold inhibitors used include potassium sorbate, propyl parabens, and cultured whey/cultured corn syrup/cultured dextrose. These latter cultured products contain naturally produced proprionic acid and other organic acids that retard mold growth.

►Oxidation Prevention Additives

Oxidation is a major problem with dried meat products which adversely affects color and flavor/taste of the product. In most cases oxidation of the fat tissue leads only to product quality changes and does not create health hazard problems but it is still undesirable by most processors.

Additives that retard oxidation are classified as either primary antioxidants or secondary antioxidants. Primary antioxidants are either synthetic (BHA, BHT, TBHQ, etc.) or natural (rosemary extract, tocopherols, smoke, etc.). These primary antioxidants react with the free radicals generated in the fat oxidation process and "break" the chain reaction. Secondary antioxidants act as oxygen scavengers, synergists, and/or curing accelerators to enhance the curing reaction. These compounds include citric acid, ascorbic acid, ascorbates, erythorbates, phosphates, lactates, starter cultures, etc., and function to either "scavenge oxygen," thereby removing it from the system; "chelate" (i.e., tie up) the catalysts that initiate oxidation; and/or create low redox potential/reducing conditions that enhance the curing reactions. Many of these compounds can act in several ways to prevent oxidation. Specific starter cultures contain the enzyme catalase that removes peroxides from the meat system (oxygen scavenger), promotes the curing reaction, and prevents rancidity development.

The proper use of any antioxidants is critical to its effectiveness. Usually a combination of primary and secondary antioxidants is employed for maximum effectiveness. The specific antioxidant should be employed for a specific meat system based on any flavor attributes, solubility, type of fat, and type of oxidation. The respective antioxidant must be stable before and after addition to the meat system and the delivery system must be appropriate for the application (e.g., fat soluble for direct addition to sausage versus water dispersible/water soluble for use in injected brines and marinades). Adding the antioxidant early in the processing is recommended for maximum efficacy as well as to achieve optimum distribution.

►Packaging

The packaging system for dried meats is very important for chemical and microbial shelf-stability. Although most dried meats are shelf-stable with regard to food safety regardless of packaging (due to lower water activity, pH), the proper packaging prevents potential mold growth (that can increase the pH, and potentially allow growth of pathogens) and product oxidation that is undesirable organoleptically. Generally, the products are packaged under vacuum or modified atmosphere where the oxygen is eliminated. In MAP (modified atmosphere packaged) products, the total elimination of oxygen often is accomplished through the use of oxygen scavengers, which are added in the packaging process, either in packets or incorporated into the film. These scavengers remove any residual oxygen that may still be present after packaging.

Critical Processing Stages for Shelf-Stability and Safety

Most of the dried meat products rely on the interaction of several parameters to achieve stability and safety. Many steps are controlled, but only a few are truly critical. Generally the critical control points for fermented shelf-stable products are fermentation, heating and, sometimes, drying. For non-fermented salt-cured products, the salting step is critical, and for dried products the drying step is critical. For some products, such as freeze-dried products or bacon bits, a cooking step may also be critical.

The main control points in the manufacture of most shelf-stable dried meats are primarily focused on the initial formulation stages where the ingredients are combined with the meat and subsequently processed. The proper combinations of salt, cure, sugars, starter cultures, etc., for the respective product must be assured. When using a starter culture, the receipt, storage, and preparation of this ingredient is essential to its function. However, although these are important parameters to control, the critical control point is at the fermentation stage, where the rate of pH drop to 5.3 or below is critical to prevent growth and enterotoxin production by *S. aureus*. The rate of pH drop can be expressed in "degree-hours". If the critical pH is not reached in the specified time, there may have been an error in the formulation process or with the starter culture.

This is the concept of degree-hours – the number of hours at a temperature above 60°F (the temperature at which staphylococcal growth effectively begins) multiplied by the number of degrees above that temperature. A process is acceptable if the product reaches pH 5.3 within a certain number of degree-hours. Processes attaining a temperature less than 90°F before reaching pH 5.3 are limited to 1200 degree-hours. Processes reaching a temperature of 90°F-100°F prior to reaching pH 5.3 are limited to 1000 degree-hours. Processes exceeding 100°F before reaching pH 5.3 are limited to 900 degree hours. For example, a product processed at a constant 80°F reaching pH 5.3 in 55 hours would meet the guideline of 1200 degree-hours, since 80°F-60°F=20°F and 20°F X 55 hours = 1100 degree-hours.

More information on this can be found in the American Meat Institute's Good Manufacturing Practices for Fermented Dry and Semi-dry Sausage Products: http://www.amif.org/FactsandFigures/SAUSAGE.pdf.

For dried whole muscle meats, particularly dry cured products, the initial salt level and application to all exposed meat surfaces is the most critical point in the operation, along with holding the salted product at relatively low temperatures until the critical brine content is achieved uniformly.

Many dried meat products are not heated significantly following the fermentation and/or salting process prior to drying; however with the increased emphasis on food safety, many more dried products, particularly in the U.S., do have a significant "heat step" in the total process to assure lethality of high numbers of specific pathogens.

This step is usually critical to achieve inactivation of the pathogens of concern in the product, and thus would be a critical control point. Consequently, the heat resistance of the target microorganisms in specific environments is a factor in determining lethality. Heat resistance is usually expressed as D-value, or the time to effect a 1-log or 90% reduction in the number of cells.

Microorganisms vary widely in heat sensitivity.

Sporeforming microorganisms

Some bacteria under unfavorable living conditions and lack of nutrients can create spores that are a dormant form of surviving bacteria. Spores are extremely resistant to temperatures and to all known cleaning and sanitizing chemicals that make them practically indestructible. They are capable of surviving decades waiting for a more favorable environment before starting to multiply again. Examples of bacteria of concern that can form spores include bacteria from the Bacillus and Clostridium groups. The physiological state (e.g., age, growth conditions) of the microbes also affects their heat resistance, as does whether the microorganism has been previously exposed to the specific environment and has "adapted" to the environment. The heating medium or environment (such as the water activity, pH, fat content, brine strength, proteins, etc.) dramatically affects heat resistance. In general, the lower the pH, the lower the heat resistance, while drying or lower water activity can increase heat resistance. Most often, added preservatives lower heat resistance.

The environment in dried meats can be highly variable, with many different formulations and processing variables. In addition, the microflora varies considerably, especially if not using a starter culture. Validation studies in specific products generally are required to assure food safety and product stability. Published validation studies for a similar formulation and process can be acceptable, as long as the reference validation is equal to or less severe than the formulation and process to be validated.

Step by Step Jerky Preparations

Below is a summary of the seven (7) general or common processing steps used in jerky production. Although an establishment's process may not include all these steps, **the lethality treatment and drying should be utilized to produce a safe product**. Other steps such as the intervention and post-drying steps may be utilized for those processes that do not achieve an adequate lethality.

- **Step 1 - Strip preparation**: Whole muscle is sliced or ground; ground product is formed into strips (some jerky is formed).

It is critical for establishments to use source materials prepared under good manufacturing practices (GMPs) designed to minimize contamination and the presence and growth of pathogens of public health concern so that the initial pathogen load is not higher than what the process is designed to reduce. Establishments that choose to purchase source materials known to be contaminated with pathogens of public health concern, such as *Salmonella* or shiga toxin-producing *Escherichia coli* (*E. coli)* (STEC) organisms such as *E. coli* O157:H7 or *E. coli* O45, should have controls in place to ensure cross-contamination between raw and RTE product does not occur.

- **Step 2 – Marination**: The strips are then marinated in a solution that often contains salt, sugar, and flavoring ingredients.

➢ **Step 3 - Interventions**: Antimicrobial interventions, before and after marinating the strips of raw product, have been shown to increase the level of pathogen reduction beyond that achieved by heating alone.

Some heating processes may not deliver an adequate lethality and, thus, may require an additional intervention step to ensure product safety. Examples of interventions that may increase the lethality of the process are:

• Preheating the meat or poultry jerky strips in the marinade to a minimum internal temperature of 160°F will provide an immediate reduction of *Salmonella* (Harrison and Harrison, 1996). Heating in marinade may produce unacceptable flavors for some products; however, other liquids such as water could be used. The times and temperatures in FSIS Appendix A: Compliance Guidelines For Meeting Lethality Performance Standards For Certain Meat and Poultry Products (referred to throughout the document as Appendix A) could be used for preheating in the liquid, although the product internal temperature should be monitored to ensure adequate lethality is achieved).

• Dipping the product in 5% acetic acid for 10 minutes before placing it in the marinade can augment the log reduction effects of drying but not enough to eliminate pathogens (Calicioglu, 2002 & 2003). This intervention may also result in an undesirable flavor.

• Dipping the product in 1:2 or 1:3 mixtures of calcium sulfate (Mionix Safe$_2$O™) and water for 30 seconds can better reduce the level of *Salmonella*, *Listeria monocytogenes (Lm)*, and *E. coli* O157:H7 compared with no pretreatment. Pretreatment with acidified sodium chlorite (Keeper®) at concentrations between 500 and 1,200 ppm was also effective. These pretreatments were effective in both dehydrators and smokehouse processing (Harrison et al., 2006).

➢ **Step 4 - Lethality treatment**:

The establishment needs to control, reduce, or eliminate the biological hazards identified in its hazard analysis. For meat and poultry jerky, these hazards will most likely include microbiological hazards from *Salmonella* spp., *Lm*, and *Staphylococcus aureus*. For beef jerky, *E. coli* O157:H7 may also be a hazard reasonably likely to occur. In recent years, several jerky products have been found to be adulterated with *Salmonella* and *E. coli* O157:H7.

The lethality treatment of poultry jerky must achieve at least a 7.0 log reduction of *Salmonella* spp. as required in 9 CFR 381.150. The lethality treatment of meat jerky should achieve at least a 5.0 log reduction of *Salmonella* spp. and should also achieve sufficient reductions in the other bacterial pathogens of public health concern (e.g., at least a 5.0 log reduction for *E. coli* O157:H7 for products containing beef as recommended in the *Salmonella* Compliance Guidelines for Small and Very Small Meat and Poultry Establishments that Produce Ready-to-Eat (RTE) Products). In addition, the lethality treatment of meat and poultry jerky should achieve at least a 3.0 log reduction in *Lm* although a 5.0 log reduction or greater is desirable for providing an even greater safety margin for ensuring that *Lm* doesn't grow during cold storage to detectable levels. However, establishments are not expected to validate that their process achieves reduction in *Lm* if it achieves sufficient reductions in *Salmonella* because *Salmonella* is considered an indicator of lethality.

In addition, an official establishment should have sound decisions in the hazard analysis that support that source materials were prepared using GMPs and other process controls such that adequate reduction results in the production of a safe product.
Official establishments choosing to use cooking to achieve lethality before drying may consider a number of different types of scientific documents to support the time/temperature/humidity combination used in the actual process.

- **Step 5 – Drying**:

Drying is the process during which water is removed from the product. After the lethality treatment, jerky is dried to meet a finished product water activity level that is sufficient for food safety purposes. After drying is complete, the establishment should monitor or verify the water activity to demonstrate that the product has attained the critical limit for shelf-stability. It is important that the establishment achieves the water activity of the finished product identified in its supporting documentation.
FSIS is aware that some manufacturers rely upon the maximum moisture protein ratio (MPR), rather than water activity, for determining whether their process adequately dries the jerky to produce a shelf-stable product. MPR is an inappropriate indicator of shelf-stability. Water activity (also referred to as a_w), however, as measured by an instrument such as a water activity meter, is the more appropriate indicator to verify jerky is properly dried for food safety. This is because water activity is a better measure of available water (or water that is not bound by other components) for microbial growth than MPR. Minimizing available water (e.g., achieving a water activity of 0.85 or less) is critical for controlling growth of pathogens. However, an MPR of 0.75:1 or less remains part of the standard of identity for jerky (for labeling purposes only). Thus, an MPR of 0.75:1 or less is necessary to label the product "jerky," but it is not always sufficient to ensure safe jerky products. In addition, in order to label a product "jerky" it should be shelf-stable. Although FSIS does not define jerky as shelf-stable in the regulatory standards of identity (9 CFR part 319), consumers consider and expect jerky to be shelf-stable.
A water activity critical limit of 0.85 or lower should control growth of all bacterial pathogens of concern as well as mold for products stored in an aerobic or oxygen containing environment such as in ambient air; however, if the product is vacuum packaged in an oxygen impervious packaging (creating an anaerobic environment where no oxygen is present), the water activity critical limit could be 0.91 or lower. These limits are based on the growth and toxin production limits for *Staphylococcus aureus* under optimal conditions with and without oxygen present (ICMSF, 1996). Establishments that choose to use these limits as support for the shelf-stability of their product may cite this guideline as supporting documentation for these limits and are not expected to provide additional scientific support.

- **Step 6 – Post-drying heat step**: A post-drying heat step may be added to increase the level of pathogen reduction beyond that achieved by heating alone.

This step may be needed for processes that do not result in an adequate reduction of *Salmonella* through the initial heating process. Adding a post-drying heat step has the potential to reduce *Salmonella* levels by approximately 2 logs from the level of reduction achieved during initial heat step. One example of a post-drying heat step that has been found to reduce *Salmonella* levels by approximately 2 logs is to heat the dried product in a 275°F oven for 10 minutes (Harrison et al., 2001).

- **Step 7 – Handling**: Product is often handled after the lethality and drying steps and prior to/during packaging.

Establishments should control their processes to prevent contamination of product with pathogens from product handling after the lethality and drying steps. Such controls should include ensuring that cross-contamination of product is minimized prior to packaging, and ensuring that the product is packaged in such a way that cross-contamination of product post-packaging is also minimized (e.g., with a good seal to maintain package integrity throughout storage, shipment and display).

KEY DEFINITIONS

The **lethality treatment** is defined as the process step or steps used to destroy pathogenic microorganisms on or in a product to make the product safe for human consumption and is considered to include the time when the thermal processing begins (e.g., the product is placed in the heated oven) until the product reaches the desired lethality time/temperature combination (also referred to as the cooking time). The purpose of the lethality step is to apply a lethality treatment to kill or reduce the level of microorganisms. Drying the jerky ensures the final product reaches a sufficient water activity to prevent the growth of microorganisms, especially toxigenic microorganisms, such as *Staphylococcus aureus*.

Product time/temperature combination

It is important that the jerky product achieve the temperature shown to be effective in the Appendix A guidelines or other scientific support documents. Most often the temperatures used during the lethality treatment that are reported in scientific support documents are the temperatures that the product should reach.

Product internal temperature can be measured by inserting a thermocouple probe into the geometric center of a beef strip. Proper insertion may be difficult because the product is so thin; therefore, FSIS recommends that establishments slice one piece of jerky twice as thick as normal so that the probe can be inserted. If this thicker piece reaches the lethality temperature, the thinner pieces should as well. In addition, to accurately measure the product temperature, the establishment should also have an understanding of factors that could affect the temperature of the product. These factors include having an understanding of the cold spots in the oven, as well as understanding of the variation in temperature of the oven during different seasons. Although monitoring product temperature is encouraged, establishments can use the oven temperature in place of the product temperature provided that the establishment has a consistent product and process and has sufficient data correlating the oven temperature with the product temperature.

FSIS has found through FSAs that many establishments often use temperatures from support documents to set critical limits for the oven temperature; however, setting the oven temperature to the temperature in the support does not ensure that the product will reach the same internal temperature which is critical to ensuring adequate lethality is achieved. FSIS has also found through FSAs that some establishments do not measure or verify that the product has achieved the desired internal lethality temperature until after drying. FSIS does not recommended verifying product temperatures only after drying because the product may have dried out before the lethality temperature was reached resulting in lower than expected pathogen reduction.

In addition to the product temperature, the amount of time the product is held at this temperature is also critical to ensuring that adequate lethality is achieved. It is important for the establishment to understand how the actual temperature of the product was taken, the

time it takes the product to reach the target temperature (known as the come-up time or CUT), and the amount of time the product is held at the target temperature compared to the scientific support documentation.
If the product is held at the target lethality treatment for less time than what was used in the scientific support then adequate lethality may not be achieved.

Cooking time to include the time when the product is placed in the heated oven until the product reaches the desired lethality time/temperature combination.
In order to achieve adequate lethality, it is important

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FSIS Appendix A:
Compliance Guidelines for Meeting Lethality Performance Standards For Certain Meat and Poultry Products
Time-Temperature Tables for Cooking Ready-To-Eat Poultry Products

For meat jerky, use of the time-temperature combinations provided in Appendix A, including those temperatures **above 158°F in which the desired lethality is instantaneous**, should help to ensure the safety of the product. These time-temperature combinations are based on experiments that were done with products without added salt or sugar. Added salt, sugar, or other substances that reduce water activity will increase the heat resistance of bacteria in a product.
However, time and experience have shown that the time-temperature combinations in the lethality compliance guidelines have been sufficient to produce safe products even with both salt and sugar added, but the **humidity during heating is a critical factor**. The humidity options in the Appendix A guidelines that are applicable to jerky processing are as follows:

o Heating roasts of any size to a **minimum internal temperature of 145 °F** (62.8 °C) in an oven maintained at any temperature if the relative humidity of the oven is maintained either by continuously introducing steam for **50 percent** of the **cooking time** or by use of a sealed oven for over **50 percent** of the **cooking time**, or if the relative humidity of the oven is maintained at **90 percent** or above for at least 25 percent of the total **cooking time**, but in no case less than 1 hour; **or**

o Heating roasts of any size in an oven maintained at any temperature that will satisfy the internal temperature and time combinations [from the chart provided in Appendix A] if the relative humidity of the oven is maintained at **90 percent** or above for at least **25 percent** of the total **cooking time**, but in no case less than 1 hour. The relative humidity may be achieved by use of steam injection or sealed ovens capable of producing and maintaining the required relative humidity.

For **poultry** jerky, to produce a safe product, establishments can use the **minimum internal temperatures** listed in Appendix A of **160°F for uncured poultry** or **155°F for cured** and smoked poultry.

NOTE: If highly pathogenic avian influenza (HPAI) virus H5N1 is identified as a hazard reasonably likely to occur, cured and smoked poultry should be cooked to at least 158°F or a time and temperature combination that achieves a 7-log$_{10}$ reduction of *Salmonella*.

A **Sealed oven** is generally defined as one in which the smokehouse doors and smokehouse oven dampers are closed to prevent moisture loss.

Relative Humidity is defined as the degree of saturation of the air by water (vapor), expressed as a percentage. Relative humidity describes the relation of the existing vapor pressure at a given temperature to the maximum vapor pressure at that temperature. Air at a given temperature can absorb vapor until its saturation (100%). The difference between the dry and wet bulb temperature is the relative humidity at that temperature. The following website http://home.fuse.net/clymer/water/wet.html contains a function for calculating the relative humidity given the wet and dry bulb temperatures. **Without sufficient humidity the product surface may dry too quickly, and the bacteria may become more heat resistant**.

The **dry-bulb** temperature refers to the ambient air temperature. It is called “dry-bulb” because the air temperature is indicated by a thermometer not affected by the moisture in the air or as a result, evaporative cooling. The dry-bulb temperature is most commonly measured by jerky-makers.

The **wet-bulb** temperature is the temperature indicated by a moistened thermometer bulb exposed to the air flow. A wet-bulb thermometer measures the extent of cooling that happens as moisture dries from a surface, a process also known as evaporative cooling. The wet-bulb temperature is always lower than the dry-bulb temperature except when there is 100% relative humidity, when they will be identical. Because evaporative cooling occurs on the surface of thin jerky strips, the wet-bulb temperature is more accurate measurement of product surface temperature.

NOTE: A literature review has shown that **at least 27-32% relative humidity** should be present during the cooking process to ensure that adequate lethality is attained. In addition, the wet bulb temperature should reach at **least 125-130°F for an hour** or more during the lethality process

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The use of a wet bulb thermometer is especially important for production at high altitudes or areas of low humidity. In fact, processing failures in the manufacture of jerky have occurred in establishments located at high altitudes. Establishments located at higher altitudes will generally have a lower atmospheric pressure. This leads to lower boiling points and faster evaporation from the product surface, which can lead to undesirable evaporative cooling and drying of the product surface.

Furthermore, at high altitudes, the relative humidity can be less at the higher altitude due to the lower air pressure (if the temperature at sea level and the high altitude is the same). As a result, at high altitudes, the amount of moisture added to the smokehouse chamber necessary to achieve a given log reduction of bacteria may need to be increased to account for lower levels of humidity in the ambient air. Adjustments to the amount of humidity added to the smokehouse chamber to account for changes in humidity in the ambient air at high altitudes will need to be made by establishments on a case-by-case basis as part of the initial design of the system to ensure that the humidity in the actual process matches the level in the scientific supporting documentation.

Establishments should also take into account variability in relative humidity in the ambient

air throughout different times of year.

Drying:
Drying is the process during which water is removed from the product. After the lethality treatment, jerky is dried to meet a finished product water activity level that is sufficient for food safety purposes. After drying is complete, the establishment should monitor or verify the water activity to demonstrate that the product has attained the critical limit for shelf-stability. It is important that the establishment achieves the water activity of the finished product identified in its supporting documentation.

FSIS is aware that some manufacturers rely upon the maximum moisture protein ratio (MPR), rather than water activity, for determining whether their process adequately dries the jerky to produce a shelf-stable product. MPR is an inappropriate indicator of shelf-stability. Water activity (also referred to as a_w), however, as measured by an instrument such as a water activity meter, is the more appropriate indicator to verify jerky is properly dried for food safety. This is because water activity is a better measure of available water (or water that is not bound by other components) for microbial growth than MPR.
Minimizing available water (e.g., achieving a water activity of 0.85 or less) is **critical** for controlling growth of pathogens.

However, an MPR of 0.75:1 or less remains part of the standard of identity for jerky (for labeling purposes only).However 0.75:1 or less is necessary to label the product "jerky," but it is not always sufficient to ensure safe jerky products. In addition, in order to label a product "jerky" it should be shelf-stable. Although FSIS does not define jerky as shelf-stable in the regulatory standards of identity (9 CFR part 319), consumers consider and expect jerky to be shelf-stable.

Shelf-stable is the condition achieved when meat and poultry products can be stored under ambient temperature and humidity conditions, and if the package integrity is maintained during storage, shipping, display at retail, and in the home, will not become unsafe throughout the manufacturer's specified shelf-life.

NOTE: Vacuum packaged products with a water activity level > 0.85 and ≤ 0.91 should be kept refrigerated once the package is opened because the product would no longer be considered shelf-stable once it is exposed to oxygen. Lack of shelf-stability once the product is exposed to oxygen is mainly a concern for products that would not be consumed within a single serving as these products are not likely to be vacuum packaged by the consumer between servings. Therefore, unless the establishment has support that the product is likely to be consumed in a single serving, vacuum packaged products with a water activity in the range of > 0.85 and ≤ 0.91 should be labeled with a statement such as **"Refrigerate After Opening**" (as described in 9 CFR 317.2(k)). 2

Moisture-protein-ratio (MPR) expresses the percent moisture divided by the percent protein. MPR is commonly used in the U.S. to classify dried sausages and other meat products. Although MPR values indicate the degree of product drying, they are not necessarily indicative of microbial safety or product shelf-stability because they do not take into account availability of the water.

What is jerky?

This product is a nutrient-dense meat that has been made lightweight by drying. A pound of meat or poultry weighs about four ounces after being made into jerky. Because most of the moisture is removed, it is shelf stable - can be stored without refrigeration - making it a handy food for backpackers and others who don't have access to refrigerators. Jerky is a food known at least since ancient Egypt. Humans made jerky from animal meat that was too big to eat all at once, such as bear, buffalo, or whales. North American Indians mixed ground dried meat with dried fruit or suet to make "pemmican." "Biltong" is dried meat or game used in many African countries. Our word "jerky" came from the Spanish word "charque."

How can drying meat make it safe?

Drying is the world's oldest and most common method of food preservation. Canning technology is less than 200 years old and freezing became practical only during this century when electricity became more and more available to people. Drying technology is both simple and readily available to most of the world's culture. The scientific principal of preserving food by drying is that by removing moisture, enzymes cannot efficiently contact or react with the food. Whether these enzymes are bacterial, fungal, or naturally occurring autolytic enzymes from the raw food, preventing this enzymatic action preserves the food from biological action.

What are the types of food drying?

There are several types of food drying. Two types of natural drying - sun drying and "adibatic" (shade) drying - occur in open air. Adibatic drying occurs without heat. Solar drying sometimes takes place in a special container that catches and captures the sun's heat. These types of drying are used mainly for fruits such as apricots, tomatoes, and grapes (to make raisins). Sun drying is not recommended for making meat jerky due to a lack of a steady heat source and the potential for contamination from animals, insects, dust, and bacteria. Drying from an artificial heat source is done by placing food in either a warm oven or a food dehydrator.

The main components of an electric food dehydrator a source of heat;

- air flow to circulate the dry air
- trays to hold the food during the drying process
- mesh or leather sheets to dry certain types of foods

Why is temperature important when making jerky?

Illnesses due to *Salmonella* and *E. coli* O157:H7 from homemade jerky raise questions about the safety of traditional drying methods for making beef and venison jerky. The USDA Meat and Poultry Hotline's current recommendation for making jerky safely is to heat meat to 160 °F and poultry to 165 °F before the dehydrating process. This step assures that any bacteria present will be destroyed by wet heat. But most dehydrator instructions do not include this step, and a dehydrator may not reach temperatures high enough to heat meat to 160 °F or 165 °F.

After **heating to 160 °F or 165 °F**, maintaining a constant dehydrator temperature of **130 to 140 °F** during the drying process is important because:

- the process must be fast enough to dry food before it spoils; and
- it must remove enough water that microorganisms are unable to grow.

Why is it a food safety concern to dry meat without first heating it to 160 °F?

The danger in dehydrating meat and poultry without cooking it to a safe temperature first is that the appliance will not heat the meat to 160 °F and poultry to 165 °F - temperatures at which bacteria are destroyed - before the dehydrating process. After drying, bacteria become much more heat resistant. Within a dehydrator or low-temperature oven, evaporating moisture absorbs most of the heat. Thus, the meat itself does not begin to rise in temperature until most of the moisture has evaporated. Therefore, when the dried meat temperature finally begins to rise, the bacteria have become more heat resistant and are more likely to survive. If these surviving bacteria are pathogenic, they can cause foodborne illness to those consuming the jerky

What research findings exist on the safety of jerky?

"Effects of Preparation Methods on the Microbiological Safety of Home-Dried Meat Jerky" was published in the *Journal of Food Protection*, Vol. 67, No. 10, 2004, Pages 2337-2341. The authors are from the University of Georgia (Brian A. Nummer, Judy A. Harrison, and Elizabeth L. Andress, Department of Foods and Nutrition, and Mark A. Harrison, Department of Food Science and Technology) and from Colorado State University (Patricia Kendall, Department of Food Science and Human Nutrition and John N. Sofos, Department of Animal Sciences).

Marinating meat doesn't make raw meat safe. "Marination alone did not result in significant reduction of the pathogen compared with whole beef slices that were not marinated," concluded the study. In the jerky studies, some samples showed total bacterial destruction and other samples showed some bacterial survival — especially the jerky made with ground beef. Further experiments with lab-inoculated venison showed that pathogenic *E. coli* could survive drying times of up to 10 hours and temperatures of up to 145 °F. A study by the Harrisons and Ruth Ann Rose, also with the University of Georgia, was published in the January 1998 *Journal of Food Protection*, Vol. 61, No. 1. The authors analyzed ground beef jerky made with a commercial beef jerky spice mixture with and without a curing mix containing salt and sodium nitrite. Half of the ground beef was inoculated with *E. coli* O157:H7 before making it into jerky strips and dehydrating it. The authors found that in both the heated and unheated samples, the jerky made with the curing mix had greater destruction of bacteria than jerky made without it. The jerky made with the mix and heated before dehydrating had the highest destruction rate of bacteria. They concluded, "For ground beef jerky prepared at home, safety concerns related to *E. coli* O157:H7 are minimized if the meat is precooked to 160°F prior to drying."

What are the USDA Meat and Poultry Hotline's recommendations for making homemade jerky?

Research findings support what the Hotline has been recommending to callers. Additionally, safe handling and preparation methods must always be used, including:

- Always wash hands thoroughly with soap and water before and after working with meat products.
- Use clean equipment and utensils.
- Keep meat and poultry refrigerated at 40 °F or slightly below; use or freeze ground beef and poultry within 2 days; whole red meats, within 3 to 5 days.
- Defrost frozen meat in the refrigerator, not on the kitchen counter.
- Marinate meat in the refrigerator. Don't save marinade to re-use. Marinades are used to tenderize and flavor the jerky before dehydrating it.
- Steam or roast meat to 160 °F and poultry to 165 °F as measured with a food thermometer **before dehydrating it.**

Dry meats in a food dehydrator that has an adjustable temperature dial and will maintain a temperature of at least 130 to 140 °F throughout the drying process

Are there special considerations for wild game jerky?

Yes, there are other special considerations when making homemade jerky from venison or other wild game. According to Keene and his co-authors, "Venison can be heavily contaminated with fecal bacteria — the degree varying with the hunter's skill, wound location, and other factors. While fresh beef is usually rapidly chilled, deer carcasses are typically held at ambient temperatures, potentially allowing bacteria multiplication

Is commercially made jerky safe?

Yes, the process is monitored in federally inspected plants by inspectors of the U.S. Department of Agriculture's Food Safety and Inspection Service. Products may be cured or uncured, dried, and may be smoked or unsmoked, air or oven dried. The following terms may be on processed jerky products:

- "Beef Jerky" - produced from a single piece of beef.
- "Beef Jerky Chunked and Formed" - produced from chunks of meat that are molded and formed, then cut into strips.
- "Beef Jerky Ground and Formed or Chopped and Formed" - produced from ground or chopped meat, molded and cut into strips. Beef Jerky containing binders or extenders must show true product name (e.g., "Beef and Soy Protein Concentrate Jerky, Ground and Formed").

"Species (or Kind) Jerky Sausage" - the product has been chopped and may be dried at any stage of the process, and it is stuffed into casings

What is the safe storage time for jerky?

Commercially packaged jerky can be kept 12 months; home-dried jerky can be stored 1 to 2 months.

Dried Meat Process Validation

Validation focuses on putting together scientific and technical information to demonstrate that the hazards of concern are properly controlled.

Dried meat process validation addresses lethality and stabilization "during the shelf-life of the product." Processors must assess which hazards are reasonably likely to occur for their product. For most of the dried meat products, manufacturers will consider the pathogens *Salmonella, S. aureus, L. monocytogenes* and, in beef, *E. coli* O157:H7. Pathogenic sporeformers such as *C. botulinum* and *C. perfringens* may also need to be addressed. Depending on the product and the identified hazards, it may be necessary to validate that the process controls the pathogen.

Currently there is no required log reduction specified for *Salmonella*; a processor must provide documentation that this organism is controlled for the specific product/process. Some processors choose to validate their processes for *L. monocytogenes*, which is generally considered to be more resistant than *Salmonella*. Processors must validate a 5-log kill of *E. coli* O157:H7 for products containing beef.

For the most part, to achieve 5-log reduction, the product must be heated to some extent. The heating effect is enhanced at lower pH; thus the final internal temperature does not have to be as high with a lower pH. The number of organisms present is important, as well as their heat resistance. Manufacturers should consider the degree of lethality for each organism of concern. Because of the nature of the finished product (low a_w) pathogenic sporeformers should not be a concern.

For dried meat products it may be desirable to conduct validation studies that demonstrate lack of growth of relevant pathogenic microorganisms if the product is contaminated after the lethality step.

There are some validated processing parameters that have been published for dried meat products, including pepperoni, hard salami, Italian salami, summer sausage, Lebanon bologna, and country hams. Validation studies have also been conducted to assess the survival of *L. monocytogenes* during storage of RTE meat products processed by drying, fermentation, and/or smoking (Ingham et al., 2004. J. Food Protect. 12: 2698-2702) to help small processors classify these products with respect to FSIS' alternatives for *L. monocytogenes* control (e.g., to assess whether the processing techniques and product characteristics can serve as antimicrobial agents or processes or post-lethality treatments).

►Examples of Validated Processes

Because there are so many different combinations of variables that impact the safety and stability of these products, it can be difficult to develop validation studies that apply broadly. A commonly used process that has been validated is to achieve a pH < 5.0, followed by a heat process to achieve 128°F (53.3°C) internal temperature for 1 hour.

Summer Sausage (fermented, semi-dry sausage)

A typical process/product validation for fermented summer sausage is as follows. The product is fermented with a starter culture at 110°F (43.3°C) until the pH is 4.7 or lower, then cooked to 152°F (66.7°C) internal product temperature. The characteristics of the vacuum packaged product are as follows.

moisture	56.7%	brine strength	5.5%
m/p ratio	3.28	pH	4.4
fat	21.2%	Titratable Acidity	0.361
salt	3.4%	aw	0.964

The process validation demonstrated complete destruction under these processing parameters of high levels of *Salmonella, Listeria monocytogenes*, *Staphylococcus aureus*, and *E. coli* O157:H7. Moreover there was no growth of the same microorganisms when inoculated at high levels post-lethality and stored at either refrigerated temperature or room temperature (the product was shown to be shelf-stable).

Pepperoni

Similar results have been observed in validation studies with pepperoni (a fermented, dry sausage) where the product is fermented with a starter culture at 102°F (38.9°C) to a pH < 5.0, then subsequently heated to 128°F (53.3°C) for 1 hour and dried to 68% final yield. Final product characteristics are as follows.

moisture	26.0%	brine strength	15.58%
m/p ratio	1.4	pH	4.7
fat	46.0%	a_w	0.896
salt		4.05%	

Country Ham

A validated process for a typical dried whole muscle product, country ham, processed with salting for 49 days at 40°F (4.4°C), post-salting drying 20 days at 85°F (29.4°C), and dried 129 days at 68-75.2°F (20-24°C) results in a final product with the following characteristics.

salt	8.0%
pH	5.5 (5.0-6.0 during process)
a_w	0.92

RAW – FERMENTED SAUSAGES

Definition

Raw-fermented sausages receive their characteristic properties (tangy flavor, in most cases chewy texture, intense red curing color) through **fermentation processes**, which are generated through physical and chemical conditions created in raw meat mixes filled into casings. Typical raw-fermented sausages are **uncooked meat products** and consist of coarse **mixtures of lean meats and fatty tissues** combined with salts, nitrite (curing agent), sugars and spices as non-meat ingredients. In most products, uniform fat particles can clearly be distinguished as white spots embedded in dark-red lean meat, with particle sizes varying between 2-12mm depending on the product. In addition to fermentation, **ripening phases** combined with moisture reduction are necessary to build-up the typical flavor and texture of the final product. The need for moisture reduction requires the utilization of **water-vapor permeable casings**. The products are not subjected to any heat treatment during processing and are in most cases distributed and consumed raw.

Raw fermented sausage products of different calibers and degrees of chopping

Biochemical processes in manufacture

Raw-fermented sausage products have been developed and produced for centuries in regions with moderate climates around the world. Traditionally, the fabrication took place during the cold season, as relatively low temperatures are required for fermentation, drying and ripening. At the end of the ripening phase, raw-fermented sausages, also known as "**dry sausages**", are considered **shelf-stable** even under higher temperatures. A sub-group of raw-fermented sausages are the semi-dry and/or spreadable products. Principles of manufacture of these semi-dry products are discussed at the end of the chapter.

In the past, when cooling facilities were not readily available, their shelf-stability made raw-fermented sausages very popular as an animal protein reserve for food security purposes. Nowadays, these products are fermented, dried and ripened in artificially climatized rooms or chambers and can therefore also be fabricated during warmer seasons and even in tropical climates.

In the specific case of raw-fermented sausages, **fermentation** refers to the breakdown of carbohydrates ("sugars") present in meat mixtures, mainly to lactic acid. Traditionally processors of raw-fermented sausages relied on the action of fermentation bacteria, naturally present in the meat contaminating flora. Relatively low temperatures (around 20°C) are instrumental in stimulating the growth of the desired **fermentation flora**, while the growth of the **spoilage bacteria** were suppressed. Conditions for spoilage bacteria become gradually more unfavorable, as the fermentation bacteria produce acids resulting in the decline of the pH-values in the product. The development of the desired fermentation flora also contributes to the **typical taste**, **appearance** and **texture** of raw-fermented sausages. An additional measure to control spoilage bacteria in the product is the controlled decrease of moisture (reduction of a_w) during fermentation and ripening. Spoilage bacteria need higher a_w values than acid producing bacteria.

These biological processes in raw-fermented sausages constitute a rare example where microbial activity can be useful. Another example is raw fermented ham. However, this biological process can get out of control, for example if temperatures in fermentation or ripening chambers are too high or if the contaminating flora is excessively numerous with an overwhelming share of spoilage bacteria. In such cases, fermentation bacteria will not sufficiently develop and the product spoils. This risk is minimized by the use of **fermentation and ripening chambers** with controlled air temperature and humidity favorable for fermentation and drying. The second measure is the use of **selected fermenting bacteria** (commercially produced microbial starter cultures), which are added to the sausage mix and develop the desired fermentation processes, until moisture contents reached are low enough to stop fermentation.

Raw-fermented sausages depend not only on fermentation to achieve the desired texture and flavor, but during their long ripening periods other biochemical and physical factors become increasingly important. Natural **fat alterations** (rancidity) take place and produce strong flavors. This process can be substantially slowed down by selecting suitable raw fat materials (preferably fresh pork back fat) and applying relatively low ripening and acclimatization parameters (e.g. 20°C and 75-80% rel. humidity). Prolonged ripening and drying also leads to **low moisture contents** with the consequence of more **concentrated flavor component** and **firmer sausage texture**. The water content of finished raw-fermented sausages is always below 35%, in many cases even less than 30%. This corresponds to an a_w of 0.90 and below and makes the product shelf-stable. Under moderate climatic conditions and storage (e.g. 20°C and 70-75% relative humidity), the products have a prolonged shelf life of over one year.

Raw-fermented sausages have **moderate acidity** with pH-values in the range of 5.0 to 5.5. Some manufacturers still rely on their typical meat plant flora to initiate the fermentation process. The use of **starter cultures** has the big advantage that the initial biological process can be controlled/directed while growth of spoilage bacteria is reduced. Raw-fermented sausages may be produced with or without **smoking**. Un-smoked products are called "**air-dried**". The **ripening** and **drying periods** are determined by the sausage formulation and casing diameter. Ripening periods can amount up to 90 days, but most raw-fermented sausages are finished within 3-4 weeks. Typical examples for dry sausages with more or less prolonged ripening periods are the various types of salamis (Hungarian, Italian, Central European, Spanish chorizo).

Recently filled raw-fermented sausage being transferred to ripening chamber

Raw-fermented sausage after 10 days in ripening chamber

Principles of manufacture

The manufacture of raw-fermented sausages at the small to medium scale meat industry level is outlined hereunder. These sectors often lack a full range of comminuting equipment and in particular equipment for accurate acclimatization during fermentation and ripening and therefore face more **technological** challenges than larger, well equipped industries.

Raw materials

The processing of raw-fermented sausages is dominated by biological and biochemical processes and raw meat materials of **excellent hygienic quality** are a precondition for the correct functioning of such processes. Lean meat from a variety of **animal sources** such as cattle, pigs, horses, donkeys, camels, sheep or goats can be used. The lean meat can be from older adult animals, as water content and water holding capacity of such meat is lower, which supports the necessary drying processes during fermentation and ripening. All meat used must be chilled for some time to reach its **lowest ph-values**.

Beef meat should have pH-values at 5.4-5.5, pork meat 5.7-5.8. All lean meats for raw-fermented sausages need extra **careful trimming** of sinews and softer inter-muscular fatty tissue.

Remaining sinews will remain tough and are not desired by consumers.

In most products fresh chilled **pork back fat** is used as it is firm and dry and remains stable without pronounced rancidity even after prolonged ripening periods. Softer inter-muscular fatty tissue should not be used as it cannot be chopped to clearly defined particles and would result in somewhat blurred unclear appearance of slices of the final products. Soft fat also increases the risk of early rancidity. If fats from other species of slaughter animals are used, only firm body fats should be considered.

Importance of bacteria

Bacterial starter cultures have a variety of functions including:

- Boosting acidity (decreasing pH)
- Intensify the curing color (acid environment catalyses curing reaction)
- Counteract rancidity of fats (due to enzymatic impacts)
- Development of flavor and taste
- Texture improvement of ripened products (by supporting formation of protein gel in sausage mixes).

Over the years, mainly bacteria belonging to the groups of *Lactobacillus, Pediococcus, Staphylococcus and Streptococcus* have been identified and cultivated for **commercial starter cultures**, as they proved to provide the best results in terms of producing lactic acid, developing ripening flavor, and are generally harmless in terms of product spoilage and impact on consumers' health. Depending on the desired taste, texture and appearance of the product, **specific cultures** are selected. The use of Lactobacillus results in fast acidification to lower pH-values, the use of Pediococcus leads to slower and milder acidification. Selected Staphylococcus strains cause a speedy reduction of nitrite, stable curing color and reduced risk of fat rancidity, especially in products fabricated with Glucono-delta-Lacton (GdL).

In most cases **mixtures** from different strains are used in order to achieve the best product specific results, for example in sausages with normal diameters (35-70 mm) an even mixture of Lactobacillus and Staphylococcus can be used to achieve the product-typical flavor, texture and taste. In sausages with of larger diameter (70-100 mm), the starter culture mixture normally contains a lower amount of Lactobacillus and a higher portion of Staphylococcus, as these products need more time to reach microbial growth inhibiting moisture contents. The strong potential of Staphylococcus to stabilize curing color and fats is helpful in this context.

Importance of salt, curing agents and sugars

One of the main targets during fermentation and ripening of raw-fermented sausages is the **reduction of their water content**. The moisture to be reduced is exclusively from the muscle meat which has a water content of around 80%. The addition of **salt** lowers a_w value of the mix by absorbing water, which presents an initial difficulty for unwanted bacteria.

Furthermore, in the presence of salt, salt-soluble proteins are extracted from the small lean meat particles after grinding and chopping. These solubilized or gelatinous proteins act like an adhesive between the interfaces of lean meat and fat particles in the meat mix. The result is an **increasingly firm structure** with progressive ripening and drying of the products. The average quantity of salt added to raw-fermented sausages should be between 26-30 g/kg (2.6-3.0%) but not below 26 g/kg (2.6%). It should be noted that the salt content in percent in the final products will always be higher than in the initial mix, as these products lose a substantial amount of water. Salt contents in final products can be from 3 - 4.5% depending on the initial salting.

In raw-fermented sausages, salt is also used as a carrier for the curing agent, normally **sodium nitrite.** This curing agent is not only responsible for the development of a typical **red cured meat color**, but also has **bacterial growth inhibiting properties**, especially on some pathogenic bacteria. In raw-fermented sausages with a slow decrease of pH-values and prolonged ripening periods, **nitrate** can also be used as a curing substance. The use of both, nitrite and nitrate results in similar color and taste. The main difference is that nitrate must first be reduced to nitrite by bacteria, which is a time-consuming process and hence only applicable to long-term ripened products. The slowly progressing acidity in such sausages allows the bacterial breakdown of nitrate to nitrite. The following reduction of nitrite to nitrogen oxide (NO), which is the substance effective in the curing reaction, is a relatively fast chemical process. The use of nitrate, mixed with nitrite is favored by some processors as it is associated with better color and flavor.

From the technical point of view, the purpose of adding **sugars** is to facilitate and strengthen the fermentation by bacteria. Provision of a sweet flavor to counteract acidity in the final product is normally not intended. The bacterial breakdown of sugars results in the accumulation of lactic acid and in a low pH-value (acidification) as well as the development of a typical flavor. In order to support this process, lactic acid producing bacteria (starter cultures such as lactobacillus or pediococcus) can be added to the sausage mix. Simple sugars such as dextrose or fructose support an early drop in pH-values as they are easily broken down by bacterial action. The breakdown of lactose is slower and takes longer. Often a mixture of different sugars is used. Another sugar-based additive is **GdL** (Glucono-delta-Lactone), which accelerates and intensifies the acidification process by reacting to glucono-acid in the presence of water (muscle tissue water). It is preferably used in semi-dry and/or spreadable products, which are not for long-term ripening and storage, but for consumption within a short period after production.

Production methods

As a rule of the thumb, raw-fermented sausages are fabricated with 20-35% fatty tissue and 65-80% lean meat, from one or more than one animal species, e.g. beef and pork or pork only or beef only. Other variations are also possible. If **fatty tissue** other than pork back fat is used the percentages for the fat are usually lower. The **techniques of comminuting** of meat and fat for raw-fermented sausages differ from other meat products.

Raw-fermented sausages may be composed of course, medium or tiny meat and fat particles. The **degree of chopping** can be visualized by the size of the fat particles in the final product. Some traditional Mediterranean (Italian, Spanish, French, etc.) salamis are chopped coarsely (6-12mm), but the majority of raw-fermented sausages are chopped moderately (2-5mm). Only a few semi-dry and/or spreadable products are finely chopped.

Different degrees of chopping (different fat particle size)

In small to medium-sized processing, there are two methods of manufacture of raw-fermented sausage mixes, which basically differ by the method of comminuting of the raw materials. Applying a simple comminuting method, only **meat grinders** are used to prepare the sausage mixes. In more advanced techniques **meat grinders** and **bowl cutters** are used.

Method 1: In small-scale operations with only **meat grinding equipment** available, production is restricted to ground sausage mixes. The lean meat needs to be thoroughly chilled (+1°C) or even slightly frozen. The fat portion should be cut into small and uniform dices (10-20 mm, domino chip size) and frozen (-12°C) in order to obtain clearly and evenly cut particles in the initial chopping of the sausage mix. Clearly cut particles of firm solid fat also avoid greasing of the casing from inside, which would make drying more difficult. Firstly, part of the lean meat is minced 3-5mm (approx. 30%) and the remaining lean meat is cut into small pieces (20-50 mm). The chilled meat pieces and frozen fat dices are thoroughly mixed with all additives (curing salt, sugars, starter cultures, spices, etc), before the minced meat portion is added and incorporated in the mixture.

The entire mixture is now passed through the meat grinder (disc size 3-6 mm), packed into the sausage stuffer and stuffed into casings. Delays leading to warming up of the mixture need to be avoided as this would result in greasing during the stuffing.

For the stuffing, natural or artificial casings can be used. Typical natural casings, depending on the desired sausage diameter, are those derived from the small intestines of pigs, sheep, cattle or horses. Artificial casings used are fibrous or collagen casings. One important requirement for casings used for raw-fermented sausages is to closely adhere to the sausage mix not only after filling but also during the drying period when sausages shrink. The casings used must be water vapor permeable, otherwise no drying during fermentation and ripening can take place and the products would spoil. The required conditions are met by natural casings and fibrous and collagen casings.

Method 2: With a **bowl cutter** available, a different technology can be applied. With this method 50% of the lean meat material is minced (3 mm) and kept at 1°C. The remaining 50% of the lean meat is cut into pieces of 30-50 mm diameter and slightly frozen (-10°C). As per method 1, the fat is cut into small dices (preferably 10-20 mm, domino chip size) and also frozen (-12°C). Firstly, the large pieces of frozen lean meat are chopped. If starter cultures are used, they must be added at this stage. After several rounds of the frozen lean meat in the bowl cutter, the frozen fat is added together with the spices and sugars and chopping is continued at a medium speed until the fat has reached the desired particle size. Then the minced chilled meat is added under low chopper speed until an even distribution is achieved. In the next step, the nitrite curing salt is added and mixed at low speed for at least 6-8 rounds until a final temperature of around -5°C is reached. This mix temperature should not be exceeded in order to avoid the greasing of the interior of the filling funnel and casings.

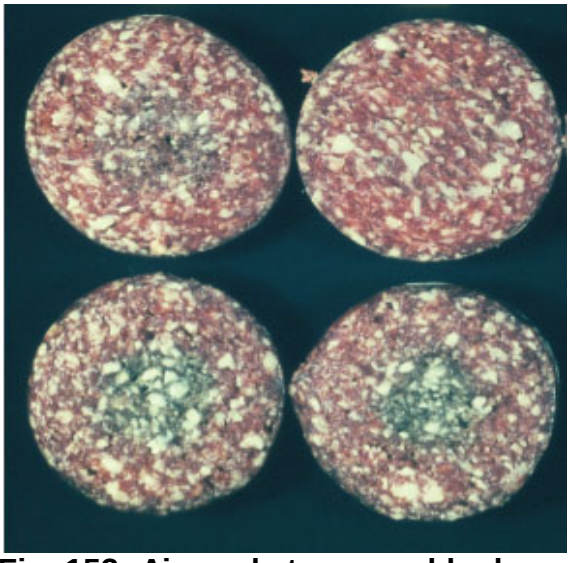


Fig. 153: Air pockets caused by loose stuffing. Discoloration caused by enclosed air. Above right tightly stuffed, no discoloration

When lean beef and pork is used for the above raw-fermented sausage fabrication, the beef should be chosen for the 50% lean meat portion to be minced, while the pork portion is preferably used frozen.

The sausage mix is packed into the sausage stuffer and stuffed into the casings as firmly as possible to avoid air pockets. Excessive air inside the casing will discolor the meat and reduce the shelf life of the sausage. Selected natural or artificial casings can be used as above.

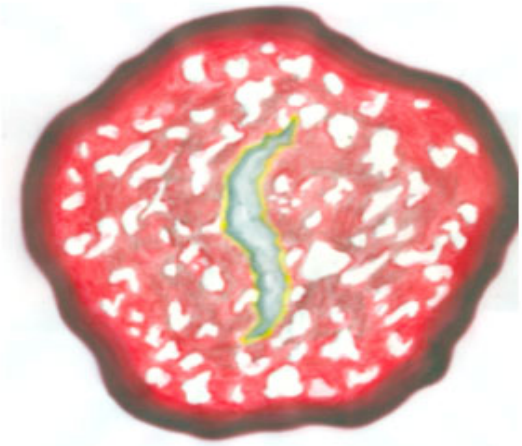
Drying/ripening

The freshly filled sausages are subjected to the crucial part of their manufacturing process, namely **fermentation**, **drying** and **ripening**. To this purpose they are transferred to either a climatized room or a modern combined smoking/drying chamber. Directly after stuffing, the sausage mix is still in the temperature range below zero (below freezing point). It is therefore advisable to include a **tempering period** of three hours at moderate room temperature before the sausages are transferred to the drying/ripening chamber.

The immediate goal is to allow **moisture** release from the sausages and to initiate the fermentation processes, e.g. to provide proper growth conditions for the fermentation bacteria. A high relative humidity at the outset of the drying operation, which keeps sausage casings wet and soft, and the gradual lowering of the air humidity in the advanced stages of the process are the key factors to enable the moisture to migrate from the interior of the sausage to the outer layer.

Temperatures and **air humidity** inside the drying/ripening chambers need to be adjusted carefully to support the ripening/drying process. The temperatures in the ripening chamber are initially kept at +22°C and are slowly reduced to +19°C. The relative humidity decreases gradually from typical values of 92-94% on the first day to 82-84% before the sausages are transferred to the ripening/storage room. During ripening the temperature is maintained at <16°C at a relative humidity of 75-78%. These physical parameters are applied to ensure controlled bacterial fermentation resulting in lowering of pH to 4.9 – 5.4 and controlled gradual dehydration resulting in remaining moisture content in finished raw-fermented sausages as low as 30%. The duration of the drying/ripening process mainly depends on the diameter of sausages and type of sugars and starter cultures used.

If the humidity is kept **too high**, excessive surface moisture is retained usually resulting in increased bacterial growth on the surface, thus forming a slimy layer. If humidity is **reduced too fast** especially in the early stages of the process, a hard and dry crust is formed at the outer layer of the sausage. This crust is unable to adjust to the reducing diameter caused by continuous loss of moisture and as a result cracks will appear in the centre of the product.



Raw-fermented-sausage.
Crack in centre as a consequence of excessively fast drying

In the first phase of drying, the **red cured meat color** is built up in the previously grey sausage mix. The curing color progresses from the centre of sausage to the outer region. Fermentation processes start practically from the point of transfer of the sausages into the drying/ripening chamber. The **duration of the fermentation** varies depending on the caliber of the sausages, particle size of the mix, temperature and ingredients. In a typical raw-fermented sausage (particle size 3 mm, stuffed in casing of caliber 65, where a sugar mix and starter culture mix is used), the lowest pH-values should normally be reached within 5-6 days. The typical flavor and texture of the products are developed after completing fermentation and ripening (Fig. 157).

One problem during the ripening period can be **mould and yeast growth** on the sausage casings, even under substantially decreased humidity. If these occur they can be brushed off and reoccurrence or further growth can be stopped by exposure of the sausages to smoke. Early (day 3-5) application of **cold smoke** at temperatures below +22°C as an additional preservation measure is highly recommended. Of course, smoking is also intended to contribute to flavor and taste. Sausages are smoked from several hours to several days or even weeks according to their diameter and type of product.

Undesirable mould growth

Desirable mould growth. Casing surface inoculated with mould starter culture (below), without mould growth (above)

One specific group of raw-fermented sausages is the "**air-dried**" type, as they do not undergo smoking. The air-drying combined with prolonged ripening periods produces a typical yeasty-cheesy flavor, which is often intensified by intended mould-growth on the casing surfaces. Not all moulds are suitable. Some species are even capable of producing poisonous substances, which may penetrate into the sausages. There are several **cultures of selected moulds** (e.g. Penicillium) available, which serve as starter cultures for desirable mould growth. A watery suspension of such moulds can be applied onto the surface of the sausages. This suspension of moulds will adhere to the casing surface and grow over the course of the ripening period to a thin white-colored mould overlay. These microorganisms are harmless from the health point of view but provide typical appearance and flavor to the sausages.

Table 6: Raw-fermented sausages of different calibers Normal fermentation process assisted by starter cultures

Sausages 75 mm diameter						Sausage 40 mm diameter				
Day	Rel. humidity in %	Temp °C	a_w	pH		Day	Rel. humidity in %	Temp °C	a_w	pH
01	92	23	0.95	5.80		01	92	22	0.95	5.80
02	92	23	0.95	5.70		02	91	22	0.94	5.70
03	91	22	0.94	5.40		03	90	22	0.93	5.40
04	90	21	0.93	5.20		04	88	20	0.91	5.10
05	89	21	0.92	5.00		05	87	20	0.90	5.00
06	88	20	0.91	4.90		06	86	20	0.89	4.90
07	87	20	0.90	4.80		07	85	20	0.88	4.80
08	86	20	0.89	4.80		08	84	19	0.87	4.85
09	85	19	0.88	4.85		09	83	19	0.86	4.85
10	84	19	0.87	4.90		10	82	18	0.85	4.90
11	83	19	0.86	4.90		11	80	18	0.83	4.90
12	82	18	0.85	4.95		12	78	18	0.81	4.95
13	81	18	0.84	4.95		13	76	17	0.80	5.00
14	80	18	0.83	5.00		14	76	17	0.79	5.00
15	80	17	0.82	5.00		15	76	17	0.79	5.05
16	78	17	0.81	5.05		16	76	17	0.78	5.05

Rel. humidity, Temperature } in ripening chamber a_w, pH } in products

Semi-dry sausages

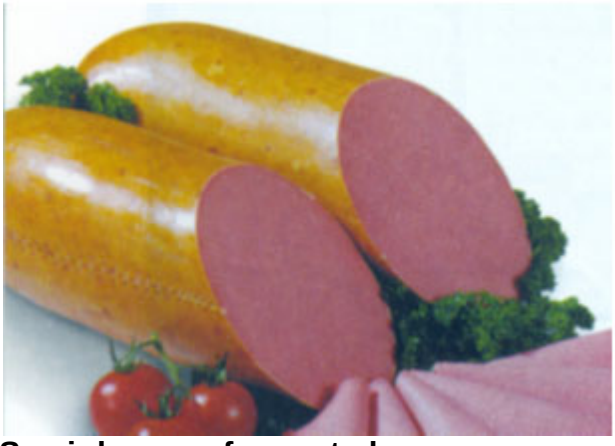
These products are produced by **forced rapid fermentation**. Certain starter cultures (Staphylococcus for speedy reduction of nitrite, stable color) are used in combination with GdL (Glucono-delta-Lacton). This boosts the growth of the desired bacterial flora (lactic acid bacteria) and drops the pH-value fast, resulting in the rapid formation of a protein gel and firm structure of the sausage, which allows slicing and cutting at an early stage. The initial fermentation and ripening period takes place at slightly higher temperatures (+24-26°C) than used for long-time ripened sausages and rarely exceeds 4-7 days. The low pH of 4.8 to 5.4 also supports the fast release of meat tissue water from the sausage, but because of the short production period, the final moisture content will not go below **40%**. The shelf life of such sausages is surprisingly long, up to one month, due to the accumulation of acids and smoke compounds.

These products rarely spoil even in ambient temperatures but they may develop excessive acidity, hence **climatized** (<+18°C) or **refrigerated storage** is recommended, in particular in subtropical and tropical countries.

Acidity in semi-dry raw-fermented sausages is relatively pronounced, which makes such products less attractive to consumer groups not familiar with acid foods. But they are popular in Europe ("Cervelats", "Mettwurst") or in North America ("Summer sausage"). The product name "summer sausage" was coined due to the fact that this product's fabrication was possible by forced fermentation during the warm season and not only in winter.

A special type in the group of semi-dry sausages is the **spreadable raw-fermented sausages**. As the name implies, these products are designed to remain soft so that they can be used as a sandwich spread. For their production the same combination of starter cultures and GdL is used, but for a different reason. The formation of protein gel must be achieved rapidly before the final mechanical chopping step. The onset of gel formation must already develop in the semi-processed sausage mix and is destroyed again by additional chopping in order to retain a soft and creamy texture in the final product. For these products, softer fatty tissues can be used as they will further facilitate the spreadable texture.

Raw-fermented sausages. Long ripening period (50 days)



Semi-dry fermented sausages. Short ripening period (10 days)

NOTES:

SECTION X – CONTROL OF RESTRICTED INGREDIENTS

OVERVIEW AND PURPOSE

The mission of the Meat, Poultry and Egg Safety Branch (MPESB) is to assure that meat, meat food, poultry, and poultry food products produced intrastate are wholesome, not adulterated, and properly marked, labeled, and packaged. MPESB requirements comply with the Federal Meat Inspection Act (FMIA), the Poultry Products Inspection Act (PPIA), and the regulations implementing these laws. Documents such as the FSIS Directives, FSIS Notices, and the Meat and Poultry Inspection (MPI) Manual are also used as references.

Whether meat and poultry products are in compliance with the laws and regulations is often determined by how the products are formulated and processed. Careful attention to the kind and amount of ingredients, their conditions of use, and the standards of product identity and composition are necessary to assure compliance.

The meat and poultry inspection regulations provide specific information on the permitted amounts and uses of various substances that are allowed to be used in meat and poultry products. These substances must not be used in a manner that would deceive the consumer by concealing spoilage or inferiority, or by causing the products to appear of a different size, weight, or quality than they actually are.

The regulations and policy memorandums also prescribe definitions and standards of identity, or composition, for certain meat and poultry products. Standards of identity set specific requirements for a product's make-up. For instance, these standards may specify the kind and amount of meat or poultry, the maximum amount of non-meat and non-poultry ingredients, and any other ingredients allowed, or expected, in the final product. Meat and poultry product standards are established to assure that consumer expectations are met for a product that is labeled with a certain name.

Additional policies have been established to guide inspection personnel in determining whether products are being prepared in accordance with the laws and regulations.

MPESB inspectors carry out monitoring activities, including checks on product preparation, to assure that official establishments are maintaining control of their processes. Among the monitoring activities are food ingredient calculations, which are intended to help ensure that meat and poultry products are not adulterated or misbranded.

Nitrates and nitrites

Nitrates and nitrites not only help kill bacteria, but also produce a characteristic flavor and give meat a pink or red color. Nitrate (NO_3^-), generally supplied by sodium nitrate or potassium nitrate, is used as a source for nitrite (NO_2^-). The nitrite further breaks down in the meat into nitric oxide (NO), which then binds to the iron atom in the center of myoglobin's heme group, reducing oxidation and causing a reddish-brown color (nitrosomyoglobin) when raw, and the characteristic cooked-ham pink color (nitrosohemochrome or nitrosyl-heme) when cooked. The addition of ascorbate to cured meat reduces formation of nitrosamines, but increases the nitrosylation of iron. The use of nitrates in food preservation is controversial, though, due to the potential for the formation of nitrosamines when the preserved food is cooked at high temperature. The usage of either compound is therefore carefully regulated; for example, in the United States, the concentration of nitrates and nitrites is generally limited to 200 ppm or lower. However, they are considered irreplaceable in the prevention of botulinum poisoning from consumption of cured dry sausages by preventing spore germination.

Sodium nitrite and **potassium nitrite** are curing agents used to fix color but most importantly they are used to make a product safe by PREVENTING botulism from developing. **Sodium nitrite** in excessive amounts can be toxic to humans; therefore it is restricted to certain amounts in meat and poultry products. Over use of it is dangerous and may create serious health hazard and under use does not protect product from botulism. So, curing agents must be use responsibly. The maximum amount of nitrite in sausage is **¼ oz. to 100 pounds** chopped meat and/or meat by-products. The use of nitrites shall **not** result in **more than 200 part per million** (ppm) in the finished product.

USDA FSIS requires a **minimum of 120 ppm** of ingoing nitrite in **all** cured "Keep Refrigerated" products, unless the establishment can demonstrate that safety is assured by some other preservation process, such as thermal processing, ph or moisture control. This 120 ppm policy for ingoing nitrate is based on safety data reviewed when the bacon standard was developed.
Except that nitrites used in bacon shall contain 120 of sodium nitrite and 550 ppm of sodium ascorbate or sodium erythorbate.

There is **no** regulatory minimum ingoing nitrite level for cured products that have been processed to ensure their shelf stability (adequate pH controls, and/or moisture controls (salami, **jerky**) in combination with appropriate packaging).

However 40 ppm nitrite is useful in that it has some preservative effect. This amount has also been shown to be sufficient for color-fixing purposes and to achieve the expected cured meat or poultry appearance.

When curing agents, nitrites, are already mixed with salt, sugar, spices, etc. they are commonly referred to as a curing compound or mix. The curing compound or mix must have the percentage of nitrite indicated on the mix container.

Dry Weight: Calculation formula;

$$\frac{\text{Lb. cure mix (x) \% nitrite(x) 1,000,000=ppm}}{\text{Green weight of meat block}}$$

XYZ Meats; as stated on the formulation approval---- salt, sodium nitrite (0.62%)

$$\textbf{.}\frac{\textbf{4 (lb. cure mix) X .0062 (\% nitrite) X 1000000}}{\textbf{20 lbs (green weight of meat block)}}\textbf{= 124 ppm}$$

124 ppm In compliance

Pickle (pump) calculations

Example: A procedure calls for 10% weight gain from pickle solution, 1,000 lbs water, 2 lbs of sodium nitrite.
Calculate the resulting ppm of sodium nitrite in the product.
Remember that in the formula, if two values are known, you can solve for the third one. **Insert the known values and solve the problem with X standing for ppm sodium nitrite, using the formula.**

$$\textbf{X equals=}\ \frac{\textbf{(weight of sodium nitrite) times 0.1 (percent of pump) times 1,000,000 (ppm)}}{\textbf{divided by 1000 (weight of water)}}$$

X=200 Example: Another other procedure calls for 1 pound 12 ounces of sodium niotrite and 1,000 lbs of pickle solution. What percent of gain will result in 200 ppm sodium nitrite in the product? **Insert the know values and solve the problem with X standing for % of gain using the formula given in the previous problem.**

$$\textbf{200 equals =}\ \frac{\textbf{1.75 (weight of sodium nitrite) times X(ppm) times 1,000,000 divided by 1,000}}{\textbf{(weight of the pickle solution)}}$$

X = .1142 X 100= 11.42% gain allowed

To exceed the ppm limit of sodium nitrite has no added benefit in product appearance or shelf life.

UNCURED PRODUCTS

Question: Are celery powder and other natural sources of nitrite approved for use as curing agents?

Answer: No, neither celery powder (whether in a pre-reduced form or with a bacterial nitrate-reducing culture) nor other natural sources of nitrite alone are approved for use in 9 CFR 424.21(c) as curing agents. The substances are currently regulated as flavorings.

FSIS (MPESB) recognizes that the naturally-occurring nitrate and nitrite contained in celery powder and other natural sources is sufficient to maintain the pink coloring of fresh meat. However, curing agents provide more than color retention; they are also important in the control of growth of *Clostridium perfringens* as well as *Clostridium botulinum* and its toxin formation in cured products. Currently available research has not supported that naturally occurring sources of nitrite **alone** can sufficiently control the growth of these pathogens when compared to products that are conventionally cured with sodium nitrite (Jackson et al., 2011a and Jackson et al., 2011b). Thus, without further scientific support, natural sources of nitrite without additional antimicrobial agents or other interventions would not be sufficient to control the growth of *Clostridium perfringens* and *Clostridium botulinum*, and cannot be considered as curing agents.

In addition, it would not be appropriate for establishments producing products containing natural sources of nitrite alone to use the third stabilization option for cured products as described in Appendix B: Compliance Guidelines for Cooling Heat-Treated Meat and Poultry Products (Stabilization). Furthermore, products containing natural sources of nitrite alone are considered uncured during the development of custom cooling schedules or use of predictive pathogen modeling program.

The main purpose for using the “Celery base” in a cooked product is to achieve color fixation. This can be accomplished with @ 40 ppm of sodium nitrite.

The addition of only “Celery base” is for the purpose of being able to claim “No added nitrites, No preservatives” (thus the common reference to these type of products as “No, No’s”).
For these types of product the “celery base” is added in a larger quantity than when used in a product that contains added sodium nitrite.

When “celery base” is added to a product that contains added sodium nitrite it is used as a flavoring, not for color fixation as the added sodium nitrite is already present.

The amount of “celery base” added as “flavoring” does not contain a sufficient amount of sodium nitrite to be of concern when calculating the ppm of sodium nitrite in the finished product.

During a formulation review prior to approval, if it is suspected than an establishment may be exceeding the ppm limit of sodium nitrite due to the addition of a large amount of “Celery Base”, a finished product sample may be taken pending approval.

APPROXIMATE CONVERSIONS FROM STANDARD / US CUSTOMARY UNITS TO SI / METRIC UNITS				
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
LENGTH				
in	inches	25 .4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
AREA				
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE				
^oF	Fahrenheit	(F-32) x 5 / 9 or (F-32) / 1.8	Celsius	^oC
ILLUMINATION				
fc	foot-candles	10.76	lux	lx

fl	foot-Lamberts	3.426	candela/m^2	cd/m^2

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
LENGTH				
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
AREA				
mm^2	millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
VOLUME				
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
MASS				
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
TEMPERATURE				
^oC	Celsius	1.8C + 32	Fahrenheit	^oF
ILLUMINATION				
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl

Common Length Unit Abbreviations:

milliliters = ml
liters = l
gallons = gal
quarts = qt
ounces = oz
cubic feet, feet cubed = ft^3
cubic meters, meters cubed = m^3
cubic inches, inches cubed = in^3

Common Weight Unit Abbreviations:

ounce = oz
gram = g or gr
milligram = mg
microgram - µg
pound = lb
kilogram or kilos = kg

Temperature Conversion - Celsius to Fahrenheit

The metric system uses the Celsius scale to measure temperature. However, temperatures are still measured on the Fahrenheit scale in the U.S. Water freezes at 0° Celsius and boils at 100° Celsius which is a difference of 100°. Water freezes at 32° Fahrenheit and boils at 212° Fahrenheit which is a difference of 180°. Therefore each degree on the Celsius scale is equal to 180/100 or 9/5 degrees on the Fahrenheit scale.

How to convert Celsius temperatures to Fahrenheit

- **Multiply the Celsius temperature by 9/5.**
- **Add 32° to adjust for the offset in the Fahrenheit scale.**
- **Example: convert 37° C to Fahrenheit.**
  37 * 9/5 = 333/5 = 66.6
  66.6 + 32 = 98.6° F

There is a mental math method to convert from Celsius to Fahrenheit. The ratio of 9/5 is equal to 1.8 and 1.8 is equivalent to 2 - 0.2

How to convert Celsius temperatures to Fahrenheit with mental math.

- **Double the Celsius temperature (multiply by 2).**
- **Take 1/10 of this number (2 * 1/10 = 0.2) and subtract it from the number above.**
- **Add 32° to adjust for the offset in the Fahrenheit scale.**
-
- **Example: convert 37° C to Fahrenheit.**
  37 * 2 = 74
  74 * 1/10 = 7.4
  74 - 7.4 = 66.6
  66.6 + 32 = 98.6° F

•

Formula for conversion from celsius to fahrenheit:

F = ((9/5) * C) + 32

- Where C = temperature in degrees Celsius
  and F = temperature in degrees Fahrenheit

Temperature Conversion - Fahrenheit to Celsius

The metric system uses the Celsius scale to measure temperature. However, temperatures are still measured on the Fahrenheit scale in the U.S. Water freezes at 0° Celsius and boils at 100° Celsius which is a difference of 100°. Water freezes at 32° Fahrenheit and boils at 212° Fahrenheit which is a difference of 180°. Therefore each degree on the Fahrenheit scale is equal to 100/180 or 5/9 degrees on the Celsius scale.

How to convert Fahrenheit temperatures to Celsius

- **Subtract 32° to adjust for the offset in the Fahrenheit scale.**
- **Multiply the result by 5/9.**
- **Example: convert 98.6° Fahrenheit to Celsius.**
  98.6 - 32 = 66.6
  66.6 * 5/9 = 333/9 = 37° C.

There is a mental math method to approximate the Fahrenheit to Celsius conversion. The ratio of 5/9 is approximately equal to 0.55555....

How to approximate the conversion of Fahrenheit temperatures to Celsius with mental math.

- **Subtract 32° to adjust for the offset in the Fahrenheit scale.**
- **Divide the Celsius temperature by 2 (multiply by 0.5).**
- **Take 1/10 of this number (0.5 * 1/10 = 0.05) and add it from the number above.**
- **Example: convert 98.6° F to Celsius.**
  98.6 - 32 = 66.6
  66.6 * 1/2 = 33.3
  33.3 * 1/10 = 3.3
  33.3 + 3.3 = 36.6 which is an approximation of the Celsius temperature
    - Formula for conversion from fahrenheit to celsius:

      C = (5/9)*(F-32)
      - Where C = temperature in degrees Celsius
        and F = temperature in degrees Fahrenheit

Volume Formulas

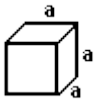
(***pi*** = π = 3.141592...)

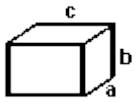
Volume Formulas

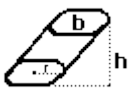
Note: "ab" means "a" multiplied by "b". "a^2" means "a squared", which is the same as "a" times "a".

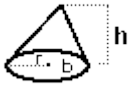
"b^3" means "b cubed", which is the same as "b" times "b" times "b".

Be careful!! Units count. Use the same units for all measurements. Examples

cube = a^3 

rectangular prism = a b c 

cylinder = **b** h = *pi* r^2 h 

cone = (1/3) **b** h = 1/3 *pi* r ^{2} h 

Volume is measured in "cubic" units. The volume of a figure is the number of cubes required to fill it completely, like blocks in a box.

Volume of a cube = side times side times side. Since each side of a square is the same, it can simply be the length of one side cubed.

If a square has one side of 4 inches, the volume would be 4 inches times 4 inches times 4 inches, or 64 cubic inches. (Cubic inches can also be written in^3.)

Be sure to use the same units for all measurements. You cannot multiply feet times inches times yards, it doesn't make a perfectly cubed measurement.

The volume of a rectangular prism is the length on the side times the width times the height. If the width is 4 inches, the length is 1 foot and the height is 3 feet, what is the volume?

NOT CORRECT .... 4 times 1 times 3 = 12

CORRECT.... 4 inches is the same as 1/3 feet. Volume is 1/3 feet times 1 foot times 3 feet = 1 cubic foot

SECTION XI - TRICHINA CONTROL

Trichina (*Trichinella spiralis*) is a microscopic parasite that can cause serious and even fatal disease that people can get by consuming untreated infested pork. There is no mandatory inspection of pork for trichina in USA. Therefore, every product containing pork must go through trichina control process to destroy possible parasite. There are few acceptable methods to successfully control trichina to produce safe pork product.

Pork treated for trichina by freezing is also known as **certified** pork.

§ 318.10 - Prescribed treatment of pork and products containing pork to destroy trichinae.

(a)(1) All forms of **fresh pork**, including fresh unsmoked sausage containing pork muscle tissue, and pork such as bacon and jowls, other than those covered by paragraph (b) of this section, are classed as products that are customarily well cooked in the home or elsewhere before being served to the consumer. Therefore, the treatment of such products for the destruction of trichinae is not required.

(2) Pork from carcasses or carcass parts that have been found free of trichinae as described under paragraph (e) or (f) of this section is not required to be treated for the destruction of trichinae.

(b) Products named in this paragraph, and products of the character hereof, containing pork muscle tissue (not including pork hearts, pork stomachs, and pork livers), or the pork muscle tissue which forms an ingredient of such products, **shall be effectively heated, refrigerated, or cured to destroy any possible live trichinae**, as prescribed in this section at the official establishment where such products are prepared:

Bologna, frankfurter, vienna, and other cooked sausage; smoked sausage; knoblauch sausage; mortadella; all forms of summer or dried sausage, including mettwurst; flavored pork sausages such as those containing wine or similar flavoring materials; cured pork sausage; sausage containing cured and/or smoked pork; cooked loaves; roasted, baked, boiled, or cooked hams, pork shoulders, or pork shoulder picnics; Italian-style hams; Westphalia-style hams; smoked boneless pork shoulder butts; cured meat rolls; capocollo (capicola, capacola); coppa; fresh or cured boneless pork shoulder butts, hams, loins, shoulders, shoulder picnics, and similar pork cuts, in casings or other containers in which ready-to-eat delicatessen articles are customarily enclosed (excepting Scotch-style hams); breaded pork products; cured boneless pork loins; boneless back bacon; bacon used for wrapping around patties, steaks and similar products; and smoked pork cuts such as hams, shoulders, loins, and pork shoulder picnics (excepting smoked hams, and smoked pork shoulder picnics which are specially prepared for distribution in tropical climates or smoked hams delivered to the Armed Services); ground meat mixtures containing pork and beef, veal, lamb, mutton, or goat meat and other product consisting of mixtures of pork and other ingredients, which the Administrator determines at the time the labeling for the product is submitted for approval in accordance with part 317 of the regulations in this subchapter or upon subsequent reevaluation of the product, would be prepared in such a manner that the product **might be eaten rare** or without thorough cooking because of the **appearance of the finished product** or otherwise. Cured boneless pork loins shall be subjected to prescribed treatment for destruction of trichinae prior to being shipped from the establishment where cured.

(c) The treatment shall consist of **heating, refrigerating, or curing,** as follows:

(1) ***Heating.***

(i) All parts of the pork muscle tissue shall be **heated** according to one of the time and temperature combinations in the following table:

Minimum internal temperature		Minimum time
Degrees fahrenheit	**Degrees centigrade**	
120	49.0	21 hours.
122	50.0	9.5 hours.
124	51.1	4.5 hours.
126	52.2	2 hours.
128	53.4	1 hour.
130	54.5	30 minutes.
132	55.6	15 minutes.
134	56.7	6 minutes.
136	57.8	3 minutes.
138	58.9	2 minutes.
140	60.0	1 minute.
142	61.1	1 minute.
144	**62.2**	**Instant.**

(ii) **Time and temperature** shall be **monitored** by a calibrated recording instrument that meets the requirements of paragraph (d) of this section, except for paragraph (c)(1)(iv).(iii) The time to raise product temperature from 60 °F. to 120 °F shall not exceed 2 hours unless the product is cured or fermented.(iv) Time, in combination with temperatures of 138 °F to 143 °F, need not be monitored if the product's minimum thickness exceeds 2 inches (5.1 cm) and refrigeration of the product does not begin within 5 minutes of attaining 138 °F (58.9 °C).(v) The establishment shall use procedures which insure the proper heating of all parts of the product. It is important that each piece of sausage, each ham, and other product treated by heating in water be kept entirely submerged throughout the heating period; and that the largest pieces in a lot, the innermost links of bunched sausage or other massed articles, and pieces placed in the coolest part of a heating cabinet or compartment or vat be included in the temperature tests.\

(2) ***Refrigerating.*** At any stage of preparation and after preparatory chilling to a temperature of not above 40 °F. or preparatory **freezing**, all parts of the muscle tissue of pork or product containing such tissue shall be subjected continuously to a temperature not higher than one of those specified in table 1, the **duration of such refrigeration** at the specified temperature being **dependent on the thickness** of the meat or inside dimensions of the container.

Table 1—Required Period of Freezing at Temperature Indicated **Temperature °F.**	**Group 1 (Days)**	**Group 2 (Days)**
5	20	30
−10	10	20
−20	6	12

(i) Group 1 comprises product in separate pieces not exceeding 6 inches in thickness, or arranged on separate racks with the layers not exceeding 6 inches in depth, or stored in crates or boxes not exceeding 6 inches in depth, or stored as solidly frozen blocks not exceeding 6 inches in thickness.

(ii) Group 2 comprises product in pieces, layers, or within containers, the thickness of which exceeds 6 inches but not 27 inches, and product in containers including tierces, barrels, kegs, and cartons having a thickness not exceeding 27 inches.(iii) The product undergoing such refrigeration or the containers thereof shall be so spaced while in the freezer as will insure a free circulation of air between the pieces of meat, layers, blocks, boxes, barrels, and tierces in order that the temperature of the meat throughout will be promptly reduced to not higher than 5 °F., −10 °F., or −20 °F., as the case may be.(iv) In lieu of the methods prescribed in Table 1, the treatment may consist of commercial freeze drying or controlled freezing, at the center of the meat pieces, in accordance with the times and temperatures specified in Table 2.

Table 2—Alternate Periods of Freezing at Temperatures Indicated **Maximum internal temperature**		**Minimum Time**
Degrees Fahrenheit	**Degrees centigrade**	
0	−17.8	106 hours.
−5	−20.6	82 hours.
−10	−23.3	63 hours.
−15	−26.1	48 hours.
−20	−28.9	35 hours.
−25	−31.7	22 hours.
−30	−34.5	8 hours.
−35	−37.2	1/2 hour.

(v) During the period of refrigeration the product shall be kept separate from other products and in the custody of the Program in rooms or compartments equipped and made secure with an official Program lock or seal. The rooms or compartments containing product undergoing freezing shall be equipped with accurate thermometers placed at or above the highest level at which the product undergoing treatment is stored and away from refrigerating coils. After completion of the prescribed freezing of pork to be used in the preparation of product covered by paragraph (b) of this section the pork shall be kept under close supervision of an inspector until it is prepared in finished form as one of the products enumerated in paragraph (b) of this section or until it is transferred under Program control to another official establishment for preparation in such finished form.

(vi) Pork which has been refrigerated as specified in this subparagraph may be transferred in sealed railroad cars, sealed motor trucks, sealed trailers, or sealed closed containers to another official establishment at the same or another location, for use in the preparation of product covered by paragraph (b) of this section. Such vehicles and containers shall be sealed and transported between official establishments in accordance with § 325.7 of this subchapter.

(3) ***Curing—***(i) *Sausage.* The sausage may be stuffed in animal casings, hydrocellulose casings, or cloth bags. During any stage of treating the sausage for the destruction of live trichinae, except as provided in Method 5, these coverings shall not be coated with paraffin or like substance, nor shall any sausage be washed during any prescribed period of drying. In the preparation of sausage, one of the following methods may be used:

Method No. 1. The meat shall be ground or chopped into pieces not exceeding three-fourths of an inch in diameter. A dry-curing mixture containing not less than 31/3 pounds of salt to each hundredweight of the unstuffed sausage shall be thoroughly mixed with the ground or chopped meat. After being stuffed, sausage having a diameter not exceeding 31/2 inches, measured at the time of stuffing, shall be held in a drying room not less than 20 days at a temperature not lower than 45 °F., except that in sausage of the variety known as pepperoni, if in casings not exceeding 13/8 inches in diameter measured at the time of stuffing, the period of drying may be reduced to 15 days. In no case, however, shall the sausage be released from the drying room in less than 25 days from the time the curing materials are added, except that sausage of the variety known as pepperoni, if in casings not exceeding the size specified, may be released at the expiration of 20 days from the time the curing materials are added.

Sausage in casings exceeding 31/2 inches, but not exceeding 4 inches, in diameter at the time of stuffing, shall be held in a drying room not less than 35 days at a temperature not lower than 45 °F., and in no case shall the sausage be released from the drying room in less than 40 days from the time the curing materials are added to the meat.

Method No. 2. The meat shall be ground or chopped into pieces not exceeding three-fourths of an inch in diameter. A dry-curing mixture containing not less than 31/3 pounds of salt to each hundredweight of the unstuffed sausage shall be thoroughly mixed with the ground or chopped meat. After being stuffed, sausage having a diameter not exceeding 31/2 inches, measured at the time of stuffing, shall be smoked not less than 40 hours at a temperature not lower than 80 °F., and finally held in a drying room not less than 10 days at a temperature not lower than 45 °F. In no case, however, shall the sausage be released from the drying room in less than 18 days from the time the curing materials are added to the meat. Sausage exceeding 31/2 inches, but not exceeding 4 inches, in diameter at the time of stuffing, shall be held in a drying room, following smoking as above indicated, not less than 25 days at a temperature not lower than 45 °F., but in no case shall the sausage be released from the drying room in less than 33 days from the time the curing materials are added to the meat.

Method No. 3. The meat shall be ground or chopped into pieces not exceeding three-fourths of an inch in diameter. A dry-curing mixture containing not less than 31/3 pounds of salt to each hundredweight of the unstuffed sausage shall be thoroughly mixed with the ground or chopped meat. After admixture with the salt and other curing materials and before stuffing, the ground or chopped meat shall be held at a temperature not lower than 34 °F. for not less than 36 hours. After being stuffed, the sausage shall be held at a temperature not lower than 34 °F. for an additional period of time sufficient to make a total of not less than 144 hours from the time the curing materials are added to the meat, or the sausage shall be held for the time specified in a pickle-curing medium of not less than 50° strength (salometer reading) at a temperature not lower than 44 °F. Finally, sausage having a diameter not exceeding 31/2 inches, measured at the time of stuffing, shall be smoked for not less than 12 hours. The temperature of the smokehouse during this period at no time shall be lower than 90 °F.; and for 4 consecutive hours of this period the smokehouse shall be maintained at a temperature not lower than 128 °F. Sausage exceeding 31/2 inches, but not exceeding 4 inches, in diameter at the time of stuffing shall be smoked, following the prescribed curing, for not less than 15 hours. The temperature of the smokehouse during the 15-hour period shall at no time be lower than 90 °F., and for 7 consecutive hours of this period the smokehouse shall be maintained at a temperature not lower than 128 °F. In regulating the temperature of the smokehouse for the treatment of sausage under this method, the temperature of 128 °F. shall be attained gradually during a period of not less than 4 hours.

Method No. 4. The meat shall be ground or chopped into pieces not exceeding one-fourth of an inch in diameter. A dry-curing mixture containing not less than 21/2 pounds of salt to each hundredweight of the unstuffed sausage shall be thoroughly mixed with the ground or chopped meat. After admixture with the salt and other curing materials and before stuffing, the ground or chopped sausage shall be held as a compact mass, not more than 6 inches in depth, at a temperature not lower than 36 °F. for not less than 10 days. At the termination of the holding period, the sausage shall be stuffed in casings or cloth bags not exceeding 31/3 inches in diameter, measured at the time of stuffing. After being stuffed, the sausage shall be held in a drying room at a temperature not lower than 45 °F. for the remainder of a 35-day period, measured from the time the curing materials are added to the meat. At any time after stuffing, if the establishment operator deems it desirable, the product may be heated in a water bath for a period not to exceed 3 hours at a temperature not lower than 85 °F., or subjected to smoking at a temperature not lower than 80 °F., or the product may be both heated and smoked as specified. The time consumed in heating and smoking, however, shall be in addition to the 35-day holding period specified.

Method No. 5. The meat shall be ground or chopped into pieces not exceeding three-fourths of an inch in diameter. A dry-curing mixture containing not less than 31/3 pounds of salt to each hundredweight of the unstuffed sausage shall be thoroughly mixed with the ground or chopped meat. After being stuffed, the sausage shall be held for not less than 65 days at a temperature not lower than 45 °F. The coverings for sausage prepared according to this method may be coated at any stage of the preparation before or during the holding period with paraffin or other substance approved by the Administrator.

Method No. 6. (A) *Basic requirements.* The meat shall be ground or chopped into pieces not exceeding three-fourths of an inch in diameter. A dry-curing mixture containing not less than 3.33 pounds of salt to each hundredweight of the unstuffed sausage, excluding the weight of dry ingredients, shall be thoroughly mixed with the ground or chopped meat. After the curing mixture has been added, the sausage shall be held for two time periods, a holding period and a drying period. The holding period will be for a minimum of 48 hours at a room temperature not lower than 35 °F. This holding period requirement may be fulfilled totally or in part before the drying period and then the remainder, if any, after the drying period or as an extension of the drying period. During the drying period, the sausage shall be held in a drying room at a temperature not lower than 50 (10.0 °F. (10.0 °C) for a period of time determined by Tables 3A, 3B, and 4. The length of the drying period, established in (c)(3)(i)(A), may be modified as provided in paragraphs (c)(3)(i)(B) and (c)(3)(i)(C) of this section.

Table 3A—Sausage Drying Room Times by Method No. 6 **Diameter of casing at time of stuffing 1**	**Days in drying room 2**
Up to:	
1 inches	14
11/2 inches	15
2 inches	16
21/2 inches	18
3 inches	20
31/2 inches	23
4 inches	25
41/2 inches	30
5 inches	35
51/2 inches	43
6 inches	50

(The drying room times for flattened or oval sausages shall use a diameter derived by measuring the circumference and dividing by 3.14 (pi).

2 Drying room time may be modified as set forth in Tables 3B and 4.

(B) *Reduction in Drying Room Time.* During the holding period, the sausage may be smoked or fermented. If the temperature is increased to 70 °F. (21.1 °C) or higher, while the sausage is being held after adding curing materials but before the drying period, the subsequent drying room times prescribed for this method may be reduced according to the schedule in Table 3B. No interpolation of values is permissible.

Table 3B—Percentage Reduction in Drying Room Time (Table 3A) Permitted by Holding Times and Temperatures Prior to Drying 1 **Minimum Time**	**Minimum Temperature 2**	**70 °F**	**21.1 °C**	**75 °F**	**23.9 °C**	**80 °F**	**26.7 °C**	**85 °F**	**29.5 °C**	**90 °F**	**32.2 °C**	**95 °F**	**35.0 °C**	**100 °F**	**37.9 °C**	**105 °F**	**40.6 °C**	**110 °F**	**43.3 °C**	**120 °F**	**48.9 °C**
24 hours	4	5	8	10	15	23	37	57	90	3 100											
48 hours	9	12	18	25	35	49	88	3 100	3 100	100											
72 hours	14	19	28	39	55	74	3 100	100	100	100											
96 hours	19	26	38	53	75	98	100	100	100	100											
120 hours	24	33	48	67	95	3 100	100	100	100	100											

In computing the days to be deducted, the number with any fraction shall be rounded to the next lower whole number and shall be deducted from the required total drying time. Example: Sausage stuffed in 3″ diameter casing requires 20 days in the drying room (from Drying Room Times, Table 3A).

If allowed to ferment, after addition of curing materials, at 80 °F. for 48 hours, the 20 day drying time may be reduced 18% (from Table 3B). Eighteen percent of 20 day equals 3.6 days. Twenty days minus 3 days equals 17 days. The total drying time required in the drying room, therefore, will be 17 days.

2 Either room temperature or internal product temperature shall be used for sausages that will be subsequently dried to a moisture-protein ratio of 2.3:1 or less. Internal product temperature shall be used for all other sausages.

3 Trichinae will be destroyed during fermentation or smoking at the temperature and length of time indicated. Therefore, no drying room period is required for products so treated.

(C) *Reduced Salt Content—Drying Room Times.* Salt content of less than 3.33 pounds for each hundredweight of sausage formulation, excluding dry ingredients, (such as salts, sugars, and spices), may be permitted provided the drying time is increased according to the schedule contained in Table 4.Trichina Treatment of Sausage by Method No. 6;

Table 4—Reduced Salt Content—Drying Room Times [Required percentage increase in drying room time (table 3A) for added salt of less than 3.33 pounds per hundredweight of sausage]

Minimum pounds of salt added to sausage 1	Increase in drying room time 2
3.3	1
3.2	4
3.1	7
3.0	10
2.9	13
2.8	16
2.7	19
2.6	22
2.5	25
2.4	28
2.3	31
2.2	34
2.1	37
2.0	40

1 Calculate the salt content for column 1 as follows: Multiply the pounds of salt in the sausage formulation by 100. Then divide this number by the total weight of sausage formulation minus the weight of dry ingredients and round down to the next lowest 0.1%. Percents may be substituted for pounds.

Example: 120 lbs. pork, 3.56 lbs. salt, 2 lbs. spices, 0.5 lbs. wine, 1 lb. water and starter culture, 0.8 lbs. sugar, .012 lbs. sodium nitrite total weight is 127.872 lbs.

$(3.56\times100)/(127.872-3.56-2-.8-.012)=356/121.5=2.93$

Therefore, the sausage drying time must be increased by 13 percent.

2 In computing the days to be added to the required total drying time, fractions shall be rounded to the next higher whole number and added to the required total drying time. Example: Sausage stuffed in 31/2 inch diameter casing requires 23 days in the drying room (from Drying Room Times). If the quantity of salt added per hundredweight of sausage is 2 pounds instead of 3.33 pounds, the drying room time must be increased by 40 percent (from Reduced Salt Content-Drying Room Times), or 9.2 days. The 9.2 is rounded up to 10 days and is added to the 23 days to equal 33 days. The total drying time required in the drying room, therefore, will be 33 days.

Method No. 7, Dry Sausages. (A) *General Requirements.* The establishment shall use meat particles reduced in size to no more than 1/4 inch in diameter. The establishment shall add a curing mixture containing no less than 2.7 pounds of salt per hundred pounds of meat and mix it uniformly throughout the product. The establishment shall hold, heat, and dry the product according to paragraph (B) or (C) below.

(B) *Holding, Heating, and Drying Treatment, Large Sausages.* Except as permitted in (C) below, the establishment shall subject sausages in casings not exceeding 105 mm in diameter, at the time of stuffing, to all of the following minimum chamber temperatures and time periods.

Treatment Schedule for Sausages 105 Millimeters (41/8 Inches) or Less in Diameter **Minimum chamber temperature**		**Minimum time (hours)**
(°F)	**(°C)**	
50	10	12
90	32.2	1
100	37.8	1
110	43.3	1
120	48.9	1
125	51.7	7

Following the preceding treatment, the establishment shall dry the sausages at a temperature not lower than 50 °F (10 °C) for not less than 7 days.

(C) *Heating and Drying Treatment, Small Sausages.* Alternatively, the establishment may subject sausages in casings not exceeding 55 mm in diameter, at the time of stuffing, to all of the following minimum chamber temperatures and time periods.

Treatment Schedule for Sausages 55 Millimeters (21/8 Inches) or Less in Diameter **Minimum chamber temperature**		**Minimum time (hours)**
(°F)	**(°C)**	
50	10	12
100	37.8	1
125	51.7	6

Following the preceding heat treatment, the establishment shall dry the sausages at a temperature not lower than 50 °F (10 °C) for not less than 4 days.(ii) *Capocollo (capicola, capacola).* Boneless pork butts for **capocollo** shall be cured in a dry-curing mixture containing not less than 41/2 pounds of salt per hundredweight of meat for a period of not less than 25 days at a temperature not lower than 36 °F.
If the curing materials are applied to the butts by the process known as churning, a small quantity of pickle may be added.

During the curing period the butts may be overhauled according to any of the usual processes of overhauling, including the addition of pickle or dry salt if desired. The butts shall not be subjected during or after curing to any treatment designed to remove salt from the meat, except that superficial washing may be allowed. After being stuffed, the product shall be smoked for a period of not less than 30 hours at a temperature not lower than 80 °F., and shall finally be held in a drying room not less than 20 days at a temperature not lower than 45 °F.

(iii) ***Coppa****.* Boneless pork butts for coppa shall be cured in a dry-curing mixture containing not less than 41/2 pounds of salt per hundredweight of meat for a period of not less than 18 days at a temperature not lower than 36 °F. If the curing mixture is applied to the butts by the process known as churning, a small quantity of pickle may be added. During the curing period the butts may be overhauled according to any of the usual processes of overhauling, including the addition of pickle or dry salt if desired. The butts shall not be subjected during or after curing to any treatment designed to remove salt from the meat, except that superficial washing may be allowed. After being stuffed, the product shall be held in a drying room not less than 35 days at a temperature not lower than 45 °F.

(iv) (iv) *Hams and pork shoulder picnics.* In the curing of hams and pork shoulder picnics, one of the methods below shall be used. For calculating days per pound, the establishment shall use the weight of the heaviest ham or picnic in the lot.

Method No. 1. The hams and pork shoulder picnics shall be cured by a dry-salt curing process not less than 40 days at a temperature no lower than 36 °F. The products shall be laid down in salt, not less than 4 pounds to each hundredweight of product, the salt being applied in a thorough manner to the lean meat of each item. When placed in cure, the products may be pumped with pickle if desired. At least once during the curing process, the products shall be overhauled (turned over for the application of additional cure) and additional salt applied, if necessary, so that the lean meat of each item is thoroughly covered. After removal from cure, the products may be soaked in water at a temperature not higher than 70 °F for not more than 15 hours, during which time the water may be changed once, but they shall not be subjected to any other treatment designed to remove salt from the meat except that superficial washing may be allowed. The products shall finally be dried or smoked at a time and temperature not less than a combination prescribed in Table 5 of Method No. 3.

Method No. 2. [Reserved]

Method No. 3. (A) ***Curing.*** (Other than bag curing): Establishments shall cure hams and shoulders by using a cure mixture containing not less than 70 percent salt by weight to cover all exposed muscle tissue and to pack the hock region. Total curing time consists of a mandatory cure contact time and an optional equalization time.

(B) *Cure Contact Time.* This is the cure contact period, during which the establishment shall keep exposed muscle tissue coated with the cure mixture at least 28 days but for no less than 1.5 days per pound of ham or shoulder. Overhaul is optional so long as the exposed muscle tissue remains coated with curing mixture.

(C) *Equalization.* The establishment may provide an equalization period after the minimum cure contact period in (B) above to permit the absorbed salt to permeate the product's inner tissues. Equalization is the time after the excess cure has been removed from the product at the end of the cure contact period until the product is placed in the drying room and the drying period begins. The total curing time (equalization plus cure contact) shall be at least 40 days and in no case less than 2 days per pound of an uncured ham or shoulder.

(D) *Removing Excess Cure.* After the required cure contact period, the establishment may remove excess cure mixture from the product's surface mechanically or by rinsing up to 1 minute with water, but not by soaking

(E) *Bag Curing.* Bag curing is a traditional ham curing technique in which the manufacturer wraps the ham and all of the cure mixture together in kraft paper then hangs them individually. The paper keeps the extra cure mixture in close contact with the product making reapplication of salt unnecessary, and it protects the product from mites and insects. Establishments may employ the bag curing method as an alternative to (A) through (D) above. An establishment which elects to use the bag curing method shall apply a cure mixture containing at least 6 pounds of salt per 100 pounds of uncured product. The establishment shall rub the curing mixture into the exposed muscle tissue, pack the hock region with the curing mixture, and use uncoated wrapping paper to wrap the product together with any remaining curing mixture. The bag cured product shall remain wrapped throughout the curing period and may or may not remain wrapped during the drying period. In any case, the curing period shall be at least 40 days but not less than 2 days per pound of an uncured ham or shoulder. After curing, the cured product shall be exposed to a drying time and temperature prescribed in Table 5.(F)
Curing Temperature. During the curing period the establishment shall use one of the following procedures:(1) The establishment shall control the room temperature at not less than 35 °F (1.7 °C) nor greater than 45 °F (7.2 °C) for the first 1.5 days per pound of an uncured ham or shoulder, and not less than 35 °F (1.7 °C) nor greater than 60 °F (15.6 °C) for the remainder of the curing period.(2) The establishment shall monitor and record daily product temperature. The room temperature need not be controlled but days on which the product temperature drops below 35 °F (1.7 °C) shall not be counted as curing time. If the product temperature exceeds 45 °F (7.2 °C) within the first period of 1.5 days per pound of an uncured ham or shoulder or if it exceeds 60 °F (15.6 °C) for the remainder of the curing period, the establishment shall cool the product back to the 45 °F (7.2 °C) maximum during the first period or 55 °F (12.8 °C) maximum during the remainder of the period.(3) The establishment shall begin curing product only between the dates of December 1 and February 13. The room temperature need not be controlled, but the establishment shall monitor and record daily room temperatures, and days in which the room temperature drops below 35 °F (1.7 °C) shall not be counted as curing time.

(G) *Drying.* After the curing period, establishments shall use one of three procedures for drying:

(1) The establishment shall subject the product to a controlled room temperature for a minimum time and minimum temperature combination prescribed in Table 5 or for a set of such combinations in which the total of the fractional periods (in column 4 of Table 5) exceeds 1.5.

(2) Establishments using uncontrolled room temperatures shall monitor and record the internal product temperature. The drying period shall be complete when, from the days which can be counted as curing time, one of the time/temperature combinations of Table 5 is satisfied or when the total of the fractional values for the combinations exceeds 1.5.

(3) Establishments using uncontrolled room temperatures shall dry the product for a minimum of 160 days including the entire months of June, July, and August. This procedure is obviously dependent on local climatic conditions and no problem exists with respect to current producers who use this procedure. Future applicants shall demonstrate that their local monthly average temperatures and the local monthly minimum temperatures are equal to or warmer than the normal average temperatures and normal minimum temperatures compiled by the National Oceanic and Atmospheric Administration for Boone, North Carolina, station 31-0977, 1951 through 1980.

Monthly Temperatures (°F) for Boone NC, 1951-1980 **Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sep.**
Normal average temperatures								
32.2	34.1	41.3	51.2	59.1	65.1	68.3	67.5	61.6
Normal minimum temperatures								
22.8	24.2	30.8	39.6	48.1	54.7	58.5	57.6	51.6

Drying Times and Temperatures for Trichina Inactivation in Hams and Shoulders

Table 5—Minimum Drying Days at a Minimum Temperature* **Minimum Drying Temperature**		**Minimum days at drying temperature**	**Fractional period for one day of drying**
Degrees fahrenheit	**Degrees centigrade**		
130	54.4	1.5	.67
125	51.7	2	.50
120	48.9	3	.33
115	46.1	4	.25
110	43.3	5	.20
105	40.6	6	.17
100	37.8	7	.14
95	35.0	9	.11
90	32.2	11	.091
85	29.4	18	.056
80	26.7	25	.040
75	23.9	35	.029

* Interpolation of these times or temperatures is not acceptable; establishments wishing to use temperatures or times not in this Table shall first validate their efficacy as provided by 318.10(c)(4) of this section.

Method No. 4. (A) Cure: Establishments shall cure hams and shoulders by using a cure mixture containing not less than 71.5 percent salt by weight to cover all exposed muscle tissue and to pack the hock region. Establishments may substitute potassium chloride (KCl) for up to half of the required salt on an equal weight basis.

(B) *Curing.* Establishments shall apply the cure at a rate not less than 5.72 pounds of salt and KCl per hundred pounds of fresh meat. The cure shall be applied in either three or four approximately equal amounts (two or three overhauls) at separate times during the first 14 days of curing.

(C) *Cure Contact Time.* Establishments shall keep the product in contact with the cure mixture for no less than 2 days per pound of an uncured ham or shoulder but for at least 30 days. Establishments shall maintain the curing temperature at no less than 35 °F (1.7 °C) during the cure contact time.

(D) *Equalization.* After the cure contact period, establishments shall provide an added equalization period of no less than 1 day per pound of an uncured ham or shoulder but at least 14 days. Equalization is the time after the excess cure has been removed from the product, the end of the cure contact period, and before the drying period begins. Establishments may substitute additional cure contact days for an equal number of equalization days.

(E) *Removing Excess Cure.* After the required cure contact period, the establishment may remove excess cure mixture from the product's surface mechanically or by rinsing up to 1 minute with water, but not by soaking.

(F) *Drying.* After the curing period, establishments shall use one of the controlled temperature methods for drying listed in Method No. 3 of this subparagraph.*Method No. 5*

(A) *Curing.* The establishment shall cure the ham to a minimum brine concentration of 6 percent by the end of the drying period. Brine concentration is calculated as 100 times the salt concentration divided by the sum of the salt and water concentrations. Percent brine = 100 × [salt] / ([salt] + [water])The Agency will accept the brine concentration in the biceps femoris as a reasonable estimate of the minimum brine concentration in the ham.

(B) *Drying and Total Process Times.* The establishment shall dry the cured ham at a minimum temperature of 55 °F (13 °C) for at least 150 days. The total time of drying plus curing shall be at least 206 days.

(C) *Ensuring an Acceptable Internal Brine Concentration.* (1) To establish compliance, the establishment shall take product samples from the first 12 lots of production as follows: From each lot,

(i) One sample shall be taken from each of 5 or more hams;

(ii) Each sample shall be taken from the biceps femoris. As an alternative to the use of the biceps femoris, the Agency shall consider other method(s) of sampling the dry-cured hams to determine the minimum internal brine concentration, as long as the establishment proposes it and submits data and other information to establish its sufficiency to the Director of the Processed Products Inspection Division;

(iii) Each sample shall weigh no less than 100 grams;

(iv) The samples shall be combined as one composite sample and sealed in a water vapor proof container;

(v) The composite sample shall be submitted to a laboratory accredited under the provisions of § 318.21 to be analyzed for salt and water content using methods from the “Official Methods of Analysis of the Association of Official Analytical Chemists (AOAC),” 15th Edition, 1990, Section 983.18 (page 931) and Section 971.19 (page 933) which are incorporated by reference. This incorporation by reference was approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Copies may be obtained from the Association of Official Analytical Chemists, suite 400-BW, 2200 Wilson Boulevard, Arlington, VA 22201-3301. Copies may be inspected at the Office of the FSIS Hearing Clerk, room 3171, South Agriculture Building, Food Safety and Inspection Service, U.S. Department of Agriculture, Washington, DC 20250 or at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202-741-6030, or go to: *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html.* If the time between sampling and submittal of the composite sample to the accredited laboratory will exceed 8 hours, then the establishment shall freeze the composite sample immediately after the samples are combined;

(v) Once the laboratory results for the composite sample are received, the manufacturer shall calculate the internal brine concentration by multiplying the salt concentration by 100 and then dividing that figure by the sum of the salt and water concentrations;

(vi) Compliance is established when the samples from the first 12 lots of production have a minimum internal brine concentration of 6 percent. Lots being tested to establish compliance shall be held until the internal brine concentration has been determined and found to be at least 6 percent.

(1) If the minimum internal brine concentration is less than 6 percent, the lot being tested shall be held until the establishment brings the lot into compliance by further processing.

(2) To maintain compliance, the establishment shall take samples, have the samples analyzed, and perform the brine calculations as set forth above from one lot every 13 weeks. Lots being tested to maintain compliance shall not be held. If the minimum internal brine concentration is less than 6 percent in a lot being tested to maintain compliance, the establishment shall develop and propose steps acceptable to FSIS to ensure that the process is corrected.

(3) Accredited laboratory results and the brine calculations shall be placed on file at the establishment and available to Program employees for review.*Method No. 6* (A) *Curing.* The establishment shall cure the ham to a minimum brine concentration of 6 percent by the end of the drying period. Brine concentration is calculated as 100 times the salt concentration divided by the sum of the salt and water concentrations. Percent brine = 100 × [salt] / ([salt] + [water])The Agency will accept the brine concentration in the biceps femoris as a reasonable estimate of the minimum brine concentration.

(D) *Drying and Total Process Times.* The establishment shall dry the cured ham at a minimum temperature of 110 °F (43 °C) for at least 4 days. The total time of drying plus curing shall be at least 34 days.(c) *Ensuring an Acceptable Internal Brine Concentration.*

(1) To establish compliance the establishment shall take product samples from the first 12 lots of production as follows: From each lot,
(i) One sample shall be taken from each of 5 or more hams;
(ii) Each sample shall be taken from the biceps femoris. As an alternative to the use of the biceps femoris, the Agency will consider other methods of sampling the dry-cured hams to determine internal brine concentration, as long as the establishment proposes it and submits data and other information to establish its sufficiency to the Director of the Processed Products Inspection Division;
(iii) Each sample shall weigh no less than 100 grams;
(iv) The samples shall be combined as one composite sample and sealed in a water vapor proof container;
(v) The composite sample shall be submitted to a laboratory accredited under the provisions of § 318.21 to be analyzed for salt and water content using methods from the "Official Methods of Analysis of the Association of Official Analytical Chemists (AOAC)," 15th Edition, 1990, section 983.18 (page 931) and section 971.19 (page 933) which are incorporated by reference. This incorporation by reference was approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Copies may be obtained from the Association of Official Analytical Chemists, suite 400-BW, 2200 Wilson Boulevard, Arlington, VA 22201-3301. Copies may be inspected at the Office of the FSIS Hearing Clerk, room 3171, South Agriculture Building, Food Safety and Inspection Service, U.S. Department of Agriculture, Washington, DC 20250 or at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202-741-6030, or go to: *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html.* If the time between sampling and submittal of the composite sample to the accredited laboratory will exceed 8 hours, then the establishment shall freeze the composite sample immediately after the samples are combined;(vi) Compliance is established when the samples from the first 12 lots of production have a minimum internal brine concentration of 6 percent. Lots being tested to establish compliance shall be held until the internal brine concentration has been determined and found to be at least 6 percent. If the minimum internal brine concentration is less than 6 percent, the lot being tested shall be held until the establishment brings the lot into compliance by further processing.

2) To maintain compliance, the establishment shall take samples, have the samples analyzed, and perform the brine calculations as set forth above from one lot every 13 weeks. Lots being tested to maintain compliance shall not be held. If the minimum internal brine concentration is less than 6 percent in a lot being tested to maintain compliance, the establishment shall develop and propose steps acceptable to FSIS to ensure that the process is corrected.

(3) Accredited laboratory results and the brine calculations shall be placed on file in the establishment and available to Program employees for review.
(v) *Boneless pork loins and loin ends.* In lieu of heating or refrigerating to destroy possible live trichinae in boneless loins, the loins may be cured for a period of not less than 25 days at a temperature not lower than 36 °F. by the use of one of the following methods:

Method No. 1. Application of a dry-salt curing mixture containing not less than 5 pounds of salt to each hundredweight of meats.*Method No. 2.* Application of a pickle solution of not less than 80° strength (salometer) on the basis of not less than 60 pounds of pickle to each hundredweight of meat.*Method No. 3.* Application of a pickle solution added to the dry-salt cure prescribed as Method No. 1 in this subdivision (v) provided the pickle solution is not less than 80° strength (salometer).After removal from cure, the loins may be soaked in water for not more than 1 hour at a temperature not higher than 70 °F. or washed under a spray but shall not be subjected, during or after the curing process, to any other treatment designed to remove salt.Following curing, the loins shall be smoked for not less than 12 hours. The minimum temperature of the smokehouse during this period at no time shall be lower than 100 °F., and for 4 consecutive hours of this period the smokehouse shall be maintained at a temperature not lower than 125 °F.Finally, the product shall be held in a drying room for a period of not less than 12 days at a temperature not lower than 45 °F.

(4) The Administrator shall consider additional processing methods upon petition by manufacturers, and shall approve any such method upon his/her determination that it can be properly monitored by an inspector and that the safety of such methods is adequately documented by data which has been developed by following an experimental protocol previously reviewed and accepted by the Department.

(d) General instructions: When necessary to comply with the requirements of this section, the smokehouses, drying rooms, and other compartments used in the treatment of pork to destroy possible live trichinae shall be suitably equipped, by the operator of the official establishment, with accurate automatic recording thermometers. Circuit supervisors are authorized to approve for use in sausage smokehouses, drying rooms, and other compartments, such automatic recording thermometers as are found to give satisfactory service and to disapprove and require discontinuance of use, for purposes of the regulations in this subchapter, any thermometers (including any automatic recording thermometers) of the establishment that are found to be inaccurate or unreliable.

(e) The requirements for using the pooled sample digestion technique to analyze pork for the presence of trichina cysts are:
(1) The establishment shall submit for the approval of the Regional Director its proposed procedure for identifying and pooling carcasses, collecting and pooling samples, testing samples (including the name and address of the laboratory), communicating test results, retesting individual carcasses, and maintaining positive identification and clear separation of pork found to be trichina-free from untested pork or trichina-positive pork.
(2) The establishment shall use the services of a laboratory approved by the Administrator for all required testing. Such approval shall be based on adequacy of facilities, reagents, and equipment, and on demonstration of continuing competency and reliability in performing the pooled sample digestion technique for trichinae.
(3) The establishment shall sample no less than 5 grams of diaphragm muscle or tongue tissue from each carcass or no less than 10 grams of other muscle tissue. Samples may be pooled but a pool shall not consist of more than 100 grams of sample. Sampling and sample preparation are subject to inspection supervision.

(4) Pork or products made from tested pork shall not be released as trichina free from the official establishment without treatment until the inspector in charge receives a laboratory report that the tested pork is free of trichina cysts.

(f) *Approval of other tests for trichinosis in pork.* The Administrator shall consider any additional analytical method for trichinosis upon petition by a manufacturer, and may approve that method upon the determination that it will detect at least 98 percent of swine bearing cysts present at a tissue density equal to or less than one cyst per gram of muscle from the diaphragm pillars at a 95 percent confidence level. Any such petitions shall be supported by any data and other information that the Administrator finds necessary.

CAPACOLLO, COOKED (Capicola, Capocolla, Capacola, Capicollo, Cappicola, Capacolo – Italian): This product does not meet the definition of ham because it is not from the hind leg of a hog. It is boneless pork shoulder butts which are cured and then cooked. The curing process may be dry curing, immersion curing, or pump curing. The cured product is coated with spices and paprika before cooking. This product shall always be labeled with "Cooked" as part of the product name. Water added is permitted.

What foodborne organisms are associated with pork?
Pork must be adequately cooked to eliminate disease-causing **parasites** and bacteria that may be present. Humans may contract trichinosis (caused by the parasite, ***Trichinella spiralis***) by eating undercooked pork. Much progress has been made in reducing trichinosis in grain-fed hogs and human cases have greatly declined since 1950. Today's pork can be enjoyed when cooked to an internal temperature of 145 °F as measured with a food thermometer before removing meat from the heat source. For safety and quality, allow meat to rest for at least three minutes before carving or consuming. For reasons of personal preference, consumers may choose to cook meat to higher temperatures.

Parasites may be present in food or in water and can be identified as causes of foodborne or waterborne illness in the United States. They range in size, from tiny single-celled organisms to worms visible to the naked eye. Their lifecycle may also vary. While some parasites use a permanent host, others go through a series of developmental phases using different animal or human hosts. The illnesses they can cause range from mild discomfort to debilitating illness and possibly death.

What are parasites?
Parasites are organisms that derive nourishment and protection from other living organisms known as hosts. They may be transmitted from animals to humans, from humans to humans, or from humans to animals. Several parasites have emerged as significant causes of foodborne and waterborne illness. These organisms live and reproduce within the tissues and organs of infected human and animal hosts, and are often excreted in feces.

How are they transmitted?
They may be transmitted from host to host through consumption of contaminated food and water, or by putting anything into your mouth that has touched the stool (feces) of an infected person or animal.

How do they vary?
Parasites are of different types and range in size from tiny, single-celled, microscopic organisms (**protozoa**) to larger, multi-cellular worms (**helminths**) that may be seen without a microscope. The size ranges from 1 to 2 µm (micrometers) to 2 meters long.

What are some common parasites?
Some common parasites are *Giardia duodenalis*, *Cryptosporidium parvum*, *Cyclospora cayetanensis*, *Toxoplasma gondii*, ***Trichinella spiralis***, *Taenia saginata* (beef tapeworm), and *Taenia solium* (pork tapeworm).

Is Frozen Food Safe?
Food stored constantly at 0 °F will always be safe. Only the quality suffers with lengthy freezer storage. Freezing keeps food safe by slowing the movement of molecules, causing microbes to enter a dormant stage. Freezing preserves food for extended periods because it prevents the growth of microorganisms that cause both food spoilage and foodborne illness.

Does Freezing Destroy Bacteria & Parasites?
Freezing to 0 °F inactivates any microbes — bacteria, yeasts and molds — present in food. Once thawed, however, these microbes can again become active, multiplying under the right conditions to levels that can lead to foodborne illness. Since they will then grow at about the same rate as microorganisms on fresh food, you must handle thawed items as you would any perishable food.

Trichina and other parasites can be **destroyed by sub-zero freezing** temperatures. However, very strict government-supervised conditions must be met. Home freezing cannot be relied upon to destroy trichina. Thorough cooking, however, will destroy all parasites.

Trichinella spiralis

Trichinella spiralis, cause of trichinellosis (also known as **trichinosis**) (TRICK-a-NO-sis) is an intestinal roundworm whose larvae may migrate from the digestive tract and form cysts in various muscles of the body. Infections occur worldwide, but are most prevalent in regions where pork or wild game is consumed raw or undercooked. The incidence of trichinosis has declined in the United States due to changes in hog feeding practices. Presently, most cases in this country are caused by consumption of raw or undercooked wild game.

How do people get trichinellosis?
People get trichinellosis (trichinosis) by consuming **raw or undercooked meats** such as pork, wild boar, bear, bobcat, cougar, fox, wolf, dog, horse, seal, or walrus infected with *Trichinella* larvae.

The illness is **not** spread directly from person to person.

Symptoms of trichinellosis
The first symptoms are nausea, diarrhea, vomiting, fever, fatigue, and abdominal pain, followed by headaches, eye swelling, aching joints and muscles, weakness, and itchy skin. In severe infections, persons may experience difficulty with coordination and have heart and breathing problems. Death may occur in severe cases.

When will symptoms appear? What is the duration?
Abdominal symptoms may appear within 1 to 2 days after eating contaminated meat. Further symptoms (eye swelling and aching muscles and joints) may begin 2 to 8 weeks after infection. Mild cases may assumed to be flu. Symptoms may last for months.

Who is at risk for contracting trichinellosis?
Persons consuming **raw or under cooked pork** or wild game.

Persons with weakened immune systems including those with HIV/AIDS infection, organ transplant recipients, or those individuals undergoing chemotherapy may be at a greater risk for infection.

How to prevent trichinellosis

- Wash your hands with warm water and soap after handling raw meat.
- **Cook** all raw pork steaks, chops, and roasts to a **minimum** internal temperature of **145 °F** as measured with a food thermometer before removing meat from the heat source. For safety and quality, allow meat to rest for at least three minutes before carving or consuming. For reasons of personal preference, consumers may choose to cook meat to higher temperatures.
- Clean meat grinders thoroughly each time you grind meat at home

SECTION XII –ADULTERATION AND MISLABELING

CHAPTER 4. MEAT AND POULTRY INSPECTION

Processor must be familiar with and comply with the *Standard of Identity* for the products produced. Federal regulations are very specific in limiting the fat content, the amount of water added, the presence of extenders and variety meats in meat/poultry products.

Article 1. Definitions and Short Title

Article 4. Adulteration

18751. A livestock or poultry product is adulterated if it bears or contains any poisonous or deleterious substance which may render it injurious to health, but in case the substance is not an added substance, such livestock or poultry product shall not be considered adulterated if the quantity of such substance in or on such article does not ordinarily render it injurious to health.

18752. A livestock or poultry product is adulterated in each of the following cases:

(a) It bears or contains, by reason of administration of any substance to the livestock or poultry or otherwise any added poisonous or added deleterious substance, other than one which is:
(1) a pesticide chemical in or on a raw agricultural commodity; (2) a food additive; or (3) a color additive; which may, in the judgment of the director, make such livestock or poultry product unfit for human food.

(b) It is, in whole or in part, a raw agricultural commodity and such commodity bears or contains any pesticide chemical which is unsafe within the meaning of Section 408 of the Federal Food, Drug, and Cosmetic Act (21 U.S.C., Sec. 346a).

(c) It bears or contains any food additive which is unsafe within the meaning of Section 409 of the Federal Food, Drug, and Cosmetic Act (21 U.S.C., Sec. 348).

(d) It bears or contains any color additive which is unsafe within the meaning of Section 706 of the Federal Food, Drug, and Cosmetic Act (21 U.S.C., Sec. 376).

A livestock or poultry product which is not otherwise deemed adulterated pursuant to subdivision (b), (c), or (d) shall nevertheless be deemed adulterated if use of the pesticide chemical, food additive, or color additive in, or on, such livestock or poultry product is prohibited by the director in official establishments.

18753. A livestock or poultry product is adulterated if it consists, in whole or in part, of any filthy, putrid, or decomposed substance or is for any other reason unsound, unhealthful, unwholesome, or otherwise unfit for human food.

18754. A livestock or poultry product is adulterated if it has been prepared, packed, or held under unsanitary conditions by which it may have become contaminated with filth, or been rendered injurious to health.

18755. A livestock or poultry product is adulterated if it is, in whole or in part, the product of an animal, including any poultry, which has died otherwise than by slaughter.

18756. A livestock or poultry product is adulterated if its container is composed, in whole or in part, of any poisonous or deleterious substance which may render the contents of the livestock or poultry product injurious to health.

Article 4. Adulteration (cont.)

18757. A livestock or poultry product is adulterated if it has been intentionally subjected to radiation, unless the use of the radiation was in conformity with a regulation or exemption in effect pursuant to Section 409 of the Federal Food, Drug, and Cosmetic Act (21 U.S.C., Sec. 348).

18758. A livestock or poultry product is adulterated in each of the following cases:

(a) Any valuable constituent has been in whole or in part omitted or abstracted from the livestock or poultry product.

(b) Any substance has been substituted, wholly or in part, for any valuable constituent.

(c) Damage or inferiority has been concealed in any manner.

(d) Any substance has been added to the livestock or poultry product, or mixed or packed with it, so as to increase its bulk or weight, or reduce its quality or strength, or make it appear of a better value than it is.

18759. A livestock or poultry product is adulterated if it is margarine containing animal fat and any of the raw material used in it consisted, in whole or in part, of any filthy, putrid, or decomposed

HEALTH AND SAFETY CODE
SECTION 110545-110655

110545. Any food is adulterated if it bears or contains any poisonous or deleterious substance that may render it injurious to health of man or any other animal that may consume it. The food is not considered adulterated if the substance is a naturally occurring substance and if the quantity of the substance in the food does not render it injurious to health.

110550. Any food is adulterated if it bears or contains any added poisonous or deleterious substance that is unsafe within the meaning of Section 110445.

Article 5. Misbranding

18781. A livestock or poultry product is misbranded in each of the following cases:

(a) Its labeling is false or misleading in any particular.

(b) It is offered for sale under the name of another food.

(c) It is an imitation of another food, unless its label bears, in type of uniform size and prominence, the word "imitation" and immediately thereafter, the name of the food imitated.

(d) Its container is so made, formed, or filled as to be misleading.

18782. A livestock or poultry product is misbranded unless it bears a label showing all of the following:

(a) The name and place of business of the manufacturer, packer, or distributor.

(b) An accurate statement of the quantity of the product in terms of weight, measure, or numerical count.

The director may permit reasonable variations, exemptions as to small packages and exemptions as to any livestock product not in a container that conforms to the purposes of this chapter.

Article 5. Misbranding (Cont.)

18783. A livestock or poultry product is misbranded if any word, statement, or other information required by, or under authority of, this chapter to appear on the label or other labeling is not prominently placed thereon with such conspicuousness, as compared with other words, statements, designs, or devices, in the labeling, and in such terms as to render it likely to be read and understood by the ordinary individual under customary conditions of purchase and use.

18784. A livestock or poultry product is misbranded if it purports to be, or is represented, as a food for which a definition and standard of identity or composition has been prescribed by the regulations of the director under Section 18731 unless it conforms to such definition and standard, and its label bears the name of the food specified in the definition and standard and, insofar as may be required by such regulations, the common names of optional ingredients, other than spices, flavoring, and coloring, present in such food.

18785. A livestock or poultry product is misbranded if it purports to be, or is represented as, a food for which a standard or standards of fill of container have been prescribed by regulations of the director under this chapter, and it falls below the standard of fill of container applicable thereto, unless its label bears, in such manner and form as such regulations specify, a statement that it falls below such standard.

18786. A livestock or poultry product is misbranded if it is not subject to the provisions of Section 18784, unless its label bears the common or usual name of the food, if any, and in case it consists of two or more ingredients, the common or usual name of each such ingredient. The director may, however, permit spices, flavorings, and colorings to be designated as spices, flavorings, and colorings without naming each, and to the extent that compliance with the requirements of Section 18784 are impracticable, or results in deception or unfair competition, by granting exemptions that conform to the purposes of this chapter.

18787. A livestock or poultry product is misbranded if it purports to be, or is represented to be, for special dietary uses, unless its label bears such information concerning its vitamin, mineral, and other dietary properties as the director, after consultation with the Secretary of Agriculture of the United States, determines is necessary to fully inform purchasers as to its value for such uses.

18788. A livestock or poultry product is misbranded if it bears or contains any artificial flavoring, artificial coloring, or chemical preservative, unless it is so indicated on the label. To the extent that compliance with the requirements of this section is impracticable, the director may establish exemptions that conform to the purposes of this chapter.

18789. A livestock or poultry product is misbranded if it fails to bear, directly upon the livestock or poultry product and on its container, as the director may prescribe, the official inspection legend and establishment number of the establishment where the product was prepared. The director may require such other information as he deems necessary to assure that the product will not have false or misleading labeling and that the public will be informed of the manner of handling required to maintain the livestock or poultry product in a wholesome condition.

MISLABELING

FOOD ALLERGIES

Protein in food is the most common allergic component. Certain types of allergic reactions occur when the body's immune system mistakenly identifies a protein as harmful. The immune system, thinking the organism (the individual) is under attack, triggers an allergic reaction. These reactions can range from mild to severe. Allergic responses include dermatitis, gastrointestinal and respiratory distress, including such life-threatening anaphylactic responses.

The scope of problem, particularly for young people, has became a significant public health issue during last decade and therefore all processors must disclosed clearly among other ingredients, all well known allergens used to produce any food product.

The most common list of the allergens includes but it is not limited to:

- ✓ **CRUSTACEA-- Shrimp, crab, lobster**
- ✓ **EGGS --Egg whites, egg yolks**
- ✓ **FISH**
- ✓ **MILK --Sodium casein ate, hydrolyzed casein**
- ✓ **PEANUTS**
- ✓ **SOY --Soy protein isolate, Hydrolyzed soy protein**
- ✓ **TREE NUTS-- Almonds, walnuts, cashews, etc.**
- ✓ **WHEAT--- Hydrolyzed wheat protein, wheat gluten**

LABEL APPROVAL

Form 79-80 (rev. 12/04)

GENERAL GUIDELINES

I. FULLY LABELED WITH THE MARK OF INSPECTION

The department only approves labels for meat/poultry products that are cooked, cured, smoked, dried, or rendered by retail processors amenable to inspection. These products must be fully labeled with an approved label, if sold to the consumer in a self-service display counter that allows the customers to serve themselves by access to the product.

II. FULLY LABELED WITHOUT THE MARK OF INSPECTION

Fresh products manufactured by the establishment and sold as self-service are to be fully labeled, however the label does not require the mark of inspection.

These products are meat/poultry and meat/poultry food products that have ingredient limitations but are NOT cooked, cured, smoked, dried or rendered.

Example include; pork sausage, meat loaf mix, bratwurst, Italian sausage, and hamburger.

III. REPACKED USDA INSPECTED PORDUCT

Meat food products and poultry food products processed under USDA meat and Poultry Inspection and re-packed in state inspected facilities are to be fully labeled; however the label does not require the mark of inspection.

IV. SERVICE SALES

Service sales must allow the customer to see the product and ask questions about the product before purchase. Service sales do not require labeling but identity of the product must be maintained until received by the consumer.

1. Meat/Poultry and meat/poultry food products displayed in bulk or clear packages requiring a retail processing facility employee to serve the customer by handling and bringing the product to the customer.
2. Products in clear protective warp held in a walk-in cooler or freezer that only has employee access requires some type of labeling, but not full labeling.
3. Bulk product that is not on display must be wrapped in the presence of the customer to be considered a service sale.
4. THUS product sold to a customer pre-wrapped in butcher paler or other similar opaque wrap would NOT be considered a service sale and would require appropriate labeling depending on the product.

REFERENCES:

The United States Department of Agriculture Food Standards and Labeling Policy Book will be used for guidance to help insure that labels are truthful and not misleading.

Stated MPI Branch policies, accepted historical or traditional names and/or methods of preparation combined with any additional provided supportive documentation will be reviewed.

Consideration will be given to suitability of names, ingredients, methods of preparation, and packaging so as to ensure regulatory compliance and not to be misleading to the consumer prior to final approval.

RESPONSIBILITIES

Assigned Inspection personnel will review received label applications (Form 79-80) for the following;

1. Typos, misspellings and all printing is legible.
2. No major deficiencies or omissions.
3. The five minimal label requirements are met.
4. Signed by an official of the establishments.
5. Signed by the assigned inspector after initial review and noted deficiencies are incorporated into the forwarded submittal.
6. Sketch approvals are submitted with an attached graphic display of the label, this may be “hand drawn”, “cut and paste”, “computer generated”, etc.
7. Final label submittals have attached the “Final” label with all noted sketch correction, deletions, additions, or modifications incorporated.
8. Final label submittals are typed, signed by an official of the establishment and the assigned inspector prior to submittal for approval.

Check List for Mandatory Features on a Label

Mandatory Features Located on PDP

- Product Name
- Handling Statement (Safe Handling Statement on all raw meat/poultry product)
- Legend / Establishment Number
- Net Weight Statement -
    - Mandatory for retail sale products. Random weight retail products can have statement on application "net weight applied prior to retail sale" instead of net weight statement.

Information Panel

- Mandatory information that is permitted to be displayed off the principal display panel
- Ingredients Statement
- Signature Line
- Nutrition Facts

Mandatory Feature Displayed Anywhere on Labeling

- Safe Handling Instructions

REQUIRED FEATURES OF A LABEL

1. Product Name
2. Ingredient Statement (ingredients listed in order of predominance).
3. Manufacture's Statement (Name and address of the establishment).
4. Net Quality of content Statement (net weight or net content).
5. Mark of Inspection and establishment number.

OPTIONAL FEATURES

1. Handling Statement (Safe Handling Statement mandatory for all fresh meat/poultry products)
2. Preparation Statement

Addition review items;

1. Is all printing legible?
2. Is a Geographic Reference made in the product name? If so, is a qualifying statement required?
3. Is a qualifying/contingency statement requirement with the product name?
4. Are all ingredients included in the ingredient statement and/or allowed?
5. Is a detailed Formulation of the product included?
6. Does the formula meet all requirements of the product standard if applicable?
7. Products with a standard of identity will be checked for compliance with published requirements, and limitations.
8. The word ingredients must be spelled out.
9. All ingredients are to be listed in Upper case letters. If a formula consists of an ingredient that is in itself is a formula, the ingredient will be marked with an asterisk * and the all the ingredients of the ingredient must be listed in small case letters and identified with an asterisk*. If more than one ingredient needs listing the number of asterisk will coincide with the number.
10. All meat ingredients and their weight (a range may be given depending on the product, i. e. 3 to 4 lbs.) must be included in the ingredient list.
11. All related items to the type of product are included. i.e. for cooked products—time/temperature.
12. If a measure is given its weight must be stated i.e. ¼ cup—2 fl oz -- .125 lb
13. Does net weight or count meet all requirements?
14. Is the handling statement applicable?

LABEL FORMULATION AND APPROVAL

Guidelines for the Completion and Submitting MPI Form 79-080 (Rev. 12/04)

MPI Form 79-080 must be completed by an establishment or its representative to request label formulation approvals from the Meat and Poultry Inspection Branch (MPIB), or from the assigned MPI personnel at individual establishments.

All information required on MPI Form 79-080 must be completed to request an approval for the use of a formula, label, or marking device applicable to state inspected meat or poultry products. All information must be typed or printed. The following information provides instructions for completing MPI Form 79-080.

1. Block 1- Establishment name (name of establishment as stated on retailed processors license

2. Block 2 -Establishment Number (number assigned to the establishment by MPI)

Enter the official plant or establishment number. If the label formulation approval is requested for use at more than one establishment, enter each establishment number where the label is to be used.

3. Block 3- Establishment address (actual location of the processing establishment)

4. Block 4 -Product Name

Enter the common name or generic product name, such as “Frankfurter”, Cereal Added” or “Italian Sausage.” Do not use trade names, brand names, or coined names, such as “Joe’s Sloppy Dogs” or “Joe’s Corn Dogs” unless the brand name is accompanied by the true product name such as “Battered Wrapped Wieners.”

Guidelines for the Completion and Submitting MPI Form 79-080 (Rev. 12/04)

5. Block 5-Approval type requested by MPI for approval.

Note: If a temporary approval is requested enter the number of days requested and the number of labels on hand in the large block under the "Approved By" block.

NOTE: Sketch and final label approvals may be concurrent when the following conditions are met;

a. An approved formulation is on file. (If applicable)

b. The sketch approval submittal is not in need of corrections, deletions, or additions. (The graphic display is in compliance with regulatory requirements).

c. The graphic display accompanying the sketch approval request is the actual label that will be placed on or in the packaged product (e.g. Self-adhesive scale generated labels).

A. If the above conditions exist, the approving/forwarding MPI inspector will apply the following changes from the normal sketch approval process prior to forwarding the Area Supervising Meat Inspector (S.M.I.).

a. Annotated on Form 79-080 (rev. 12/04) in the "Sketch App. Number "box the appropriate sketch approval number.

b. In the FOR OFFICIAL USE ONLY BOX.

i. Leave the Number (stamped) box blank.

ii. Leave the Approval Type unchecked

iii. Mark the Preliminary Approval "Approved" box.

iv. Sign the "Preliminary Approved By" box.

B. Attach the actual label to the back of Form 79-080 (Rev.12/04)

6. Block 6-Sketch approval number.

If a final approval is requested, enter the sketch approval number,

7. Block 7- Date of sketch approval

If a final approval is requested, enter the date the sketch was approved, if applicable.

8. Block 8- Type of Product

Check the appropriate box for the product as presented to the consumer

9. Block 9- Internal Temperature of product (deg)

Enter the upper limit of internal product temperature if applicable as described in the method of preparation and remarks block

Guidelines for the Completion and Submitting MPI Form 79-080 (Rev. 12/04)

10. Block 10-Type of material of Label (casing, wrappers, cartons, inserts)

Complete this block only if the product is to be offered for sale at self-service retail level. State the dimensions of the principal display panel. The principal display panel consists of the entire side of the package where the label is to be placed and is considered as the area most likely to be view by the consumer at the time of sale. Include the type of labels such as "pressure sensitive label".

11. Block 11-Ingredients

List each ingredient in the product by weight in their order of predominance. If a product consists of several components, list each component separately and list each ingredient of that component. If additional space is required attach a continuation sheet(s).

12. Block 12-Weight (lbs)

Weights of the individual ingredient or component may be in pounds, ounces, or kilograms, or grams. DO NOT use gallons, pints, cups, teaspoons and the like. DO NOT use fractions. Express fractional amounts in two decimal points, for example 1¼ lbs. would be expressed as 1.25 lbs.

13. Block 13-Method of Preparation and Remarks

Briefly, but thoroughly, describe the procedures used to formulate the product. Examples of processing procedures include:

A. Weather the product is sectioned, chopped, ground, reformed or stuffed;
B. Cooking temperatures
C. How are liquids injected into the product
D. Method of curing hams, corned beef, pastrami, and other similar products.

NOTE: Approval of the label does not necessarily mean approval of the processing procedures.

14. Block 14-Establishment Representative

The signature of the applicant or applicant's agent must appear here.

15. Block 15-Date

The date of the signing of the applicant or applicant's agent must appear here.

Guidelines for the Completion and Submitting MPI Form 79-080 (Rev. 12/04)

BLOCKS 16- 21 FOR OFFICIAL USE ONLY (See Block 5 if applicable)

16. Block 16 Number (stamped) block is to be annotated for formulation and sketch approval by the submitting MPI inspector with the establishment specific number.

A. In addition the submitting MPI inspector will annotate the following

Block 17 Mark the Approval Type accordingly
Block 18 Mark the Preliminary Approval "Approved" box.
Block 19 Sign the "Preliminary Approved By" box.

20. Block 20 Official Approval (no action required)

21. Block 21 Supervising Meat Inspectors will mark the appropriate box after review

22. Block 22 Approved By is to signed by the reviewing Supervising Meat Inspector

23. Block 23 Blank Space
This space will be used by MPI personnel for comments, correction, deletions, and additions or any other actions or activities to be taken by the establishment prior to re-submittal for final approval and request for temporary approval information.

23. Block 23-Inspector
The signature of the establishment's assigned MPI inspector receiving the label formulation application.

24. Block 24-Date

The date the assigned MPI Inspector received the label formulation submittal.

Section 908.6. Marking of Meat Food Products and Poultry Meat Food Products.

(a) Labeled product passed for human food, processed in meat processing establishments licensed under Food and Agricultural Code section 19010, derived from United States Department of Agriculture-inspected product or from fallow deer products inspected and passed at a custom livestock slaughterhouse shall bear the following official inspection legend:

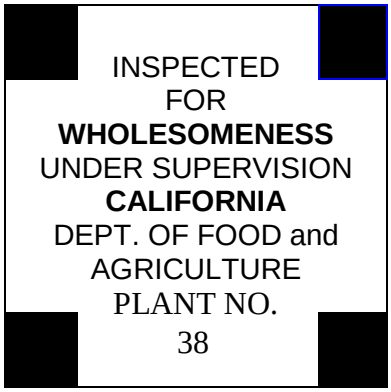
[1] The number "38" is given as an example only. The establishment number of the meat processing establishment where the product is prepared shall be used in lieu thereof.

Lines 3 and 5 are to be in **bold** type.

The Inspection Legend (Mark of Inspection)
For Red Meat and Further Processed Poultry
SHAPE: A true octagon ("Stop Sign") all sides of equal length.
WORDING: Inside the "Stop sign"
Line one: INSPECTED
Line two: FOR
Line three: **WHOLESOMENESS**
Line four: UNDER SUPERVISION
Line five**:** **CALIFORNIA**
Line six: DEPT. OF FOOD and
Line seven: AGRICULTURE
Line eight: PLANT NO. XXXX
Lines three and five are in bold type

The legend may be of any size it must be legible. The "cross" is for raw unprocessed poultry, non-amenable species (quail pheasant etc.) and rabbit products.

NOTE: BLACK SQUARES ARE NOT PART OF THE LABLE BUT USED ONLY TO SHOW THE "CROSS" SHAPE



For Raw Unprocessed Poultry
SHAPE: A "cross" shape. Truly a square that has the corners indented 1/5th the measurement of the square.
WORDING: Inside the "Cross"
Line one: INSPECTED
Line two: FOR
Line three: **WHOLESOMENESS**
Line four: UNDER SUPERVISION
Line five**:** **CALIFORNIA**
Line six: DEPT. OF FOOD and
Line seven: AGRICULTURE
Line eight: PLANT NO.
Line nine: Actual plant number—example --38

NOTE [1] The number "38" is given as an example only. The establishment number of the meat processing establishment where the product is prepared shall be used in lieu thereof.

Sanitation Standard Operating Procedures Requirements

Foodborne illnesses are the important public health problem in the USA. Data from various sources suggest that foodborne microbial pathogens may cause up to 7 million cases of illnesses each year, and 7,000 deaths. Of these, nearly 5 million cases of illnesses and more than 4,000 deaths may be associated with meat and poultry products.

The Meat, Poultry and Egg Safety Branch took steps to improve the safety of meat and poultry products through regulatory requirements implemented in 2010 of Sanitation Standard Operating Procedures (SSOPs) throughout official state inspected operations. California Code of Regulations sections 902.9 through 902.14 requires Custom Livestock Slaughterhouses and Meat Processing Establishments to develop, implement and maintain written Standard Operating Procedures for Sanitation (SSOP).

***California Poultry Inspection Regulations, Article 7, Section 1215 through 1221** requires Poultry Plants to develop, implement and maintain written Standard Operating Procedures (SSOP).*

Sanitation Standard Operating Procedures (SSOP) are the sanitation procedures that meat and poultry plants use, both before and during operations, to prevent contamination of products or adulteration.

FIVE SSOPs REQUIREMENTS

The next few pages provide general guidelines on how to create plant Sanitation Standard Operating Procedures (SSOP) that meet regulatory requirements and reflect plant operations and settings. This guideline doesn't fit any particular plant that is currently under inspection. Management in each plant is responsible for creating and implementing a SSOP that is adequate for plant operations and successfully prevents contamination of product or product adulteration.

1. The first requirement is that the plant has a written SSOP plan describing daily sanitary procedures the establishment will conduct before and during operations they will be conducted to prevent direct contamination or adulteration of product(s).

§ 416.12 Development of Sanitation SOP's. (a) The Sanitation SOP's shall describe all procedures an official establishment will conduct daily, before and during operations, sufficient to prevent direct contamination or adulteration of product(s).

Specificity and detail on how the plant wants to accomplish this component is up to the plant. The emphasis of this requirement is the ***prevention of direct contamination or adulteration of product.*** *Plants should develop procedures that can realistically be carried out given their size, management and empowerment philosophy, and nature of operations. The goal is to* ***prevent*** *direct product contamination and have procedures to* ***immediately react*** *to occurrences of direct product contamination.*

*****In short, the establishment must say what they are going to do, do what say, monitor that they did what they said and document when they did it.***

2. The second requirement is that the written SSOPs plan is signed and dated by an official with overall on-site authority or a higher level official of the establishment. The SSOPs plan must be signed upon initiation and when modified.

§ 416.12 Development of Sanitation SOP's (b) The Sanitation SOP's shall be signed and dated by the individual with overall authority on-site or a higher level official of the establishment. This signature shall signify that the establishment will implement the Sanitation SOP's as specified and will maintain the Sanitation SOP's in accordance with the requirements of this part. The Sanitation SOP's shall be signed and dated upon initially implementing the Sanitation SOP's and upon any modification to the Sanitation SOP's.

The individual with overall authority on-site or a higher level official of the establishment must sign and date the SSOP (a) when they first begin using it and (b) anytime changes are made to it. Many facilities use signature log pages to meet this requirement.

3. The third requirement is that the SSOP plan identifies pre-operational sanitation procedures and distinguishes them from sanitation activities to be carried out during operations. These pre-operational procedures at a minimum must address the cleaning of food contact surfaces of facilities, equipment, and utensils.

(§ 416.12 Development of Sanitation SOP's (c) Procedures in the Sanitation SOP's that are to be conducted prior to operations shall be identified as such, and shall address, at a minimum, the cleaning of food contact surfaces of facilities, equipment, and utensils.

This third requirement of SSOP may raise many questions by industry as to how specific in detail they are to get. Plants may, but are not required to, go into great detail in listing each specific piece of equipment for cleaning and monitoring in the written SSOP.

***However, all pieces of plant equipment used must be cleaned and sanitized prior to next use. Plants are expected to utilize acceptable chemicals, cleaning compounds and* other tools strictly in the way recommended by product manufacturers.**

Methods used by a plant to monitor and maintain pre-operational sanitation procedures, and the frequency for operational procedures may be met under this requirement or under requirement one. Effectiveness of pre-operational sanitation procedures will be determined through the verification/inspection process.

More detailed information about pre-operational procedures and operational activities needed to be conducted in every operation to assure production of safe product is provided in other paragraph of this document.

4. The fourth requirement is that the written SSOP shall specify the frequency with which each procedure in the Sanitation SOP is to be conducted and identify individual(s) who are responsible for implementing and maintaining daily sanitation procedures.

(§ 416.12 Development of Sanitation SOP's (d) The Sanitation SOP's shall specify the frequency with which each procedure in the Sanitation SOP's is to be conducted and identify the establishment employee(s) responsible for the implementation and maintenance of such procedure(s).

Plants should identify these individual(s) by name or job title.

The written document must identify WHO is responsible for making sure that these procedures are performed as stated in the document and the frequency at which the procedure will be conducted. This may be one or more than one person or position.

Effectiveness of responsible employee(s) in implementing and maintaining daily sanitation activities will be determined through the verification process, NOT through the evaluation function.

5. The fifth and last requirement is that establishments maintain daily records that demonstrate they are carrying out the sanitation procedures outlined in their SSOP plan, including corrective actions taken.

§ 416.16 Recordkeeping requirements. (a) Each official establishment shall maintain daily records sufficient to document the implementation and monitoring of the Sanitation SOP's and any corrective actions taken. The establishment employee(s) specified in the Sanitation SOP's as being responsible for the implementation and monitoring of the procedure(s) specified in the Sanitation SOP's shall authenticate these records with his or her initials and the date.

(b) Records required by this part may be maintained on computers provided the establishment implements appropriate controls to ensure the integrity of the electronic data. (c) Records required by this part shall be maintained for at least 6 months and made accessible/ available to FSIS (MPESB). All such records shall be maintained at the official establishment for 48 hours following completion, after which they may be maintained off-site provided such records can be made available to FSIS (MPESB) within 24 hours of request.

Plant management has flexibility in designing such records. There is no set format required, only that a record is maintained. Daily documentation (hard copy) of monitoring of stated procedures must be available for review when requested by MPESB personnel. Completed hard copy record or the results of the recorded monitoring may be maintained (stored) on a computer in lieu of hard copy retention as long as they are accessible to inspection personnel.

Implementing and Monitoring the written SSOP

§ 416.13 Implementation of SOP's.

(a) Each official establishment shall conduct the pre-operational procedures in the Sanitation SOP's before the start of operations.

b) Each official establishment shall conduct all other procedures in the Sanitation SOP's at the frequencies specified.

(c) Each official establishment shall monitor daily the implementation of the procedures in the Sanitation SOP's.

The establishment is responsible for developing written procedures that are adequate to prevent direct contamination of product before and during their operation. Each establishment must perform these procedures as written. Daily monitoring of these procedures is also required to ensure that the procedures are adequate and performed as written.

*If the establishment writes a procedure in its SSOP, it must implement that procedure and **monitor it at least once daily**. They must document their monitoring procedures as a means of providing evidence that the procedures were adequate and performed as written.*

There are many acceptable forms of documenting the monitoring procedures. All records must be initialed and dated daily at the time the observation took place by the employee(s) responsible for implementing and monitoring the SSOP. Each facility should use a form of documentation that accurately represents the monitoring procedures they use in their operation.

Evaluating the Effectiveness of the SSOP

§ 416.14 Maintenance of Sanitation SOP's.

Each official establishment shall routinely evaluate the effectiveness of the Sanitation SOP's and the procedures therein in preventing direct contamination or adulteration of product(s) and shall revise both as necessary to keep them effective and current with respect to changes in facilities, equipment, utensils, operations, or personnel.

To meet the regulatory requirements, the establishment must routinely evaluate the effectiveness of the SSOP in preventing direct contamination of product. This means that the establishment must review their procedures on a regular basis to be certain that they are effective. The establishment should also routinely review their SSOP monitoring records to determine if they need revising and document (date and signature) the review. If monitoring records indicate certain pieces of equipment are found to be unacceptable frequently or certain personnel are not following procedures correctly, the procedures in the SSOP may need to be changed to address these issues or employee(s) need to be retrained. Also, if changes are made in the facilities, equipment, utensils, operations, or personnel, the SSOP may need to be ~~must be~~ revised to keep it effective. Remember, the SSOP must be signed and dated when any modification or review is made.

Corrective Actions

Because no system is perfect, sanitation problems can occur. If a problem occurs, product may become contaminated or adulterated.
Any time product has been contaminated or adulterated or direct product contact surfaces are unclean, the establishment must take appropriate corrective actions and document them!

§ 416.15 Corrective Actions.

(a) Each official establishment shall take appropriate corrective action(s) when either the establishment or FSIS determines that the establishment's Sanitation SOP's or the procedures specified therein, or the implementation or maintenance of the Sanitation SOP's, may have failed to prevent direct contamination or adulteration of product(s).

(b) Corrective actions include procedures to ensure appropriate disposition of product(s) that may be contaminated, restore sanitary conditions, and prevent the recurrence of direct contamination or adulteration of product(s), including appropriate reevaluation and modification of the Sanitation SOP's and the procedures specified therein or appropriate improvements in the execution of the Sanitation SOP's or the procedures specified therein.

A Corrective action is an action taken by the plant employee(s) when either the plant or MPESB Inspector determines the Sanitation SOP or procedures therein may have failed to prevent direct contamination or adulteration of product(s).

Corrective actions include the procedures to ensure appropriate disposition of product(s) that may be contaminated, restoration of sanitary conditions, and prevention of the recurrence of direct contamination or adulteration of product(s).

1. *Ensuring the appropriate handling of affected product (if necessary)*

    a. ***If product has been contaminated, it may need to be disposed of. In some situations, it may be reprocessed.***

    b. ***In some cases, product has not been affected. For instance, if a monitor checks a piece of equipment for cleanliness before it is used for processing and finds a dirty spot, no product has been affected as the equipment had not been used yet.***

2. *Restoring sanitary conditions*

    a. ***The operation must take any measures necessary to correct the problem.***

3. *Preventing recurrence*

    a. ***The operation must identify actions they will take to prevent the problem from happening again in the future.***

Corrective actions will be, recorded, dated and initialed by the responsible plant employee.

There are many ways to document corrective actions; however, any documentation needs to include the three items identified above. A written corrective action might look like this:

Corrective Actions Procedures

Date	***Problem***	***Handling of product***	***How sanitary conditions have been restored***	***Preventive measures***	***Initials of identified responsible team member***
1/15/05	*Rust observed on the saw blade during pre-operational monitoring*	*No product affected, equipment not in use yet*	*The rusty saw blade was removed and replaced with a new one*	*Blades will be inspected for rust and changed on a regular basis*	*BG*

Records Retention

§ 416.16 Recordkeeping requirements.
(a) Each official establishment shall maintain daily records sufficient to document the implementation and monitoring of the Sanitation SOP's and any corrective actions taken. The establishment employee(s) specified in the Sanitation SOP's as being responsible for the implementation and monitoring of the procedure(s) specified in the Sanitation SOP's shall authenticate these records with his or her initials and the date.

(b) Records required by this part may be maintained on computers provided the establishment implements appropriate controls to ensure the integrity of the electronic data. (c) Records required by this part shall be maintained for at least 6 months and made accessible and available to CDFA. All such records shall be maintained at the official establishment for 48 hours following completion, after which they may be maintained off-site provided such records can be made available to CDFA within 24 hours of request.

The daily SSOP records and corrective actions are to be kept on-site for 48 hours and maintained for at least 6 months. After the initial 48 hours, the records may be kept off-site provided that they can be retrieved for inspection personnel within 24 hours of the request.

HOW TO MAKE YOUR OWN SSOP

General considerations

Plant sanitation is plant management's responsibility and it must fully address facility setup, operational/processing equipment, and plant employees. These practices or procedures (SSOP) must be documented (checklists) to validate that meat or meat product safety was maintained during time of production or processing. For the internal needs of an operation, documentation is the most efficient and accurate way to confirm that employee duties regarding sanitation have been performed. Documentation is also vital for external regulatory credibility, as written proof for regulatory agencies or inspectors of the plant's cleaning and sanitation procedures.

SSOP should be specific to each facility where meat or poultry products are produced or processed. It should fully reflect plant operations, plant setup and address plant sanitation difficulties. Various cleaning schedules, including daily, weekly, monthly and annual duties, should be integrated to provide a well rounded sanitation plan. A good sanitation program ensures that meat contact surfaces are free of previously processed products and other contaminants.

Regulations require that plant rooms, compartments, equipment, and utensils used for processing or handling meat or poultry must be kept clean and in sanitary condition (cleaning and sanitizing on a regular schedule). Cleaning is removing the dust, debris or other visible contaminants from a surface. Once the surface is clean, it is to be sanitized to remove the potential for microbial contamination.

Sanitizing is not effective without cleaning the surface first.

Operations with poor sanitation in the meat food environment can significantly increase the risk of contaminating final product. Pathogenic microorganisms may be found more often there, on the equipment in use, on the hands of employees, on the floors or in any other places in the plant.

Sanitation procedures and evaluation

Plant must identify individual(s) who have responsibility for implementing and maintaining daily sanitation activities.

Sanitation procedures must be documented, describing chemicals used, cleaning procedure for various equipment, plant utensils, rooms, etc. Contact time required for cleaning compounds and sanitizers must be stated clearly. SSOP's effectiveness should be evaluated periodically by plant management and findings of this evaluation are to be documented.

Cleaning equipment and machinery

All pieces of equipment in contact with meat or meat product may serve as a vehicle for spreading microbial contamination. Therefore, they must be cleaned and sanitized before being used. Equipment brought from storage or equipment that has not been used is to be cleaned, sanitized and inspected immediately before use. Equipment and tools used for cleaning are to be dedicated exclusively for raw or processed areas, and be easily distinguishable (one method being color-coding) from other equipment.

Remember to clean and sanitize all CLEANING EQUIPMENT before using it.

A. Preoperational procedures (cleaning& sanitizing before operations)

Procedures *conducted prior to operations must address* ***at a minimum the cleaning of food contact surfaces, equipment, and utensils****.*

Specify the frequency *of conducting each procedure and the* ***employee responsible*** *for conducting it****.***

This part must identify and describe all cleaning and sanitizing procedures performed on a regular basis to prepare processing areas of the plant for ***the next operational period.*** *In other words, it is a clearly written description of the plant's main cleaning and sanitizing processes. In most plants, cleaning takes place at the end of the operational hours but it can also be conducted just before operations start. Establishment must conduct pre-operational procedures stated in SSOP before start of operations.*

Other parts of the plant are to be cleaned on various cleaning schedules, weekly, monthly etc. to maintain an acceptable level of cleanliness in order to prevent potential product contamination or adulteration.

Outside premises, as part of the plant, are to be kept reasonably free from any organic or hazardous material.

Different cleaning equipment (brushes, pads, buckets etc) are to be used in different parts (raw product, cooked product) of the plant to prevent cross contamination.

Operational procedures must be conducted at frequencies specified in SSOPs. Establishments must monitor and document daily the implementation of the procedures in the SSOPS.

Example of written procedures that can easy be adopted in any type of operation:

1. Dry Clean

- *Gross soils will be removed from the equipment and floor production supplies (product, product ingredients, packaging materials) will be removed from production areas*
- *Trash will be removed from all production areas*
- *Drain baskets will be emptied (if applicable)*
- *Each piece of plant equipment used or to be used will be disassembled to proper level to provide accessibility to direct product contact surfaces*

2. First Rinse (Pre-rinse) - recommendations and tips

- *The remaining visible soils will be removed (90% to 95%) with warm-water.*
- *Gross soils will be removed from the equipment and floor.*
- *120°F to 140°F: warm enough to melt fat (but not too hot, that it will bake on organic matter)*
- *Water pressure boosted —200 psi with 3/16 nozzle (high pressure will not be used because it will create aerosols containing bacteria)*
- *All equipment rinsed until visually free of soils*

3. *Soap and Scour*

- *Physical effort (scour) will be used to remove films, fats, and other proteins*
- *Walls, then the floor, and then the equipment will be foamed cleaning chemicals will be applied according to manufactures recommendation; such as contact time (i.e., 10 minutes)*
- Physical effort (scour) will be used to remove films, fats, and proteins

4. Post Rinse and Inspection

5. Remove and Assemble of equipment

- *The post rinse will be in the order the detergent was applied: walls, then the floor and the last the equipment*
- *A flashlight will be used to verify cleanliness throughout step 4 to ensure food contact surfaces are 100% free of soils, hazes, or water beads; verified by sight, feel and smell prior assemble*
- *Employees will wash and sanitize hands prior to assembling equipment*
- *The removal of all cleaning chemicals will be verified by either sight, smell, or pH testing*

- *All standing water and overhead condensation will be removed (Standing water prevents sanitizer contact with the surface)*

- *Inaccessible parts (product contact surfaces) will be sanitize prior to assembling as per manufacture's recommendations*

- *Parts (product contact surfaces) that will not be accessible for inspection after assembling will be Pre-op inspected prior to assembly*

6. *Sanitize*

- *The exterior of assembled equipment with direct product contact surfaces will be sanitized as per manufacture's recommendations.*

- *Processing area's walls (5 ft. minimum) and floor will be sanitized*

- *Sanitized equipment will be left to air dry and/or pooling sanitizer will be removed*

7. *Pre-Op Area Inspection*

- *Production areas will be inspected prior to operations to ensure productions equipment is free from cleaning chemicals, tools and cleaning supplies.*

A Flashlight will be used during Pre-op Inspection !

a. *The Pre Operational inspection will be completed as spelled out in the plant SSOP*

b. *Inspect all food contact surfaces visibly*

c. *Check overhead directly over food contact surfaces*

d. *Check areas under food contact surfaces that may impact the food contact surface*

e. *All deficiencies will be noted and corrected, feedback will be provide to the responsible persons*

B. Operational procedures (sanitation activities during operations)

*The document must identify which procedures are performed **during operations** on a daily basis to prevent product contamination or adulteration.*

***Examples of operational procedures in various types of operations*:**

- *Employees wash and sanitize their hands upon entering the production area and during production as necessary to prevent product contamination*
- *Gloves, aprons, etc. not carried or worn outside from the production area of use.*
  All used equipment cleaned and sanitized as needed but at a minimum every 4-5 hours of operation when working not under refrigerating temperature
- *Employees use Sanitizing foot/hand dips prior to entry into a cooked exposed product area (processing operation)*
- *Outer garments for cooked products (e.g., aprons, smocks, gloves) will be identified by color or by an identifying tag (processing operation)*
- *Outer garments will be hung in designated locations when employees leave the production area. .*
- *Outer garments for cooked products (e.g., aprons, smocks, gloves) will be identified by color or by an identifying tag.*
- *Outer garments are change at least every 5 hours of use and when they become unacceptable for use due to excessive product buildup or contaminated.*
- *Employees change outer garments, wash hands and put on clean disposable gloves prior to handling red meat or cooked products.*
- *Tubs, trays and other items to be reused during production that did not receive pre-operational sanitation inspection will be cleaned sanitized and inspected and passed by the licensed plant inspector, and the results recorded on the operational sanitation report prior to use.*
- Equipment such as helmets, boots, mesh gloves, should be cleaned and inspected for defects daily, and replaced as needed.

All processing equipment is to be cleaned and sanitized with an effective bactericide at regular and documented intervals. They should be cleaned, sanitized, and check prior to daily start up. Sanitizing is to occur only after the area has been cleaned. There should be documentation (laboratory results) that prove that the sanitizing method used regularly in the plant is effective against most pathogenic organisms such as Salmonella, E. coli, Listeria monocytogenes and so forth leaving sanitized surfaces free from microorganisms.

Clean product storage areas regularly.

Remove as much as practical, all visible debris, soil, dirt, and unnecessary items from product storage areas on an ongoing basis. Clean these areas on a regularly scheduled basis and take steps to minimize free-floating dust and other airborne contaminants.

Comply with your own SSOPs

A Sanitary SOP identifies and describes all procedures that plant will conduct daily and identifies frequency with which each procedure is to be conducted. Sanitary SOP identifies also plant employee(s) responsible for the implementing and recording those procedure(s).

All procedures in the Sanitary SOP are to be conducted at the frequency specified. Implementation of procedures is to be monitored and recorded. Plant management is to evaluate the effectiveness of the Sanitation SOP and revise as necessary.

Verification and Validation of the SSOP Design

All CDFA inspected establishments must have an SSOP that meets the development (basic design) requirements in § 416.12 before a ***Retail Processing, Custom Slaughter or Poultry Processing License*** *is issued. The basic procedure to verify that the SSOP was designed and implemented properly as well as validation that SSOP adequately implemented sanitary procedures was performed when the establishment began operations.*

➡**§ 902.9. (§1216 Poultry Reg.) Development of Sanitation Standard Operating Procedures.**

a.) On or before January 1, 2010, each official establishment shall develop, implement, and thereafter maintain written sanitation standard operating procedures (Sanitation SOP's) in accordance with the requirements of this article.

Both verification and validation are also to be performed annually near the end of the January (approximately one year from anniversary date of January 1, 2010) and anytime there are major changes to the establishment's existing SSOP.

§ 416.14 Maintenance of Sanitation SOP's.

Each official establishment shall routinely evaluate the effectiveness of the Sanitation SOP's and the procedures therein in preventing direct contamination or adulteration of product(s) and shall revise both as necessary to keep them effective and current with respect to changes in facilities, equipment, utensils, operations, or personnel.

This yearly process must ensure that SSOP fully reflects plant operation, plant setup and it addresses thoroughly and successfully plant sanitation that will create sanitary environment that produces safe and unadulterated product.

RECORDKEEPING

The requirement for SSOP documentation is applicable to all stages of production of state inspected product ONLY.

The operational recordkeeping procedure requires daily documentation of the *establishment's daily implementation and monitoring of the SSOP operational procedures and any required corrective actions. This is to verify that the establishment has daily records that demonstrate the establishment has implemented the operational procedures, monitored those procedures, and taken corrective actions when necessary.*

Monitoring procedures should be conducted as they are specified in the SSOP. If the SSOP document specifies a frequency at which the monitoring procedures will be conducted, the establishment shall conduct the procedures at the frequency specified in the SSOP at a minimum of once daily.

Records shall verify that the monitoring (pre-operational inspection) was conducted daily prior to the start of operations. Records shall verify that each time the establishment documented that food contact surfaces were found unacceptable, corrective action was implemented effectively.

Each time the establishment has documented the finding of contaminated product or food contact surfaces (equipment, utensils, etc.), there should be documented corrective actions that meet the requirements of §416.15 adequate to:

1) Ensure appropriate disposition of product (when product is involved);

2) Restore sanitary conditions; and

3) Prevent recurrence.

The establishment employee responsible for the implementation or monitoring shall authenticate the records with initials or signature and the date. There must also be a written record of any corrective actions required by §416.15. These records must be ***maintained daily****.*

NOTE: *Most of the time product will not be involved during pre-operational sanitation monitoring. When the establishment finds direct food contact surfaces that are unacceptable during its monitoring of pre-operational sanitation and cleans the surfaces before product passes over that surface, there is no noncompliance. In these situations, CDFA believes the establishment's SSOP has worked as intended.*

RECORDKEEPING (cont.)

If the establishment has not recorded its monitoring activities, has not recorded corrective actions when food contact surfaces contamination has been observed, or has not initialed or signed and dated the daily record for authentication, ***there is noncompliance.***

If the establishment found product was contaminated, records should verify that it has documented corrective actions that meet the requirements of §416.15.

§ 416.16 require the establishment to maintain ***daily*** *records sufficient to document the implementation and monitoring of the SSOPs and any corrective actions taken.* The *establishment must have records documenting that monitoring has been conducted daily for each of the procedures specified in the SSOPs.*

If the establishment has specified a monitoring frequency in the SSOP that is more frequent than daily, the documentation would have to reflect that the monitoring activities had been conducted at the specified frequencies. The establishment employee specified in the SSOPs as being responsible for the implementation and monitoring of the procedures shall authenticate these records with initials or signature and the date.

If the establishment has not recorded its monitoring activities, has not recorded corrective actions when product contamination is observed, or has not initialed and dated the daily record for authentication, ***there is noncompliance****.*

SANITATION INSPECTION

A Processing Inspector (P.I.) before assessing the sanitary conditions in a processing operation by performing the pre-operational inspection procedure should:

- *Have a good flashlight.*
- *Have a pen or pencil.*
- *Have CDFA Rejected/CDFA Retained tags (green) and some means (tape, string, rubber bands) of affixing these tags to equipment, departments, product, etc.*
- *Have a checklist to record your pre-operational findings.*

Pre-Operational Sanitation Inspection

*Direct food contact surfaces must be **organoleptically** clean. This means that the surfaces **look clean, feel clean, and smell clean**. Food contact surfaces are to be visually examined for product residues that might be left from previous days' operations. These contact surfaces should be felt to determine if there are residues or foreign materials (e.g. grit, dust, etc.) present from previous days' operations that are not visible. Persons performing pre-operational inspection should be aware of any odors in these areas that may indicate insanitary conditions.*

> ***Clean** means that the contact surfaces are free of foreign material such as fat, blood, hair, rust, dust, grease, and cleaning chemicals.*

Processing Inspector (P.I.) must conduct thoroughly pre-op inspection prior each day of operation as written in SSOP to be able to find any sanitary deficiencies that may contaminate or adulterate final product.

When the establishment's P.I. finds a contaminated food contact surface (foreign material, residue from previous day's product, etc.) during pre-operational inspection, and implements its procedure by cleaning the surface before product passes over the surface, there is no noncompliance.

In these situations, CDFA believes the establishment's SSOP has worked as intended.
***NOTE:** Most of the time product will not be involved during pre-operational sanitation monitoring.*

Operational Sanitation Inspection

For example, all equipment in the production areas will be rinsed with warm water during the lunch break, then foamed and scrubbed as necessary to remove product residues, rinsed with potable water and sanitized. The similar procedures will be applied to all food contact surfaces when changing meat species or when changing from a raw to cooked product will take place.

- If the establishment does not conduct the procedures for cleaning the production areas and equipment during operations as stated, there is noncompliance with §416.13(a).

For example, product incidentally drops on the floor in the raw product area; the utility person will promptly remove the product from the floor, trim the contaminated surfaces, wash the product at the product wash station, and re-inspect it for any contamination before placing it back into production

- If the establishment is not monitoring the product reconditioning procedure daily, there is noncompliance with §416.13(c).

Although there is no regulatory requirement, establishments may have a procedure in its SSOPs for reconditioning product that incidentally comes in contact with a non-food contact surface (such as the floor).

> *This procedure is used for occasional instances of product contamination. If the establishment is following its written procedures and monitoring these procedures, the establishment would not be required to take corrective action that meets the requirements of §416.15 every time product falls on the floor. If the establishment does not have a reconditioning procedure in its SSOP, it would be required to take and document corrective actions that meet the requirements of §416.15 each time product falls on the floor.*

For example, a production employee will observe all overheads in product storage areas and remove condensation as necessary during operation.

- *If the production employee is not performing the procedure to prevent condensation from directly contaminating or adulterating product, there is noncompliance with §416.13(b).*

SAMPLE

SANITATION STANDARD OPERATING PROCEDURES

Est. #_____ Name_____

The following Management personnel will be responsible for the implementation and maintenance of the following SSOP.

The Processing Inspector (P.I.) will be responsible for the Daily monitoring and documentation of compliance with the SSOP requirements.

Management_____ Date_____
Printed Name _____ Implementation

Management_____ Date_____
Printed Name_____ Maintenance

Processing Inspector_____ Date_____
Printed Name _____ Monitoring

SANITATION STANDARD OPERATING PROCEDURES

General Equipment Cleaning.

I. Pre-operational sanitation – Equipment and Facility Cleaning.

Equipment in processing areas will be cleaned and sanitized immediately after each day's production by the plant's designated employees, before the next days, beginning of operation.

1. Equipment requiring disassembly will be disassembled to exposed direct contact surfaces. Removable parts are placed into the proper container for transfer to a cleaning location.

2. Large product debris is physically removed.

3. Equipment parts are rinsed with water to remove remaining particulate.

4. An approved cleaner (See cleaning chemical list SSOP Form # 5) is used to clean the equipment.

5. Parts are cleaned and rinsed with potable water at 120-140 degrees.

6. Equipment parts are sanitized with an approved sanitizer (See cleaning chemical list SSOP Form # 5) and rinsed if necessary.

7. Equipment is allowed to air dry.

8. After equipment is inspected and found acceptable (with results annotated on the preoperational sanitation checklist) it will be assembled, and sanitized with an approved sanitizer (see cleaning chemical list SSOP Form # 5).

SANITATION STANDARD OPERATING PROCEDURES

A. Simple Hand Tools and Utensils Cleaning.

1. Simple equipment and hand-tools are cleaned in the same manner excluding disassembly.

B. Cleaning of Facilities – floors, walls, and ceilings(Production Area).

1. Debris is swept up and discarded.

2. Direct contact surfaces of facilities and walls are rinsed with potable water from top to bottom at the end of each production day.

3. All non-direct product contact facilities and ceilings are cleaned as needed, and as scheduled (see cleaning plan and schedule SSOP Form # 4).

4. Facilities are cleaned with approved cleaner, according to manufacturer's directions.

5. Facilities are re-rinsed with potable water from the top to bottom.

6. Walls and floors are sanitized with an approved sanitizer, and rinsed if necessary.

C. Monitoring, and Record-keeping.

1. The PI performs daily organoleptic sanitation inspection before the start of operations. The results will be recorded on the daily pre-operational sanitation report. If items inspected are acceptable, the proper abbreviation is applied to the appropriate box on form SSOP Form # 1.
2. Corrective actions taken as a result of unacceptable inspection results will be proper documented.

D. Corrective actions.

1. When the PI determines that any of the following items or areas is unacceptable, they will be re-cleaning and sanitation and re-inspected until acceptable. Corrective actions taken will be documented on the corrective action sheet (SSOP Form # 3) preventative measures may include employees being retrained.

II. Operational Sanitation

Objective: Processing is performed under sanitary conditions to prevent direct and cross-contamination of food products. All processing employees will adhere to the operational sanitation provisions of the SSOP's. All checks and findings will be recorded on SSOP Form # 2.

A. Sanitation Procedures

1. Employees clean and sanitize hands, knives, and other hand tools, cutting boards, etc., as necessary during processing to prevent the contamination of other products.

2. All equipment, tables and other product contact surfaces are cleaned and sanitized throughout the day as needed.

3. Raw and cooked products are kept in separate areas designated raw or RTE (ready to eat). Cross-contamination is avoided by keeping the two separate and utilizing different tools for each.

4. Outer garments are changed when the tasks are interchanged between cooked and raw products.

5. Employees are required to take appropriate actions when switching tasks that include but are not limited to: washing hands, changing exterior uniform, and cleaning the resulting work station.

SANITATION STANDARD OPERATING PROCEDURES

E. Personal hygiene

1. Every person working in food handling area will maintain a high degree of personal cleanliness and will wear clean suitable outer garments. Employees exhibiting unhygienic practices will be removed from production and disciplined according to company policy.

2. Management will ensure: Clean uniforms and protective clothing will be worn during food handling activities.

3. Hands: Thorough hand washing is essential throughout food processing operations to ensure food hygiene. Employees are required to wash hands;

- Before starting work
- After using the toilet
- After taking a break
- After handling raw foods
- After handling rubbish
- Before handling cooked/prepared foods
- After touching your nose, mouth, hair, eyes

4. Hair: Employees will keep their hair covered, with hair nets and/or hats in the production areas. Employees with Facial hair will wear beard nets. Readjustment of head covering should always take place away from food preparation rooms and be followed by hand washing.

5. Metal clips and grips will not be used to tie back hair as they can fall into food and cause injury to consumer.

6. Employees will not ear, smoke, touch, or blow their nose while in a food processing area.

7. Protective clothing: will remain in the production area upon the employee leaving the production area and will not be worn to and from work or to the toilet or be worn when emptying trash bins, etc. and return to production.

8. Protective clothing will always be changed when going from activities in a raw product area to a finished, ready-to-eat product area.

9. The communal welfare facility will periodically checked for acceptability of hot and cold running water, soap, and paper towels.

B. Monitoring and Record-keeping.

1. The PI will continuously monitor the sanitation procedures and at a minimum every four hours records the results on the Operational Sanitation Report, (SSOP Form # 2) verified with initials of the PI conducting such inspections.

2. The PI is responsible for ensuring that employee hygiene practices, employee and product traffic patters, sanitary product handling procedures, and cleaning procedures are maintained during the operational hours.

C. Corrective Actions.

1. When the PI identifies operational sanitation problems the P.I. will,

a. Stop production, if necessary,

b. Take the appropriate action to restore sanitary conditions.

c. Retain product if necessary

d. Ensure proper disposition of retained product

e. Determine the cause of the contamination/adulteration and take proper actions to correct any problems. (Re-adjust equipment, retraining employees, etc.)

2. If improper procedures have resulted in cross-contamination of processed product corrective action may include the reprocessing of processed products.

3. Corrective actions will be recorded on the Operational Sanitation Corrective Action Sheet. SSOP Form # 3

PRE-OPERATIONAL SANITATION SSOP
Form # 1

Establishment Name

Establishment Number

Management Signature

PI Signature

Fill in spaces across from the items using the appropriate symbol:
(A) Acceptable (U) Unacceptable

Day of the Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Processing Areas																															
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2.																															
3.																															
4.																															
5.																															
6.																															
7.																															
8.																															
9.																															
10.																															
Initials of person performing Inspection																															

OPERATIONAL SANITATION SSOP
Form #2

Establishment Name

Establishment Number

Management Signature

PI Signature

Fill in spaces across from the items using the appropriate symbol:
(A) Acceptable (U) Unacceptable

Day of the Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Processing Areas																															
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9.																															
10.																															
Initials of person performing Inspection																															

Establishment Name _____

Establishment #_____

SSOP Form # 3 Corrective Actions

Date	Problem Identified	Handling of Product	How sanitary conditions have been restored	Preventative Measures	Initials

NON-DIRECT CONTACT SURFACES SANITATION SSOP Form #4

Establishment Name

Establishment Number

Management Signature

PI Signature

Fill in spaces across from the items using the appropriate symbol:
(A) Acceptable (U) Unacceptable

Day of the Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Processing Areas																															
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10.																															
Initials of person performing Inspection																															

SANITATION STANDARD OPERATING PROCEDURES
SSOP Form # 5

Est. #_____ Name_____

Approved Chemicals list

1. **Cleaning agents**

   Name. **Manufacture**

   a. _____

   b. _____

   c . _____

   c. _____

   e. _____

2. **Sanitizing agents**

   a. _____

   b. _____

   c. _____

   d. _____