Cured Meat and Poultry Product Operations

Objectives

Upon completion of this module, the student will be able to:

1. Define curing.
2. List and describe three curing methods.
3. List and describe five methods of applying a curing solution.
4. List two cure accelerators used in curing products.
5. Describe the term smoking.
6. Explain how the smoking process chemically reduces bacterial growth.
7. Identify at least two establishment responsibilities for producing cured and smoked meat and poultry products.
8. Identify at least two inspection program personnel responsibilities when assigned to a cured and smoked meat or poultry operation.
9. Identify the restricted ingredients used in a pickle solution or curing formulation.
10. Describe the physical appearance of meat product to which nitrate and/or nitrite has been applied.
11. Identify the amount of added curing solution allowed in different types of cured products, such as rounds, briskets, tongues, and turkey thighs.
12. Describe product massaging and tumbling.
13. Identify four advantages and two disadvantages of massaging and tumbling.
14. Describe how to perform the % Yield/Shrink task.
15. Define green weight, pumped weight, finished weight, actual percent pump/pick-up and effective percent pump/pick-up.
16. Calculate the maximum amount of curing agent, curing accelerator, and phosphate allowed, when given a formula, and determine if these restricted ingredients are in compliance.
17. Calculate the volume of a tank, when given the dimensions of a tank.
18. Calculate the maximum amount of cure mix allowed, based on percent of pump, when cure mixes are used in formulations that contain specific amounts of restricted ingredients.
19. Compute parts per million of restricted ingredients in cured meat products at the time of pumping to determine compliance.
20. Calculate the actual percent of pump allowed in pork bellies when given the weight of restricted ingredients and weight of the curing solution.

21. Identify restricted ingredients allowed in bacon products and the parts per million allowed for each ingredient.
22. Calculate parts per million allowed for each restricted ingredient approved for use in bacon products.
23. Calculate the yield of cured pork bellies when given finished weight and green weight numbers.
24. Calculate the percent shrink for dry cured pork products.

Reference Materials

FSIS Regulations

FSIS Directive 7620.3, *Processing Inspector's Calculations Handbook*

FSIS Directive 7000.1, *Verification of Non-Food Safety Consumer Protection Regulatory Requirements*

Introduction

The art of preservation of meat products was a tradition that began out of necessity for travelers needed food to last without spoiling. The methods used are as old as history itself. Long before packing establishments were developed, it had been found that cuts of meat could be preserved by submerging them into a salt solution, or by packing them in dry salt. These salted meat items could be held for extended periods and consumed at a later date. Cured, dried meats have been around for hundreds of years.

Since this meager beginning, the cured meat and poultry industry has evolved. It is this expanding and fast changing industry that Inspection Program Personnel (IPP) in the meat and poultry inspection program that are charged with regulating; thus, FSIS regulations and enforcement must, out of necessity, keep pace with industry development and technology.

IPP must have a working knowledge of the cured meat and poultry industry in order to effectively verify an establishment's process controls. This module correlates industry practices and techniques with FSIS regulations and will pinpoint areas of inspection responsibility.

This portion of the module begins by familiarizing IPP with the definitions of two terms that are used throughout this module: *curing and smoking*.

Curing is placing specific chemical agents in or on meat and poultry, such as pork ham, pork shoulder picnics, pork bellies, beef top and bottom rounds, beef knuckles, beef briskets, beef tongues, and poultry cuts to preserve it.

Smoking is subjecting meat and poultry cuts to an environment of smoke generated from hardwood, hardwood sawdust, corn cobs, or natural or artificial liquid smoke that has been transformed into a true gaseous state by applying direct heat.

As the process of meat and poultry curing developed, the industry emphasized four factors: preservation, flavor, color, and tenderness. In recent years, a fifth factor, yield, has come into the forefront. This factor has been stimulated by a highly competitive industry and consumer acceptance of a water-added product. The following are descriptions of each factor as they apply to meat and poultry curing.

Preservation

To preserve meat and poultry, the undesirable microorganisms on the meat surfaces that cause spoilage must be inactivated and destroyed. One of the most effective means of accomplishing this is by introducing salt, in the amount permitted, into the meat because it provides some flavoring and preservation properties. The number of salt-resistant types of bacteria and other microorganisms varies widely. The growth of some bacteria is inhibited by salt concentrations as low as 2%, whereas other types are able to survive in salt concentrations up to the saturation point (26%). Fortunately, the growth of many undesirable organisms normally found in meat and poultry products is inhibited at very low concentrations of salt. Since the salt has to penetrate the meat to preserve it, the temperature must be low enough to prevent decomposition and high enough to induce salt penetration.

Flavor

Flavor is another factor of great concern to the manufacturer. The flavor of cured meat is thought to be a composite result of the flavors of the curing agents and those developed by bacterial and enzymatic action. Because of the amount of salt used in the curing process, the salt flavor is the most predominant.

Sugar plays an important role as food for the flavor-producing bacteria of meat during long curing processes. Bacon may be the exception, in that after frying, it has a distinctly sweet taste. More importantly, because of the tremendous amount of salt used, sugar serves to reduce the harshness of the salt in cured meat and poultry. As with any additive, there may be any amount of sugar that is permitted in the finished product or it must be added in a sufficient amount to meet the intended purpose.

- Amount permitted
  - Sugar (sucrose) or dextrose—sufficient for purpose
  - Brown Sugar—sufficient for purpose
- Saccharin—for bacon 0.01% in the finished product

The addition of protein materials such as hydrolyzed plant protein, hydrolyzed vegetable protein, and monosodium glutamate (MSG) acts as a flavor enhancer and must be sufficient for the purpose in which it is used. Gelatin acts as a binder or congealer for certain meat food products.

Note: On meat and poultry product labels, proteinaceous materials must be specifically listed by their common or usual name because their primary purpose is not flavor. For instance, the terms "plant" and "vegetable" are **NOT** acceptable. The source of the protein must be specified, such as hydrolyzed ***soy*** protein.

The use of approved hardwoods, such as: hardwood, hardwood sawdust, corncobs, corncob meal, redwood, redwood sawdust, apple sawdust, mesquite wood, or mesquite sawdust in the process of smoking gives product the characteristic smoke flavor and color. Smoking also acts to preserve flavor. To some degree, smoking is bacteriostatic (inhibits bacterial growth) and bactericidal (kills bacteria) to most surface organisms. Smoking also dehydrates the surface of the product and deposits a resinous material on the meat surface due to the condensation of some phenolic and aldehyde compounds. These compounds produce an effective chemical barrier against growth and penetration of organisms. Excessive showering of product may remove some of the beneficial effects of the smoke and surface salt.

Note: If product is labeled “Hickory Smoked,” the sawdust or wood used for smoking is predominately hickory.

Color

The next factor to consider is color. The development and maintenance of a stable red color is very important in cured and smoked meat operations. Sodium or potassium nitrate or nitrites are the cure agents used to process cured meats. Cure agents are responsible for the development of the characteristic stable red color in the meat. Nitrate is used as source of nitrite or a reservoir for nitrite. Nitrate has no direct effect on meat or poultry products. Because it acts as a reservoir from which nitrite can be produced over time, it is more practical to use nitrates in cured products requiring long production times such as dry-cured pork products. When nitrate is used as the cure agent, the conversion (reduction) of nitrate to nitrite by bacteria in the meat or poultry is a necessary step in the development of the cure color. The amount of nitrate that is reduced to nitrite is dependent upon the numbers of nitrate-reducing bacteria and several environmental conditions such as temperature, moisture content, salt content, and pH. Hence, the conversion rate and subsequent amount of nitrite that is formed is difficult to control. Similarly, the further reduction of nitrite to nitric oxide, which reacts with myoglobin (muscle pigment) to produce the cured color, is affected by the same environmental conditions. If nitrite is used as the cure agent, there is no need for the nitrate reduction step, and the development of the cure color is much more rapid.

If the cured meat is heated, exposed to a more acidic environment, or left long enough under normal conditions, the nitric oxide myoglobin is converted into a stable red pigment called nitrosohemochrome. This is why a cured piece of meat remains red when heated and a fresh piece turns gray or brown. The amount of color that develops during the curing process depends on the amount of muscle pigment (myoglobin) present in the meat.

The time required for a cured color to develop may be shortened with the use of cure accelerators. Examples are ascorbic acid and erythorbic acid, or their derivatives, sodium ascorbate and sodium erythorbate. Cure accelerators tend to speed up the chemical conversion of nitrous acid to nitric oxide. Myoglobin must be in a reduced state to combine with nitric oxide. Cure accelerators tend to keep myoglobin in the reduced state and readily combines with nitric oxide. Cure accelerators also serve as oxygen scavengers, preventing the fading of the cured meat color in the presence of sunlight and oxygen.

Tenderness

Product tenderness is a processor's concern. Tenderness is more of a problem with certain beef cuts than with pork cuts. Consequently, more emphasis is placed on tenderness when beef is used. With the original methods of curing, which involved long periods of time, both pork and beef were excessively salty and tough. This toughness was probably due to the continued action of the salt dehydrating the meat fibers. With the advent of artery pumping, quick curing, and high temperature smoking, the packer could produce meats that are definitely tenderer.

Yield

This brings us to the fifth and final factor which is yield. By necessity, the packer is very concerned with yields in cured and smoked meat and poultry products. The market is extremely competitive, thus adding to the incentive to produce noncomplying product.

Factors Affecting Yield

Phosphates. The use of phosphates in cured and smoked meat and poultry products has been widely adopted by the meat industry. Its primary purpose is to reduce excessive shrinkage or "purge" (cook out) when the product is cooked. Phosphates also increase the water holding capacity of the available protein in the product, without increasing the apparent saltiness of the product. Test results with phosphates indicate that their use to increase yields is much more effective at high processing temperatures, such as those used to produce fully cooked product.

Binders and Extenders. The following binders and extenders are used in cured pork products to prevent purging of the brine solution. The approved binders listed below must be used individually, unless otherwise stated. In some cases, certain binders and extenders may be combined, but only in specified amounts. (For more details, see §424.21(c)).

- Amounts permitted
  - Carrageenan—**NOT** to exceed 1.5% of product formulation
  - Food starch modified— **NOT** to exceed 2% or 3.5% of product formulation depending on the cured pork product
  - Sodium caseinate— **NOT** to exceed 2% of product formulation
  - Isolated soy protein— **NOT** to exceed 2% of product formulation

Note: The above binders are only approved for use in ***cured pork products*** labeled as "Ham with Natural Juices", “Ham, Water Added” and “Ham and Water Product—X% of Weight is Added Ingredients.”—9 CFR 319.104

Other Factors. Other factors that affect yield are smoking and cooking time, humidity, the type of casing used, i.e., pervious or impervious.

Massaging or tumbling. Massaging is used to increase yield. Massaging or tumbling subjects meat or poultry chunks to mechanical treatment to facilitate protein extraction. This is accomplished by placing the product in a vat with an agitator or in a tumbler for varying periods of time depending upon the type of equipment used.

Basically, the results of the treatment on the meat and poultry chunks are muscle fiber disruption with a corresponding release and coating of the muscle with a salt-soluble protein. The protein then is heat-coagulated by cooking to form a binding matrix between muscle chunks, thus giving the muscle chunk an intact muscle appearance.

There are some distinct ***advantages*** in massaging. There is an accelerated brine dispersion in the cured product; improved uniformity of cured color and texture; an enhanced release of salt-soluble protein (myosin) to produce a creamy, tacky, exudate; increased yield because of reduced weight loss during cooking; and facilitating water binding without using prepared gelatins or binders.

There are also some ***disadvantages*** with massaging. Excessive mechanical treatment may cause excessive muscle destruction. Insufficient treatment may cause product to exhibit poor binding and slicing characteristics. There is also the possibility of poor cure distribution, poor color development, and bacterial contamination due to excessive handling.

Curing Methods

There are three general methods of curing, with a number of variations for each method. These methods are pickle curing, dry curing, and dry salt curing.

Dry Curing

Dry curing is the application of salt alone; salt, nitrate, and/or nitrite; or salt, nitrate, and/or nitrite with sugar directly to the surface of the meat. Meat subjected to this curing method cannot be injected with, or immersed in, a cure solution.

Dry Salt Curing

Dry salt curing is modification of the dry curing method, which includes the same mixtures in dry curing, except that product may be injected with cure solution directly into the muscle tissue (not through the circulatory system). Just prior to being covered with the dry mix, the meat may be momentarily moistened to facilitate salt penetration.

Curing Solution

A cure solution could be prepared with:

- water and salt (a plain or salt **brine**);
- water, salt, nitrate and/or nitrite **pickle**; or
- water, salt, nitrate and/or nitrite and a sugar (e.g., sweet **pickle**).

Other ingredients could be added to enhance flavor. When formulating a brine or pickle solution some operations prepare the brine in 100° salometer strength (saturated solution approximately 26% salt by weight). This is then diluted to the desired strength at the time of formulation. At 60°F, one gallon of saturated brine weighs approximately 10.03 lb and contains approximately 2.64 lb salt or 26.4% salt. Additional salt will settle to the bottom of the container. The temperature of pumping pickle usually runs from about 40°F to 70° F.

A pumping pickle may also be used as a cover pickle. Product covered with cover pickle for any length of time should be checked by the IPP to assure the amount of added solution does not affect the establishment’s procedural controls. After mixing, a pickle solution should be continually agitated to assure a uniform blend of the curing agents and to prevent ingredients such phosphates from precipitating out of the pickle.

Cure solutions are often reused. When a cure solution is reused, it should be filtered to keep it clear, free of sediment, and prevent decomposition. Mechanical pumping devices are sometimes used to recirculate the solution that spills directly from the product and the needles through a continuous filtration system. The IPP should check the filter to ensure that it is in good repair and removing meat residue and sediment.

Application of Curing Solutions

There are several methods of applying curing solutions to meat and poultry cuts. It is important that the IPP be familiar with the different methods of applying curing solution to meat and poultry cuts. There are five basic methods to apply *curing solutions* to meat and poultry cuts.

Osmosis was the earliest method used. This method involves covering the meat cuts with dry cure or completely submerging the meat cuts in a curing solution for an extended period of time (2 to 6 weeks) which is also called immersion curing.
The ***stitch method*** injects curing solution deep into the muscle with a single orifice needle. This method is considered better than the submerging method because the packer can quickly get a deeper penetration of the cure.

Spray pumping is a variation of the stitch method using a needle with many orifices to allow for more uniform distribution of the pickle.

Artery pumping introduces the curing solution into the natural circulatory system.

The last method, ***needle injection,*** is essentially the stitch method. The difference is that a machine with ten or more needles, sometimes spring-loaded for injecting bone-in product, is used. This method is considered more efficient and economical.
Whichever method is used, the IPP should be familiar with pumping procedures and equipment.

Cured Meat and Poultry Product Standards

FSIS has established maximum limits for the amount of solution and ingredients that may be added to cured **raw and cooked** meat and poultry products. If the amount of added solution is equal to or less than the maximum limit, the processor ***is not*** required to declare the addition and amount of the solution on the product's label.

The words "**added solution**" are often replaced by more specific processing terms such as "pump" or "pick-up". Which term is used depends on the method of applying the solution.

- **Pump** is the amount (pounds) of a solution *injected*, either intramuscularly or intra-arterially, into a piece of meat or poultry.

- **Pick-up** is the amount (pounds) *absorbed* by a piece of meat or poultry when the solution is **mechanically agitated** (massaged or tumbled) into it or when the meat or poultry has been submerged or immersed in the solution.

  Note: The Calculation Aid uses the term **"Gain"** in the main menu for these values!

Yield limitations and added solution (pump/pick-up) limitations are interrelated. For instance, corned beef brisket can be pumped with a curing solution up to 20%. Hence, the finished cured briskets shall not have a yield greater than 100% + 20%, which is a total of 120%.

Standard of Identity of Cured Beef Products: §319.100 – §319.103

A. Corned Beef

Corned (cured) beef shall be prepared from beef brisket, navels, clods, middle ribs, rounds, rumps, or similar cuts using one or a combination of the curing ingredients specified in §424.21(c).

B. Corned Beef Brisket

In preparing *corned beef brisket, the* application of curing solution to the beef brisket shall not result in an increase in the weight of the finished cured product of more than 20% over the weight of the fresh uncured brisket. In other words, the green (fresh uncured) weight of the beef briskets **CANNOT** be increased by more than 20% without the presence and amount of the added ingredients indicated on the label.

Any corned beef brisket whose weight after pumping exceeds 20% over the weight of the fresh uncured brisket may be prepared if the products are descriptively labeled to indicate the presence and amount of the additional substances.

Examples of product names include: "CORNED BEEF BRISKET CONTAINS UP TO X% OF A SOLUTION OF WATER, SALT, NATURAL FLAVORINGS, SODIUM ERYTHORBATE, GARLIC AND SODIUM NITRITE" or "CORNED BEEF BRISKET CONTAINS X % OF A SOLUTION OF WATER, SALT, SODIUM PHOSPHATE, AND

SODIUM NITRITE." ***X% percent labeled products are discussed in the next module.***

The actual percentage is determined by subtracting the green weight of the beef brisket from the pumped or treated weight of the product and dividing by the green weight of the beef brisket. This calculation is for ***uncooked*** product.

C. Corned Beef Round and Other Corned Beef Cuts

In preparing *corned beef round* and other corned beef cuts (except "corned beef brisket"), the curing solution shall be applied to pieces of beef weighing no less than one pound. Such application shall ***not*** result in an increased weight of more than 10% over the weight of the fresh uncured beef cut. In other words, the green weight of the cured beef round and other cuts (except beef briskets) **CANNOT** be increased by more than 10% without the presence and amount of the added ingredients indicated on the label.

Corned beef cuts (other than beef briskets) whose weight after pumping exceeds 10% over the weight of the fresh uncured beef cuts may be prepared if the products are descriptively labeled to indicate the presence and amount of the additional substances.

Examples of product names include: "CORNED BEEF CONTAINS UP TO X% OF A SOLUTION OF WATER, SALT, NATURAL FLAVORINGS, SODIUM ERYTHORBATE, GARLIC AND SODIUM NITRITE" or "CORNED BEEF CONTAINS X % OF A SOLUTION OF WATER, SALT, SODIUM PHOSPHATE, AND SODIUM NITRITE." ***X% percent labeled products are discussed in the next module.***

The actual percentage is determined by subtracting the green weight of the beef cut from the pumped or treated weight of the product and dividing by the green weight of the beef cut. This calculation is for ***uncooked*** product.

C. Cooked Corned Beef Products

In preparing cooked corned beef, the application of curing solution to beef products shall not result in an increase of weight over the weight of the fresh uncured product (green weight). In other words, the weight of the cooked beef briskets (and other

cooked beef cuts— §319.102) must return to green weight or their yield **CANNOT** be greater than 100%.

Cooked corned beef products, whose weights after cooking exceed the weights of the fresh uncured beef, may be prepared if the products are descriptively labeled to indicate the presence and the amount of the additional substances.
Product names that are acceptable include “CORNED BEEF CONTAINS UP TO X% OF A FLAVORING SOLUTION.” ***X% percent labeled products are discussed in the next module.***

D. Cured Beef Tongue

In preparing *cured beef tongue,* the application of curing solution to the fresh beef tongue shall ***not*** result in an increase in the weight of the cured beef tongue of more than 10% over the weight of the ***fresh*** uncured beef tongue. Tongues are usually artery-pumped and placed in a cover pickle for 4 to 7 days. Due to their size and the fact that they retain pickle very well, it is quite easy to pump tongues to a high percentage of added solution. The percent pump can be quite accurately determined by a lot method provided they are cured in lots of uniform weight ranges. Since FSIS does not require a minimum temperature on smoked tongues, it is even more important that a proven establishment procedure is followed to produce product compliance.

Cured Pork Products §319.104

(a) Cured pork products, including hams, shoulders, picnics, butts and loins, shall comply with the minimum meat Protein Fat Free (PFF) percentage requirements set forth in the following chart:

Type of cured pork product	***Minimum meat PFF percentage[1]***	***Product name and qualifying statement***
Cooked ham, loin[2]	20.5	(common and usual)
	18.5	(common and usual) with natural juices
	17.0	(common and usual) water added
	<17.0	(common and usual) and water product—X% of weight is added ingredients[3]
Cooked shoulder, butt, picnic[2]	20.0	(common and usual)
	18.0	(common and usual) with natural juices
	16.5	(common and usual) water added
	<16.5	(common and usual) and water product—X% of weight is added ingredients[3]
Uncooked cured ham, loin	18.0	Uncooked (common and usual)
	<18.0	Uncooked (common and usual) and water product—X% of weight is added ingredients[3]
Uncooked cured shoulder, butt, picnic	17.5	Uncooked (common and usual)
	<17.5	Uncooked (common and usual) and water product—X% of weight is added ingredients[3]

[1] The minimum meat PFF percentage shall be the minimum meat protein which is indigenous to the raw unprocessed pork expressed as a percent of the non-fat portion of the finished product; and compliance shall be determined under §318.19 of this subchapter for domestic cured pork product and §327.23 of this subchapter for imported cured pork product.

[2] The term ‘‘cooked’’ is not appropriate for use on labels of cured pork products heated only for the purpose of destruction of possible live trichinae.

[3] Processors may immediately follow this qualifying statement with a list of the ingredients in descending order of predominance rather than having the traditional ingredients statement. In any case, the maximum percent of added substances in the finished product on a total weight percentage basis would be inserted as the X value; e.g., Ham and Water Product—20% of Weight is Added Ingredients

(b) Cured pork products for which there is a qualifying statement required in paragraph (a) of this section shall bear that statement as part of the product name in lettering not less than 3/8 inch in height, or in lettering not less than one-third the size of the largest letter in the product name if it is in the same color and style of print and on the same color background as the product name. However, the Administrator may approve smaller lettering for labeling of packages of 1 pound or less, provided such lettering is at least one-third the size and of the same color and style as the product name.

The establishment must control the process and prepare cured pork products in compliance with the PFF regulations. PFF is the meat protein content expressed as a percent of the nonfat portion of the finished product. This definition allows the monitoring of all added ingredients including water, since anything added to the product dilutes the natural meat protein content. As the added ingredient levels increase, the PFF content decreases. For instance, a ham with the same analytical composition (fat and meat protein level) would have a % protein on a fat free basis of 22 with no ingredients added and with 20% ingredients added it would have % protein on a fat free basis of 18.33.

The product label is the key for distinguishing between cured pork products subject to the PFF regulations. The product label determines which PFF standard is used to determine compliance because the label directly reflects the meat protein content. The product name qualifying statement, e.g., “natural juices” or “water added” represents the minimum PFF percentage for the cured pork product.

If an establishment loses control of its process, it should submit a product sample to a laboratory for meat protein and fat analyses and use the following formula to determine the PFF for the cured pork product. In accordance with §318.19, the establishment must verify that the calculated PFF value is not below the Absolute Minimum PFF for the cured pork product. The “Absolute Minimum PFF” is that PFF of a single sample that is so far below the standard that the lot cannot possibly have a lot average which is equal to the standard and represents noncompliance with the regulation.

$$\text{PFF} = \frac{\text{\% Meat Protein by Analysis}}{100 - \text{\% Fat by Analysis}} \times 100$$

Note: Ingredients that contribute some protein content, e.g., mustard, ISP, MSG, hydrolyzed plant protein, or meat stocks) may be added to cured pork products, but their

presence and amounts must accompany any product sample sent to a laboratory. The laboratory should then deduct the amount of protein contributed by the additive before calculating the ***meat*** protein content.

Country Ham: §319.106

“Country Ham,” “Country Style Ham,” or “Dry Cured Ham,” and “Country Pork Shoulder,” Country Style Pork Shoulder,” or “Dry Cured Pork Shoulder,” are the uncooked, cured, dried, smoked or unsmoked meat food products made respectively from a single piece of meat conforming to the definition of “ham,” as specified in 317.8(b)(13) of the subchapter, or from a single piece of meat from a pork shoulder. They are prepared in accordance with §319.106(c) by the dry application of salt (NaCl) and one or more of the optional ingredients as specified in §319.106(d). They may not be injected with curing solutions nor placed in curing solutions.

The weight of the finished hams and pork shoulders shall be at least 18 percent less than the fresh uncured (green) weight of the article. In other words, the finished hams or shoulders must shrink at least 18%. Shrink limitations and yield limitations are interrelated. Therefore, finished hams or shoulders shall not have a yield greater than 82%.

Bacon: §319.107

The weight of cured pork bellies ready for slicking and labeling as “Bacon” shall not exceed the weight of the fresh uncured pork bellies (green weight).

Turkey Ham: §381.171

Turkey ham is fabricated from boneless turkey thigh meat, with the skin (and surface fat attached to the skin) removed. It is cured and may or may not be smoked. The finished product weight shall not exceed the original (green) weight of the thigh meat prior to curing. A qualifying statement, “Cured Turkey Thigh Meat,” is required. An additional descriptive statement (“Chunked and Formed,” “Ground and Formed,” or “Chopped and Formed” as appropriate to indicate particle size) is needed if the thigh meat was cut through the muscle during preparation.

If the finished product has not returned to the green weight of the thigh meat, the label must include, in addition to the name “Turkey Ham,” words that specify the amount of

additional substances. For example, product may be labeled as “TURKEY HAM, CURED TURKEY THIGH MEAT CONTAINS X% OF A SOLUTION OF WATER, SALT, DEXTROSE, SODIUM PHOSPHATE, AND SODIUM NITRITE” or “TURKEY HAM, CURED TURKEY THIGH MEAT, GROUND AND FORMED X% ADDED WATER.” ***X% percent labeled products are discussed in the next module.***

Establishment Responsibilities

Establishments that produce Protein Fat Free (PFF) controlled *cured* pork products, pickle-*cured* beef products, pickle-*cured* poultry products, pickle-*cured* pork bellies have specific responsibilities for controlling product preparation and following their processing procedures. Establishment management has the following responsibilities:

- Utilize in-plant controls, such as accurate pre-weighing of ingredients, to ensure ***all*** regulatory requirements are met,
- Adhere to proven processing procedures for curing, cooking and chilling,
- Adopt procedures to minimize product variation, e.g., lot product to be pumped (hams, picnics, or briskets) into two-to three-pound weight ranges,
- Furnish all necessary assistance (labor) to the IPP so he or she can perform the added solution, yield or shrink check rapidly and accurately,
- Assist the IPP in determining the tare weight of trucks or containers used for the added solution, yield or shrink regulatory determination, and
- Provide accurate scales, lighting, tanks, and carts necessary to conduct the added solution, yield or shrink regulatory determination.

The establishment’s written processing procedures at a minimum must list the ingredients (names and weights) used to formulate the pickle solution and the *targeted* percent pump/pick-up. If the pickle cured product is cooked, additional information is needed such as smokehouse cook times and temperature, chilling times and temperatures and targeted cook and chill shrinks—9 CFR 320.1(b)(11) and 381.175(b)(6).

Effective controls must be implemented to prevent adulteration with excess cure solution. One way to accomplish this is with in-plant “weight control.” The establishment may submit lab samples periodically to determine the effectiveness of the control.
The establishment could positively identify the product by placing a tag bearing the date, product name, curing ingredients, green weight, piece count, pumped weight, signature

of establishment employee, and lot number on each container (vat, truck, drum, etc.) of briskets.

During the curing period, if pieces are removed from any container, the establishment should enter the number and weight of pieces removed on the tag attached to the container. The establishment should check any or all containers at the time of shipment (up to ½ hour after cover pickle has been drained). The weight and number of pieces removed during the curing period must be added back to the shipping weight to facilitate correct calculations for percent added solution (no more than 20% over green weight).

NFSCP PHIS Tasks

IPP are responsible for being familiar with the establishment's production practices and written processing procedures; evaluating their effect on finished product; observing the amounts of restricted ingredients used; calculating the percent of curing solution added to the product to ensure that restricted ingredients are properly used, pumping procedures are uniform, and the percentage of solution added is in compliance.

The proper inspection tasks used to verify the cured meat and poultry product regulatory requirements may not always be readily apparent. Below are two commonly used tasks for the products covered in this module.

Performing the General Labeling Task

Inspection program personnel perform this task to verify general labeling regulatory requirements and determine if the label accurately reflects the finished product.

- **General Labeling Requirements**

  Verifying that the general labeling requirements have been met involves:

  - observing the application of the label or labeling,
  - selecting labels and labeling for review, and
  - reviewing the establishment's labeling records.

When IPP observe the packaging and labeling operations, they ensure that immediate containers of meat and poultry products have a label attached to them and that shipping containers bear the required information.

When IPP select and review the label/labeling being applied to the container or package, they determine if:

- the label contains the mandatory features and other required information such as a qualifying statement or descriptive designation, and
- any printing or colors on the label and packaging material gives a false impression or does not meet specific formatting criteria.

Product is misbranded if its label is missing a required feature, qualifying statement, or descriptive designation or is anyway false or misleading.

When IPP review the establishment's labeling file, they determine if the:

- label is on file and either met the generic approval requirements or was sketch approved by LPDS,
- label required sketch approval by LPDS and if so, the sketch is attached to the final label,
- label is being used beyond the expiration date if it has been granted a temporary approval by LPDS, and
- product's formulation (if applicable) and processing procedures are attached to or accompany the label/labeling.

If IPP find noncompliance, they issue an NR and take the appropriate action necessary to ensure misbranded product does not enter commerce.

- **Label Accurately Reflects the Product**

Determining that the label accurately reflects the finished product involves reviewing the product's formulation record and observing its actual preparation and, in some cases, performing formula calculations.

When IPP perform this task, they should select one or more batches of product at formulation and verify ingredient amounts comply with the formula on file and that no undeclared ingredients are added or declared ingredients are omitted.

The verification may involve:

- observing pre-weighed ingredients for proper identification and weights, or
- observing establishment employees weighing ingredients or

- actually, weighing pre-weighed ingredients to determine if the weight on the container is accurate.

An ingredient added at a different level than indicated in the product formula could affect the ingredient order of predominance on the label. The product is misbranded if a declared ingredient is omitted, an ingredient is added but not declared on the label, or the ingredient order of predominance is not accurate. Depending on the type of undeclared ingredient (e.g., an allergen) that is added to the product, it may be either adulterated or misbranded or both.

The regulations and many product standards of identity allow the establishment to add various ingredients to the formulae of certain meat and poultry products. Some meat and poultry components used in the formulation may have regulatory limits. Some nonmeat ingredients have a specified maximum amount or percentage allowed in the product. These nonmeat ingredients are called **restricted** ingredients. The establishment ***MAY*** add the component or ingredient in any amount up to its permitted limit.

If the product is formulated with a meat or poultry component with a regulatory limit or with a restricted ingredient, the IPP should select one or more batches of product during formulation. They should determine the amount or percentage of the meat or poultry component and/or the amount one or more restricted ingredients used in the formula. The IPP verifies that the:

- percentage of meat or poultry component meets the regulatory limit,
- restricted ingredient is allowed in the product, and
- the amount of the restricted ingredient added to the product does not exceed the regulatory limit.

Verifying meat and poultry components or restricted ingredients are in compliance with regulatory limits usually requires the IPP to perform a formula calculation.

When meat or poultry components or restricted ingredients are added at levels in excess of their maximum regulatory limit, they become **economic adulterants**. For example, a RI ingredient, e.g., nitrite exceeds the maximum amount allowed.

If IPP find noncompliance, they issue an NR and take the appropriate action necessary to ensure adulterated or misbranded product does not enter commerce.

Performing the %Yield/Shrink Task

*Inspection program personnel (IPP) perform the percent yield/shrink task in establishments that are preparing meat or poultry cuts, parts and products with added solutions at levels that **do not** require the product's label to be qualified with a statement to indicate the percent of the solution and ingredients added to the product.*

When performing this task IPP select an appropriate product and verify compliance with regulatory requirements by reviewing establishment records and labels, calculating the % added solution, yield or shrink, and comparing the result with the appropriate regulatory requirement and product label.

The added solution, product shrink, and yield verification determinations are performed on one or more **subgroups** (samples) of product or on entire batches of product. To calculate the % yield, shrink or added solution, IPP have the establishment weigh a subgroup (sample) of product before and after the appropriate step in the process (pumping, injecting, dipping, cooking, chilling, or drying). There is not a specified number of pieces of product that must make up a subgroup. The number of pieces selected and weighed should be representative of the lot size. For example, the IPP may select 20 or 30 pieces of meat or poultry and have them weighed before the solution is applied (green weight) and 20 or 30 pieces after the appropriate processing step, e.g., pumping, immersion, or cooking and chilling, and have them weighed (finished weight). After IPP obtain the subgroup or batch weights (green and finished weights), they are to perform a calculation to verify that the added solution or the product's yield or shrink complies with the product's standard of identity or regulatory requirement.

When verifying added solution compliance, IPP may have the **SAME** pieces of meat or poultry weigh before (actual green weight) and after the application of the curing, tenderizing or flavoring solution (treated or pumped weight). Identification of the pieces of meat or poultry should be maintained. This method is the most accurate way to determine the percent added solution.

IPP may use another method to determine the percent added solution under certain circumstances, e.g., the scale and pumping or injecting apparatus are not in the same area or room. In this situation, IPP **may** select and have pumped or treated pieces of meat or poultry weighed before selecting fresh unpumped or untreated pieces **provided** that the pieces **are uniform** in size and weight (e.g., lotted into 2-to-3 lb weight ranges). The green weight is determined from different pieces of meat or poultry. All pieces selected must be in the same weight range.

Shrink and yield determinations should be conducted on entire lots of product. However, in many instances it is not feasible to perform shrink and yield tests with the entire weight of the lot (inspection personnel time constraints or extremely large lot size). Therefore, weighing a large enough portion (subgroup sample) to represent the lot would be acceptable.

To accurately determine the percent of the solution and the amount of each restricted ingredient added to a product via the solution, IPP have to differentiate between an **actual** or **effective** percent pump or pick-up.

- ***Actual Percent Pump or Pickup*** is the amount (pounds) of a water-based or oil-based solution (curing, tenderizing, marinating, etc.) pumped or injected into or picked up by a piece of meat or poultry that ***is not held for a period of time*** and allowed to drain prior to being further processed. This is expressed as a percentage of the weight of the meat or poultry before it is pumped with the solution.

- ***Effective Percent Pump or Pickup*** is the weight gained (expressed as a percent) by the meat or poultry ***after draining for the specified amount of time*** in the establishment's written procedure and represents the amount of reactive solution that remains in the product. Any reactive ingredients (nitrites, phosphates, enzymes, flavors, etc.) in the solution are thought to remain in solution during the drain time after pumping, rather than reacting immediately with the meat or poultry protein. Therefore, using the effective percent pump in calculations more accurately reflects the ingoing amount of solution and RI ingredients.

If the IPP determines that the effective or actual % pump or pickup (gain) exceeds the maximum amount of solution allowed in the product, i.e., the standard of identity for the product, there may be regulatory noncompliance. The IPP would need to determine if the establishment has records or data to demonstrate that it is consistently or routinely adding solution below the maximum amount of solution allowed. If the IPP determines that the ingoing amount of a restricted ingredient exceeds the regulatory limit, there is regulatory noncompliance.

Note: Both methods of determining compliance above (i.e., weighing product) also apply to **cured cooked beef** products, except that the percentage of solution remaining in the

product after cooking and chilling (finished weight) is used rather than actual or effective % pump in the calculation.

Supplemental Information

TITLE:	Cured Meat and Poultry Product Operations
RESOURCES:	MPI Regulations FSIS Directive 7620.3, Processing Inspectors' Calculations Handbook Cured Meat and Poultry Product Operations Module
SUPPLEMENTS:	Each supplement introduction highlights the information for that supplement.
PURPOSE:	These calculations and references will provide inspection program personnel with sufficient knowledge to accurately determine compliance and initiate appropriate actions during their verification of various cured meat and poultry operations.
***NOTE*:**	For the purpose of all supplement problems, an answer to 2 decimal points is acceptable. **Do not round up when calculating restricted ingredients.**

Supplement 1

Restricted Ingredients

This section includes information on ingredients and the limitations for their use in curing compounds and curing solutions that are to be applied in or on meat and meat food products and poultry and poultry food products. It also covers mathematical calculations to determine compliance for the following restricted ingredients:

- Curing agents and curing compounds,
- Curing accelerators, and
- Phosphates

Note: In the establishment, FSIS Directive 7620.3, *Processing Inspectors' Calculations Handbook* can be used to assist you.

IPP may use two methods to determine curing agent, curing compound, curing accelerator or phosphate compliance. They can determine the ingoing parts per million of the cure agent, cure accelerator, or phosphate used in the pickle formula and then compare their result against the ingoing amount allowed by the Meat and Poultry Inspection (MPI) regulations. If the calculated ingoing amount is equal to or less than the amount allowed by regulation, the product is in compliance. Alternatively, they could determine the maximum amount of the cure agent, cure compound, cure accelerator or phosphate allowed in the formula and then compare their calculated result to the amount that is actually being used in the formula. If the amount used in the pickle formula is equal to or less than the maximum amount allowed, the product is in compliance.

Limits for restricted ingredients (RI) permitted in pickle cured meat and poultry products are expressed in terms of ounces (oz) or pounds (lb) per gallons of pickle solution, or as percentages (%) in the Table of Approved Substances in section 424.21(c) of the MPI Regulations and FSIS Directive 7120.1. The same limits may be expressed in parts per million (ppm) which are more convenient units for verifying food additive compliance. The conversion of curing agent and accelerator weight limits, and the phosphate percentage limit to parts per million (ppm) limits is shown in Table I.

Note: When nitrate and nitrite are used in combination, the limits are calculated separately and the permitted maximum (weight or ppm) of each may be used.

TABLE 1
Conversion of Restricted Ingredient Weight or Percentage Limitations to PPM

Limitations

Cure Agent Limits in Regulations	**Converted to Maximum PPM Limit** **General PPM Equation for Pickled Product:** $$\textbf{ppm} = \frac{\textbf{lb RI} \times \textbf{\% pump} \times \textbf{1,000,000}}{\textbf{lb of pickle}}$$ If 1-gallon pickle weighs 10 lb (wt. base when regulations were written), then 100 gallons weighs 1000 lb.
Nitrite 2 lb to 100 gallons of pickle at 10% pump	$\frac{2 \text{ lb} \times .10\ (10\%) \times 1{,}000{,}000}{1000 \text{ lb}} = 200 \text{ ppm}$
Nitrate 7 lb to 100 gallons of pickle at 10% pump	$\frac{7 \text{ lb} \times .10\ (10\%) \times 1{,}000{,}000}{1000 \text{ lb}} = 700 \text{ ppm}$
Note: *When nitrite and nitrate are used in combination, the limits are calculated separately and the permitted maximum (weight or ppm) of each may be used.*	

Cure Accelerators in Regulations	**Converted to ppm**
	If 1 gal pickle weighs 10 lb, then 100-gal pickle weigh 1000 lb
Ascorbic Acid and Erythorbic Acid	75 oz. = 75/16 = 4.687 lb
75 oz to 100-gal pickle at 10% pump	$\frac{4.687 \times 0.10 \times 1{,}000{,}000}{1000} = 469$ ppm
Ascorbate and Erythorbate	87.5 oz = 87.5 oz/16 = 5.468 lb
87.5 oz to 100-gal pickle at 10% pump	$\frac{5.468 \times 0.10 \times 1{,}000{,}000}{1000} = 547$ ppm
Phosphates in Regulations	**Converted to ppm**
Used to decrease cooked out juices:	
5 percent of phosphate in pickle at 10% pump (meat regulations)	5% in pickle = 5 lb in 100 lb $\frac{5 \times 0.10 \times 1{,}000{,}000}{100} = 5000$ ppm
0.5% of total product (poultry regulations)	5000 ppm = 0.005 = 0.5%
0.5% of phosphate in product (meat regulations)	5000 ppm = 0.005 = 0.5%
Used to protect flavor:	
0.5% of total product (meat regulations)	5000 ppm = 0.005 = 0.5%

Curing Agent (Nitrite and Nitrate) Compliance Determinations

Table II lists the maximum parts per million (ppm) for each of the four curing agents permitted in products, based on the curing method used. The limits vary among curing methods because the methods differ in the efficiency with which the curing agent is brought in contact with the meat and/or poultry. Limits for nitrite/nitrate combinations and combination procedures (such as pumping and dry curing) are addressed in the Processing Inspectors' Calculation Handbook.

TABLE II
Maximum Ingoing Nitrite and Nitrate Limits (in PPM) for Meat and Poultry Products*

Curing Agent	Curing Method			
	Immersion Cured	Massaged or Pumped	Comminuted	Dry Cured
Sodium Nitrite	200	200	156	625
Potassium Nitrite	200	200	156	625
Sodium Nitrate	700	700	1718	2187
Potassium Nitrate	700	700	1718	2187

* *There are more stringent limits for curing agents in bacon to reduce the formation of nitrosamines. For this same reason, nitrate is no longer permitted in any bacon (pumped and/or massaged, dry cured, or immersion cured). Refer to the supplement that address bacon manufacturing on page 50 of this handout, for specific information.*

The amount of ingoing nitrite or nitrate used in pumped, massaged, injected, or immersion-cured products, such as hams, poultry breasts, poultry rolls, corned beef, etc., is based on the **green weight** of the meat and/or poultry used in the product formulation.

The green weight is the weight of the meat and/or poultry (e.g., ham, chicken breast, pork belly, beef brisket or pork trim for sausage) prior to processing (such as grinding and adding ingredients, pumping with a solution, adding batter and

breading, cooking, or drying). Nothing has been added or removed from the meat and/or poultry.

Nitrate is converted (by bacterial action) to nitrite and is a color fixer. Nitrate can be used in pickle alone. It can be used in pickle with nitrite. If nitrate is used in conjunction with nitrite, the limits of the two compounds are calculated separately and the permitted maximum of each may be used. Refer to this calculation in the *Processing Inspectors' Calculation Handbook.*

In immersion curing, the submerged meat or poultry absorbs the cover pickle solution, slowly, over a long period of time. The calculation for nitrite or nitrate uses percent pick-up rather than the percent pump. The percent pick-up is the total amount of cover pickle absorbed by the meat or poultry. It is used in the calculation for immersion cured products in the same way percent pump is used in the calculation for pumped products

Curing Accelerator Compliance Determinations

Cure accelerators speed up the color development (color fixing) of cured products by accelerating the chemical conversion of nitrite to nitric oxide. In addition, cure accelerators aid in keeping myoglobin (muscle pigment) in the reduced state so that it can readily combine with nitric oxide to form nitric oxide myoglobin. Since cure accelerators aid the curing agents in cure color development, they **may only** be used in combination with the curing agents

Table III lists the permitted maximums for accelerators used alone ***and*** in combination in the curing of pumped, massaged, and immersed meat or poultry products other than bacon. Maximums for sodium ascorbate and sodium erythorbate (isoascorbate) in bacon are given on page 50 of this handout.

TABLE III
Maximum Ingoing Cure Accelerators (in PPM)
for Meat and Poultry Products

Cure Accelerator	Maximum Limit
Ascorbic Acid	469 ppm*
Erythorbic Acid	469 ppm*
Sodium Ascorbate	547 ppm*
Sodium Erythorbate (isoascorbate)	547 ppm*

Citric Acid or Sodium Citrate	may replace up to half of any one of the above *Except in bacon

The amount of ingoing cure accelerators used in cured, pickled products, such as ham, corned beef, turkey ham, etc., is based on the ***green weight of the meat and/or poultry and/or meat/poultry byproducts*** used in the product formulation.

All the methods for calculating nitrite and nitrate amounts also apply in the calculation of cure accelerator amounts. Different limits apply, depending upon which cure accelerator is used as shown in Table III.

Phosphate Compliance Determinations

Phosphates are frequently added to curing solutions and cured product formulations because of the numerous beneficial effects they have in meat and poultry curing. Phosphates increase the water retention (water binding capacity) of the meat and poultry, which reduces the shrinkage (moisture loss) and purge (cook-out) of pickle-cured products during further processing. The improved water binding results from the reaction of the phosphate ions with the meat and poultry proteins. Phosphates also improve the sensory characteristics of the product (texture, juiciness, and tenderness), improve the stability and uniformity of the cure color, and suppress the development of rancidity in cured products. Phosphates tend to precipitate out of pickle if not agitated.

Phosphates are permitted in meat and poultry products, unless otherwise prohibited by the regulations, to reduce the amount of cooked-out juices. Phosphates in pickle-cured meat products such as ham, corned beef, and bacon are limited to 5% in a pickle at a 10% pump level. Phosphates in pickle-cured poultry products such as turkey ham are limited to .5% in the total product. Both limits are equivalent to 5000 ppm. For ***pickle cured meat products***, the maximum ingoing phosphate limit is based on the green weight of the meat or meat byproduct in the product formulation. Calculations for phosphate(s) are the same as those for nitrite and cure accelerators in pickle-cured **meat** products.

Pickle Solution Compliance Determinations

First, when the pickle is measured by volume, not weight, determine its weight by multiplying the number of gallons of water by 8.33 (the weight in pounds of a gallon of water) and adding the actual weight of the other ingredients. Next, if two parts of the

equation are known, the third can be calculated by substituting the known values using the following ***calculation equation***:

$$\text{ppm (parts per million)} = \frac{\text{lb Restricted Ingredient (RI)} \times \text{\% Pump} \times 1{,}000{,}000}{\text{lb Pickle}}$$

Example Problem

1. **Solving for ingoing RI parts per million (ppm)**

   An establishment's written procedure calls for 10% pump, 100 gal of pickle weighing 1,000 lb, and 2 lb of sodium nitrite.

   ("X") = unknown

   $$X = \frac{2 \times 0.1 \times 1{,}000{,}000}{1{,}000}$$

   $$X = \frac{200{,}000}{1{,}000}$$

   X = 200 ppm ingoing nitrite

   Note: Ingoing parts per million for cure accelerators and phosphate (meat product only) are determined using the same method except the weight of the cure accelerator or phosphate would be substituted into the equation for the weight of nitrite.

2. **Solving for maximum percent pump**

   Pickle "A" contains 1 lb 12 oz of nitrite for 1,000 lb. What percent of pump is permitted?

   Calculation: Convert 1 lb 12 oz to 1.75 lb nitrite allowed at 200 ppm

   $$200 = \frac{1.75 \times X \times 1{,}000{,}000}{1{,}000}$$

In this instance, all the known values are moved to the left side of the equation, leaving “X” on the right and keeping it in the numerator. To transfer a value from one side of the equation to the other, it is simply moved to the numerator on the other.

$$\frac{200 \times 1{,}000}{1.75 \times 1{,}000{,}000} = X$$

$$\frac{200{,}000}{1{,}750{,}000} = X$$

$$0.1142 = X$$

11.42% maximum % pump allowed

3. Solving for maximum amount of restricted ingredient

Establishment 38 is using a cure mix with 6.25% nitrite. The establishment is planning to pump hams at 12% using a pickle solution. How much cure mix can the establishment use per 100 gal of pickle at this level of pump if the pickle weight is 9.5 lb per gallon?

Calculation: $200 = \frac{X \times 0.12 \times 1{,}000{,}000}{950}$

In this instance, all the known values are moved to the left of the equation, leaving “X” on the right where it is in the numerator.

$$\frac{200 \times 950}{0.12 \times 1{,}000{,}000} = X$$

$\frac{190{,}000}{120{,}000}$ = 1.58 lb nitrite allowed per 100 gal of curing solution

Special Note: To find the amount of cure mix allowed, IPP divide the amount of nitrite allowed (in this case 1.58 lb) by the percent nitrite in the mixture (in this case 6.25% nitrite).

$$\frac{1.58}{0.0625} = 25.28 \text{ lb pickle solution allowed in each 100 gallons of pickle}$$

4. Determining the volume of a container

Pickle tank "C" is a rectangular tank with these dimensions:
Length = 60 inches; Width = 48 inches; Height = 48 inches

How many gallons will it hold when completely filled?

Special Note: There are 231 cubic inches in a gallon and 7.48 gallons in a cubic foot.

ANSWER: $V = \frac{LWH}{231}$

$$V = \frac{60 \times 48 \times 48}{231}$$

$V = 598.44$ gal

Special Note: When calculating for restricted ingredients, the tanks are usually never filled to the brim. Therefore, IPP may calculate for the gallons per inch of depth and multiply the gallons per inch by the height in inches that the tank will be filled to find the total volume.

5. Determining volume in a partially filled tank

Pickle tank "D" is a rectangular tank with these dimensions:
Length = 65 inches; Width = 60 inches; Height = 48 inches

How many inches from the top would 600-gal measure in this tank?

ANSWER: V = 65" × 60" × 48"

$$V = \frac{187200}{231}$$

V = 810.39 gallons

$$V = \frac{810.39 \text{ gal}}{48 \text{ in}}$$

V per inch in height = 16.88 gal

H = 600 gal ÷ 16.88 in

H = 35.55 inches in tank

H = 48 in − 35.55 in

H = 12.54 inches or 12.5 inches from the top of the tank

Cure Agent and Cure Accelerator Determination Workshop

Curing Problem 1

The General Labeling task appears on the task calendar today. The establishment's production sheet indicates that boneless ham water added using processing procedure A03 is being prepared today. You go to the production office and review procedure A03. Procedure A03 indicates that pickle solution is prepared in a 200-gallon batch. A gallon of pickle weighs 10 lb. The target pump is 14%.

The restricted ingredients used in the pickle formula for procedure A03:
Phosphate—72 lb; Nitrate—8 lb; Nitrite—2 lb 10 oz.; and Sodium Ascorbate—5 lb

In the pickle preparing room, you find procedure A03 posted above the pickle tank. It is the same procedure you observed in the production office. You find the tank used for mixing this pickle has these dimensions:

40" length; 40" width; 30" height

The 200-gallon mark is located 3” from the top of the tank.

Note: There are 231 cubic inches in a gallon

QUESTIONS

1. Is the mark on the tank correct (i.e., 200 gallons)? If not, what concerns do you have?

2. a) Calculate the ingoing parts per million (PPM) for each restricted ingredient based on 200 gallons of pickle.

   b) Calculate the ingoing PPM for nitrite based on the gallons of pickle you determined in question 1.

   c) Did these calculations support your concern(s) from question 1?

      YES _____ NO _____

      If you answered yes, why?

d) Based on the A03 pickle formula (200 gallons), was the regulatory limit exceeded for any of the restricted ingredients?

YES _____ NO _____

Curing Problem 2

The General Labeling task is on the task calendar today. The establishment's written procedure states that the beef brisket pickle solution is prepared in an 860-gallon curing vat. The total ingredients (including water) weigh 8,586 lb. The pump target is 12%.

(**Note:** The cure ingredients are combined in a curing compound.)

The cure compound label states:

Sodium nitrite	23%
Sodium erythorbate	25%
Salt carrier	52%
Total	100%

What is the maximum amount of curing compound permitted in this pickle formula?

_____ lb

Curing Problem 3

A. How many gallons are contained in a cylindrical drum filled to within two inches of the top with pickle if the drum dimensions are 24" (diameter) X 30" (height)?

Note: $V = \pi r^2 h$ $\pi = 3.14$ r = radius h = height V= volume
There are 231 cubic inches in a gallon

_____ gallons

B. How much nitrite, nitrate, and ascorbic acid could be used if the establishment wants to pump 15%? (A gallon of pickle weighs 9.68 pounds.)

Nitrite _____ lb

Nitrate _____ lb

Ascorbic Acid _____ lb

Supplement 2

Added Solution and Shrink Determinations

Several meat food products and turkey ham have specific regulatory limits for the amount of water that can be added or picked-up from a curing solution. Inspection program personnel must perform pump or pick-up determinations to verify that the amount of solution added to the product is in accordance with the regulations, the establishment's written procedures, or product label. IPP also perform shrink and yield tests to verify that the product's finished weight meets the regulatory requirement prior to packaging.

This supplement includes examples and/or practice problems designed to assist IPP in:

- Performing percent added solution (pump/pick-up) determinations;
- Performing product shrink determinations
- Performing cooking/cooler shrink determinations;
- Interpreting processing procedure charts; and
- Calculating maximum amounts of restricted ingredients allowed.

Percentage of Added Solution (Gain in the Calculation Aid) Determination

Calculation Equation

$$\frac{\text{(pumped, treated, or massaged) weight - green weight}}{} \times 100 = \%\ \text{pump or pick-up}$$

green weight

Note: Pumped weight, treated weight, or massaged weight can be in inserted into the above equation depending upon the method in which the solution is applied, e.g., *treated weight* is used when the product is dipped or submerged in the solution; ***pumped weight*** is used when the solution is injected into the cut.

Note: The green weight is the weight of the meat and/or poultry prior to processing (such as adding ingredients, pumping with a solution, cooking, or drying)

Calculation Method

IPP can use the steps in the table below to compare a product's green weight with its pumped, treated, or massaged weight and determine the percent added solution.

STEP		EXAMPLE
1	Determine the green weight of a given number of pieces of fresh (unpumped, untreated, etc.) meat or poultry or an amount of fresh (unpumped, untreated, etc.) meat or poultry product that will represent the lot.	Fifteen beef briskets to be pickle- cured weigh 227.6 lb.
2	If a drain time is listed in the establishment's written procedure, allow the pumped/treated product to drain for the specified time period and then weigh. If no drain time is listed, take the weight directly after pumping.	After *pumping*, the *same* fifteen beef briskets weigh 271.1 lb.
3	Subtract the green weight from the pumped or treated weight to obtain the pounds of added solution.	271.1 lb – 227.6 lb 43.5 lb of solution
4	Divide the pounds added solution by the green weight.	43.5 lb ÷ 227.6 lb = 0.1911

5	Convert the decimal answer into the percentage of added solution by multiplying by 100.	0.1911 × 100 = 19.11% added solution. In this case 19.11% could also be referred to as the *effective* percent pump (if product is drained) or *actual* percent pump (if product is not drained).

Comments

If the beef briskets in the above example were targeted to have a 15% pump had a 19.11% effective or actual pump, the briskets are in compliance with the regulatory limit (20%), however, the establishment would not be following its written procedure. If a consistent pattern of over pumping (indicates lack of process control) is identified, then the IPP shall request that establishment management update its written procedure to reflect the effective or actual pumping percentage—9 CFR 320.1(b) (11) or 381.175(b) (6). Any pumping above the establishment's target pump but below the maximum solution allowed in the product should be discussed at the weekly meeting. The establishment response needs to be documented in the MOI.

If the IPP determined the amount of curing solution added to the raw beef briskets in the example above was 21% (i.e., above the regulatory limit of 20%), there may be regulatory noncompliance. If the establishment can demonstrate with records (e.g., its own added solution tests during the shift and previous shifts) that the added curing solution is consistently or routinely 20% or below, then there is no noncompliance. On the other hand, if the establishment cannot demonstrate that the added curing solution is consistently or routinely 20% or below (i.e., has no data or records), then the IPP would retain the lot of beef briskets until the briskets drain to 20% percent added solution. The IPP would document this noncompliance.

Additional Added Solution Example Calculations

1. A pump test shows 30 fresh, uncured hams had a green weight of 450 pounds; the same 30 pumped hams had a weight of 510 pounds. The procedure indicates 16% target pump.

   What percent added solution does this test show?

   Answer: 510 – 450 = 60 lb

60 ÷ 450 = 0.133 or 13.3%

If a consistent pattern of under pumping is identified, then the IPP should request that management adjust the procedure to reflect the actual pumping percentage. Pumping equipment is checked for accuracy daily by the establishment and should be spot checked by the IPP. The under pumping should be discussed at the weekly meeting and the establishment's response documented in the MOI.

2. A second test was conducted on 25 pork hams. The procedure indicates a 19% effective pump.

   Pumped weight = 260 lb; Green weight = 210 lb

   What is the percentage of added solution?

   Answer: 260 – 210 = 50 lb of solution
   50 ÷ 210 = 0.2380 or 23.80%

   Note: The IPP should request that the establishment demonstrate that these hams are in compliance with the minimum PFF value in the table in 9 CFR 319.104 after they are cooked and accurately labeled because they have been over pumped by 4.8%. IPP should also verify the amount of ingoing restricted ingredients are in compliance using the 23.8% effective pump. This finding should also be discussed at the weekly meeting and the establishment's response documented in the MOI.

Maximum Percent (Gain, Pump or Pick-up) Determination

To verify that the level of ingoing restricted ingredients (curing agents, cure accelerators, phosphates, etc.) in a pickle formula are in compliance, IPP can determine the maximum % pump for each restricted ingredient and compare it to the targeted % pump. The listed target % pump *shall never be greater than* the maximum % pump allowed for any restricted ingredient in the solution. To verify restricted ingredient compliance at the time of pumping, the effective or actual % pump must be compared to the maximum % pump allowed for the pickle solution.

Calculation Equation

$$\frac{\text{lb restricted ingredient} \times \% \text{ pump} \times 1{,}000{,}000}{} = \text{ppm}$$

lb pickle

Calculation Method

IPP may use the steps in the following table to determine the maximum percent pump allowed for each restricted ingredient in a pickle or curing solution.

STEP		EXAMPLE
1	Determine the weight of the nitrite added to the pickle solution, the total weight of the pickle solution, and the target percent pump from the label transmittal form or the establishment's written procedure record/chart. *If any two of these quantities are known, the third can be calculated by substituting the known values into the equation.*	Pickle Formula Water 1310.00 lb Salt 132.00 lb Dextrose 18.00 lb Phosphate 35.00 lb Sodium Erythorbate 3.25 lb Sodium Nitrite 1.75 lb Total 1500.00 lb Beef briskets are pumped with 16% solution.
2	Enter the weight of the nitrite, the weight of the pickle solution, and the ppm limit for nitrite (200 ppm) into the equation and solve for ***n***, the maximum percent pump.	We have 1.75 lb of nitrite in 1500 lb of solution that is to be pumped into beef briskets at a targeted level of 16%. However, what would be the maximum % pump allowed in the event the establishment exceeded the target % pump? $200 = \frac{1.75 \times n \times 1{,}000{,}000}{1500}$

3	Convert the decimal answer into the percent pump by multiplying by 100.	0.1714 × 100 = 17.14 % is the maximum pump % level for nitrite. Since the target % pump is 16%, this processing procedure would produce beef briskets in compliance for ingoing nitrite.

Comments

If the weights and maximum permitted levels (in ppm) of phosphate and sodium erythorbate were substituted into the table on the previous page, the IPP would obtain a maximum % pump of 21.42% for phosphate and 25.24% for sodium erythorbate. Although three different maximum % pump levels exist for this pickle solution, 17.14% would be the maximum % pump level allowed for this solution because the ingoing nitrite limit would be exceeded at any % pump greater than 17.14%.

As stated before, restricted ingredient compliance *must be* verified at the time of pumping. Verifying at this point helps assure that the pumping machine is in proper adjustment and draining procedures are followed. This can be done by determining the effective or actual % pump and comparing it with the maximum % pump for the pickle solution. For example, if the beef briskets on page 36 were pumped with the pickle solution in Step 1 in the table on the previous page, they would be out of compliance for ingoing nitrite because the effective or actual % pump (19.11%) is greater than the maximum % pump (17.14%) for the pickle solution.

Each restricted ingredient's compliance at the time of pumping could also be verified by inserting its weight, *the effective or actual % pump*, and the weight of the pickle solution into the equation in Step 2 of the table on page 39 and solving for ppm.

Maximum Amount of Added Solution (Gain) Allowed Determination

Beef cuts or beef briskets dipped or submerged into or injected with pickle solutions *may not* have more than the 10% or 20% solution added to them in accordance with regulations.

Calculation method

The steps in the table below will assist IPP in determining the maximum amount (pounds) of added solution.

STEP		EXAMPLE
1	Multiply the green weight of the meat or poultry to be pumped/treated by the amount of solution allowed -- 10% (.10) or 20% (.20).	Ten beef tongues treated with a pickle cure Ten tongues weigh 38 lb 38 lb × .10 (10%) 3.8 lb of solution permitted
2	Add the untreated (green) weight and the solution permitted to get the total maximum weight of the treated product.	38.0 lb + 3.8 lb 41.8 lb would be the maximum amount the ten tongues could weigh after being treated.

Finished Product Shrink and Cooking/Cooling Shrink Determinations

After processing, some products must weigh **a certain percentage less** than the green weight of the fresh meat cut. IPP are responsible for verifying the shrinkage of various cured meat products. For example, dry-cured hams and pork shoulders must shrink a minimum of 18%--9 CFR 319.106(c) (7). IPP may also verify that the establishment is following its written processing procedures required by 9 CFR 320.1(b) (11) and 381.175(b) (6).

Use the equation on the next page to verify the percent shrink compliance of dry cured hams and pork shoulders. This equation may also be used to determine the shrink for other meat food products that are required to have specific amount of shrink, e.g., bacon bits and barbecued meat.

Calculation Equation

$$\frac{\text{green weight meat or poultry - finished weight}}{\text{green weight meat or poultry}} \times 100 = \%\ \text{shrink}$$

Note: Finished weight is the weight of the meat and/or poultry plus the weight of any ingredients added during processing minus the weight loss (shrink) from smoking, cooking, cooling or dying.

The steps in the table below should be used when IPP want to find a finished product's percent shrink.

.

STEP		EXAMPLE
1	Determine the green weight of the meat.	Dry-Cured Pork Shoulders Pork shoulders 500 lb
2	Determine the weight of the product after processing (cooking, drying, etc).	After the specified curing and drying period, the pork shoulders weigh 395 lb
3	Subtract the weight of the product after processing (finished weight) from the green weight of the meat to find the amount the product shrunk.	500 lb - 395 lb 105 lb
4	Divide the number of pounds the product has shrunk by the green weight of the meat.	105 lb ÷ 500 lb = 0.21
5	Convert the decimal answer into the percentage of shrink by multiplying by 100.	0.21 × 100 = 21% shrink (in compliance). The weight of the pork shoulders is at least 18% less than the fresh uncured (green) weight of the pork shoulders

Cook and Chill Shrink Determinations

The establishment must adhere to its written procedures, e.g., solution formulation, cooking and chilling time, temperature and humidity, and cook and chill shrinks. Smokehouse instrument charts should be checked periodically against a known

accurate thermometer to determine the accuracy of the recording devices. When an establishment is producing a PFF controlled cured pork product and does not meet the target shrinks, the product may not be accurately labeled, e.g., ham natural juices versus ham water added versus ham X% of weight is added ingredients. Likewise, if an establishment is producing cooked cured beef product or cooked turkey ham and does not meet the target shrinks, the finished product weight may exceed the original (green) weight of the beef cut or thigh meat prior to curing, i.e., the product yield is more than 100%. ***Cooked*** corned beef products and turkey ham, whose weights after cooking exceed the weights of the fresh uncured beef or thigh meat, must be descriptively labeled to indicate the presence and the amount of the additional substances, e.g., “Corned Beef Containing 15% Solution” or “Turkey Ham, Cured Turkey Thigh Meat 25% Added Water.”

Use the following equation to determine the percent cook shrink or chill shrink of ***cooked*** bacon bellies, PFF-controlled cured pork products, cured beef products, and turkey ham.

Calculation Equation

$$\frac{\text{weight in (smokehouse/oven/cooler) - weight out (smokehouse/oven/cooler)}}{\text{weight in (smokehouse/oven/cooler)}} \times 100 \text{ \% shrink}$$

The steps in the following table should be used when IPP want to determine the percentage of cook or chill shrink.

STEP		EXAMPLE
1	Determine the weight of the product (less tare) going into the smokehouse, oven, cooler, etc.	1000 lb. of turkey thigh meat
2	Determine the weight of the product (less tare) coming out of the smokehouse, oven, cooler, etc.	927 lb of Turkey Ham after cooking and smoking
3	Subtract the weight coming out from the weight going in to find the amount of product shrink.	1000 lb 927 lb 73 lb
4	Divide the number of pounds shrunk by the product weight going into the smokehouse, oven, cooler, etc.	73 lb ÷ 1000 lb = 0.073

5	Convert this decimal answer into the percentage of shrink by multiplying by 100.	0.073 × 100 = 7.3% cook shrink

Additional Example Shrink Calculations

1. The establishment may record or periodically monitor the cooking shrink.

   Cooking Shrink Example

   The weight of 60 hams on a smokehouse tree going into a smokehouse is 990 lb. The hams have been pumped at 14%. The same tree coming out of the smokehouse weighed 910 lb. What is the percentage of smokehouse shrink?

   $\frac{990 - 910}{990} \times 100$ 80 ÷ 990 = 0.0808 or 8% shrink

2. Similar to the cooking shrink, the establishment may monitor cooler shrink.

   Cooler Shrink Example

   The weight of 60 hams on a smokehouse tree (hot weight) going into the cooler is 910 lb. The weight of the same 60 hams after the minimum chill time is 895 lb.

   $\frac{910 - 895}{910} \times 100$ 15 ÷ 910 = .0164 or 1.6% shrink

Note: When shrinks targets listed in the establishment's written procedure are exceeded, the IPP should discuss this finding at the weekly meeting and document the establishment's response in the MOI. If the establishment has a history or pattern of not meeting the target cooking and chilling shrinks, the IPP should request that the establishment update the written processing procedure. When the product is cooked corned beef or turkey ham, the IPP should also determine if the corned beef product or turkey ham returned to the weight of the fresh briskets or turkey thigh meat (green weight). When the product is a PFF-controlled product, the IPP should request that the

establishment demonstrate that the product is truthfully labeled, e.g., the minimum PFF value in §319.104 is met for qualifying statement in the product name (ham natural juices, ham water added, or ham X%..., etc.)

Added Solution and Shrink Calculation Workshop

The chart below is a written cured ham example processing procedure for establishment 38. Review the information in the chart and answer the questions on the next page.

Processing Procedures for Cured, Cooked, and/or Smoked Ham

STYLE Fully Cooked
EST. # 38 **PRODUCT** Bone-in Ham with Natural Juices **Weight Ranges** 14/16

PICKLE FORMULA			USUAL PROCEDURES	
100-Gal Pickle weighing 1000 lb	LB	% PUMP		
SALT	92.5		% PUMP	16
CORN SYRUP	40		LB. PRESSURE	60
WATER 100 GAL	833		SPEED	—
PHOSPHATE	30		BEGIN S.H. TEMP.	140° F
NITRITE	1.25		TIME	2 hours
ASCORBATE	3.25		MIDDLE S.H. TEMP.	160° F
			TIME	2 hours
			FINISH S.H. TEMP.	180° F
			TIME	8 hours
			TOTAL S.H. TIME	12 hours
			INT. FINISH F°	152° F
			% S.H. SHRINK	12%
			% COOLER SHRINK	2%
			S.H. HUMIDITY	70
TOTALS	1000.0		COOLER TIME	24 hours

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PROCEDURE REVIEW

DATE	PUMP TEST			SMOKEHOUSE PERIODS						SHRINK			
	GREEN WT	PUMPED WT	% PUMP	FIRST		SECOND		FINISH		SMOKEHOUSE		COOLER	
				TIME	F°	TIME	F°	TIME	F°	HOT WT	%	CHILL	%
2/15	455	528	16.0	1:55	140	2:20	162	8:00	182	472 lb	10.94	458 lb	2.96
2/23	420	486	15.7	2:00	140	2:00	160	8:00	180	432 lb	11.83	422 lb	2.31

Processing Procedure Chart Problems

1. Calculate the maximum percent of pump permitted for each restricted ingredient.

   a. Phosphate _____ %

   b. Nitrite _____%

c. Ascorbate _____ %

2. Is the % of pump indicated on the procedure chart acceptable?

   _____ Yes If you answered "NO", identify *by ingredient*; the percent that is not acceptable.

   _____ No _____; _____; _____; _____.

3. Calculate the pump tests and compare your answers to the procedure chart.

   Test dated 2/15 _____ % pump

   Test dated 2/23 _____ % pump

Added Solution and Shrink Problems

1. The % Yield/Shrink task is on the task calendar today. The establishment is producing product labeled Corned Beef Brisket. The target pump on the establishment's written procedure for the beef briskets is 18%. There is a 30-minute drain time for the pumping procedure. The establishment has data indicating that it

does % added solution (pump) checks once a month. You select a stainless-steel bin with several corned beef briskets (approximately 90) and follow the establishment to the scale and have them weighed. After the weight of the bin is removed, the beef briskets weigh 895 lb green. You accompany the bin of beef briskets to the pumping machine and observe them being pumped with a curing solution. You place a U.S Retained tag on the bin with the pumped briskets and write pump test on the tag. Thirty minutes later you return to the processing room and have the bin moved to the scale and weighed. After the weight of the bin is removed, the beef briskets weigh 1,105 lb pumped. Are the briskets in compliance?

_____ % pump (added solution)

_____ in compliance

_____ not in compliance

2. The % Yield/Shrink task is on the task calendar today. The establishment is producing product labeled Country Style Bone-in Hams. The Bone-in hams are place on stainless steel rack and covered with the salt, curing agents, spices, etc. Each rack holds 80 hams. After the hams are placed on the racks but before the dry curing ingredients applied to them, you have the establishment weigh a single rack of hams. The hams weigh 1,280 lb. You place a U.S Retained tag on the rack with

the uncured hams and write shrink test on the tag. The establishment begins covering the hams with the dry curing ingredients. Each time the establishment overhauls the hams (adds new dry curing ingredients) they notify you. After 45 days they notify you they are going to hang the hams on tree and move them to the drying (ripening) room. You observe the hams transferred from the rack to a tree and you transfer the U.S. Retained tag to the tree. After another 155 days the establishment informs that they want to remove the hams from drying room and package and label them. While on the way to the packaging room, you have the establishment weigh the hams on the tree. After the weight of the tree is removed, the finished hams weigh 1,042 lb.

_____ % shrink

_____ in compliance

_____ not in compliance

Supplement 3

Bacon Processing

This supplement includes information on bacon manufacturing and IPP verifications activities including bacon restricted ingredients and bacon yield determinations. The establishment is responsible for controlling bacon manufacturing to assure that the finished product is in compliance with FSIS Regulations §318.2, §319.107, and §424.22. Calculation examples are provided for reference purposes.

Introduction

Because of problems associated with *nitrosamine formation* in bacon, FSIS regulations, section 424.22(b) (1) prescribe the regulatory amounts of nitrite and sodium ascorbate or sodium erythorbate (isoascorbate) to be used in pumped and massaged bacon. For the immersion curing and dry curing of bacon, maximum amounts of sodium and potassium nitrite are prescribed in section 424.22(b) (2) and (3) of the regulations.

Establishment management must develop written pickle formulas and processing procedures for preparing bacon (9 CFR 320.1(b)(11) and 381.175(b)(6)). The pickle formula and targeted percent pump or pick-up or cure mixture must ensure that the restricted ingredient limits listed below are met.

Regardless of the curing method used, restricted ingredient calculations for bacon are based on the ***green weight*** of the skinless belly. For rind-on bacon, e.g., where the skin is sold as part of the finished product, a restricted ingredient conversion calculation is necessary. ***Nitrate is no longer permitted in any curing method for bacon.***

Restricted Ingredient Limits

Pumped and/or Massaged Bacon (rind-off): These bellies are injected with a cure solution or a cure solution is added to them by massaging or tumbling. Pumped and/or massaged bacon must contain 120 ppm ingoing sodium nitrite (or 148 ppm potassium nitrite).

550 ppm ingoing sodium ascorbate or sodium erythorbate (isoascorbate) is required in pumped and massaged bacon, in addition to any prescribed amount of nitrite.

Note: When determining ***pumped and/or massaged*** product compliance with the nitrite and ascorbate (or erythorbate) limits, the Agency allows a ***plus or minus*** 20% ppm allowance at the time of injecting or massaging due to variables in pumping procedures, draining, purge, etc.

For example: 20% = 0.20, thus 0.20 × 120 ppm nitrite = 24 ppm

120 ppm	120 ppm
- 24 ppm	+ 24 ppm
96 ppm minimum nitrite	144 ppm maximum nitrite

The same calculation can be done for ascorbate or erythorbate (440 ppm minimum, 660 ppm maximum).

The additional solution added to the product from the higher effective or actual % pump than the establishment's target % pump would be considered negligible because the finished product weight must return to green weight.

The 20% variation is only for actual pump test and is not to be used when determining pickle formulas or % pump for the establishment’s written procedure.

Immersion Cured Bacon (rind-off): These bellies may be place in a pickle solution containing salt, nitrite, and flavoring. A maximum of 120 ppm of nitrite or equivalent of potassium nitrite (148 ppm) can be used in immersion cured bacon.

Note: The calculation method for nitrite in immersion cured bacon is the same as that for nitrite in other immersion cured products.

Dry Cured Bacon (rind-off): These bellies are cured by covering them with a pre-

measured amount of cure mixture. A maximum of 200 ppm of nitrite or equivalent of potassium nitrite (246 ppm) can be used in dry cured bacon.

Note: The calculation method for nitrite in dry cured bacon is the same as that for nitrite in other dry cured products.

Bacon labeled “Dry Cured” may not be injected with, or immersed in, a curing solution. Bacon labeled “Dry Salt Cured” may contain a curing solution injected directly into the tissues but not through the circulatory system. It is then covered with dry curing mixtures.

Pumped, Massaged, Immersion Cured, or Dry Cured Bacon (rind-on): The maximum limit for ingoing nitrite and sodium ascorbate or sodium erythorbate must be adjusted if bacon is prepared from pork bellies with attached skin (rind-on). A pork belly's weight is comprised of approximately 10 percent skin. Since the skin retains practically no cure solution or cure agent, the maximum ingoing nitrite and sodium ascorbate or erythorbate limits must be reduced by 10 percent. For example, the maximum ingoing limit for nitrite and sodium ascorbate or erythorbate for pumped pork bellies with attached skin would be 108 ppm [120 ppm − 12 ppm (120 × .10)] and 495 ppm [550 ppm − 55 ppm (550 × .10)], respectively.

Written Bacon Processing Procedure Ingoing Restricted Ingredient Determination

Calculation Equations

The equation for determining nitrite compliance in a proposed pumped or massaged bacon processing procedure is:

$$\frac{\text{lb nitrite} \times \%\ \text{pump} \times 1{,}000{,}000}{\text{lb pickle}} = \text{ppm}$$

In pumped and/or massaged bacon, this equation can be used to determine:

- The permitted weight of nitrite allowed, if you know the weight of the pickle solution and the target percent pump to be used.

- The minimum weight of the pickle solution that can be made, if you know the weight of the nitrite and the target percent pump to be used

- The maximum percent pump, if you know the weight of the nitrite and the weight of the pickle solution

- Whether or not a procedure will be in compliance with the regulations, if you know the weight of the nitrite, the weight of the pickle solution, and the target percent pump to be used.

To determine nitrite compliance based on the ***effective or actual % pump***, you can use the equation above by replacing the target pump with the effective or actual % pump. ***Alternatively***, you could use the following variations to the equation on the previous page:

$$\frac{\text{lb nitrite} \times 1{,}000{,}000}{\text{lb pickle}} = \text{ppm nitrite in the pickle}$$

ppm nitrite in the pickle × effective or actual % pump = ppm nitrite in the bacon

IPP can use the steps in following table to determine if a proposed bacon processing procedure will produce product in compliance with the regulations.

STEP		EXAMPLE
1	Determine the weight of the nitrite added to the pickle solution, the total weight of the pickle solution, and the target % pump from the establishment's written procedure.	Pickle Formula Water 1996.3 lb Salt 302.2 lb Sugar 156.2 lb Sodium Phosphate 31.3 lb Sodium Erythorbate 11.5 lb Sodium Nitrite 2.5 lb Total 2500 lb *Target pump is 12%*
2	If all three factors are known, one can just solve for ***ppm*** and compare the answer with the regulation to determine if the procedure produces bacon in compliance. ***Note:*** *The ingoing ppm of sodium erythorbate and sodium phosphate can be determined by replacing the pounds of nitrite with the pounds of sodium erythorbate and sodium phosphate and performing the mathematics.*	We have 2.5 lb of nitrite and want to make 2500 lb of pickle and pump at a level of 12%. Is this in compliance? $n = \frac{2.5 \times 0.12 \times 1{,}000{,}000}{2500}$ n = 120 ppm nitrite (in compliance)

Ingoing Nitrite at the Time of Pumping Determination

Example 1

IPP can use the steps in the following table to determine if bacon is in compliance at the time of pumping and/or massaging. The pickle formula in the table above will be used as the example in this table.

STEP		EXAMPLE
1	Multiply the weight of the sodium nitrite by 1,000,000.	2.5 lb sodium nitrite × 1,000,000 = 2,500,000 ppm nitrite.
2	Divide this figure by the weight of the pickle solution.	2,500,000 ÷ 2,500 = 1000 ppm nitrite in the pickle solution.
3	Multiply this figure by effective or actual % pump to obtain ppm. Refer to the How to Determine the Percentage of Added Solution section previously discussed in this handout to learn how to determine the effective or actual % pump.	1000 ppm × 0.096 (9.6 % effective pump) = 96 ppm ingoing nitrite in the pork bellies. Product ***is*** in compliance with the 20% ppm allowance.

Example 2

Establishment 38 has a vat of uncured (green) bellies weighing 1,635 pounds. After pumping and draining the vat of bellies weighs 1,782 pounds. The establishment's written bacon production procedure calls for using 1.2 lb of sodium nitrite in a pickle weighing 1,000 lb and a 10% pump.

Step 1: Determine effective *% of pump* (use the added solution equation)

1,782 (treated wt) – 1,635 (green wt) = 147 ÷ 1,635 (green wt) = 0.0899 × 100 = *8.99% pump or 9.0% pump*

Step 2: Determine *ppm* of ingoing nitrite based on effective or actual % of pump (use the ppm equation from Table 1)

$$\text{ppm} = \frac{1.2 \text{ lb} \times 0.09 \times 1{,}000{,}000}{1{,}000 \text{ lb}} = 108 \text{ ppm (above 96 ppm which is the 20\% variation)}$$

The establishment's process produces bacon that is in compliance for ingoing nitrite!

Bacon Yield Determination

In accordance 9 CFR 319.107, the weight of the pork bellies produced by pumping, immersion, massaging, or tumbling that are ready for slicing, packaging and labeling as "Bacon" must not exceed the green (fresh uncured) weight of the pork bellies. In other words, the weight of the cured pork bellies must return to green weight or their yield **CANNOT** be greater than 100%. FSIS does not routinely sample for added solution or ingredients; therefore, the determination of solution above the green weight is accomplished by the IPP's in-plant % yield tests. IPP assigned to a bacon producing establishments will verify that the bacon yield is in compliance when performing %Yield/Shrink task.

Bacon Yield Determination Method

Note: When determining yield and comparing green weight to pumped weight, it is *not* necessary to compare the same uncured pork bellies as long as a comparison is done on pork bellies produced under similar conditions and the subgroup (in this case all 100) are in the ***same weight range***.

Step 1: Use a subgroup such as 50 uncured (green) pork bellies of the same weight range (e.g., 10-12 pounds). Normally bellies are skinned and trimmed prior to pumping.

Step 2: Determine total weight of 50 cured pork bellies that have:

- Completed the chilling cycle as described in the establishment's processing procedure.
- Previously undergone skinning/trimming prior to pumping.

  If any trimming or removal of any portion of pork bellies occurs after pumping/massaging, the weight of these trimmings must be added when determining the finished weight.

Note: If the green weight must be calculated with the skin on, the finished weight figures must include the weight of the skin.

Calculation Equation

Determine the yield by inserting the green (fresh, uncured) weight pork bellies and the finished weight (cured bellies ready for slicing) into this equation:

$$\text{Percent yield} = \frac{\text{finished weight}}{\text{green weight}} \times 100$$

Note: Finished weight is the weight of the meat and/or poultry plus the weight of any ingredients added during processing minus the weight loss (shrink) from smoking, cooking, cooling or dying.

Bacon Yield Determination Example

Establishment 38 produces bacon. The IPP selects 50 chilled bellies from the cooler and has them weighed. The total green weight is 705 lb. The IPP selects 50 uncured bellies and has them weighed. The total finished weight is 717 lb.

The percent of yield is:

$$\frac{717 \text{ lb}}{705 \text{ lb}} \times 100 = 101.7\%$$

Remember that IPP are to determine whether product complies with the regulations based on production lots or process controls rather than on an individual % yield result. Although a % yield result of 101.7 is above 100% before concluding there is regulatory noncompliance, the IPP should determine if the establishment is routinely conducting % yield tests. If so, when the average of the establishment's recent yield results is 100% or less, then there is no regulatory noncompliance. However, when the establishment's yield results also indicate a pattern or history of producing bacon with a yield above 100% or the establishment is not routinely conducting bacon yield determinations, then the % yield result of 101.7 would be considered noncompliant.

Bacon Calculation Workshop

1. Establishment 38 has recently expanded its production of cured product to include curing and slicing bacon. The establishment's pickle formula and written processing procedure on file is provided below. The Labeling-Product Standards task appears on the task calendar today. Review the establishment's procedure chart and answer the questions related to this bacon processing procedure.

Processing Procedure for Smoked Bacon

STYLE Heat Treated
EST. # 38 **PRODUCT** Bacon **Weight Ranges** 10/12

BACON PICKLE FORMULA				USUAL PROCEDURES	
SKIN OFF X	**SKIN ON** ____	**LB**	**OZS**	**% PUMP**	12
WATER		1990.30		**LB. PRESSURE**	60
SALT		300.20		**DRAIN TIME**	30 minutes
SUGAR (DEXTROSE)		150.30		**TIME IN SMOKE**	7-7.5 hours
SODIUM PHOSPHATE		31.25		**S.H. HUMIDITY**	70-75%
NATURAL FLAVORINGS		14.00		**SMOKEHOUSE TEMP**	125-130°F
SODIUM ERYTHORBATE		11.45		**BACON INTERNAL TEMP**	126-128°F
SODIUM NITRITE		2.50		**TIME HELD**	1-7 Days
				% COOLER SHRINK	2-4%
TOTALS		2500			

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a) Based on the bacon pickle formula identified in the chart, calculate the ingoing parts per million (ppm) for:

Sodium erythorbate _____ ppm

Sodium nitrite _____ ppm

b) The establishment is producing bacon using the processing procedure above, so you decide to proceed to the pumping machine and select 50 pork bellies from lot 1A1 (weight range 10-12 lb). The 50 bellies weigh 545 lb before pumping. After pumping, the same bellies weigh 604.5 lb.

NOTE: Base your calculations on the amount of sodium nitrite in the bacon pickle formula in the processing procedure above.

The actual % of pump is _____ %

The ppm of ingoing nitrite (based on the actual pump) is _____ ppm.

The pump procedure will produce bacon in compliance? YES ____ NO _____

2. The % Yield/Shrink task appears on the task calendar today. You select 50 uncured pork bellies from lot 2B3 (12-14 lb weight range). The 50 pork bellies weigh 635 lb (green weight). Then you select 50 cured/smoked bellies from the cooler. These bellies range in weight from 12-14 lb each, and weigh 649 lb. The establishment does not routinely perform and document bacon yield determinations.

   The % yield is _____.

   Is the bacon in compliance with 9 CFR 319.107? YES ____ NO _____

Attachment 1: Solving for an Unknown Value

Introduction

This section gives a very simplified explanation of how to solve the basic equations used to determine the amount of restricted ingredients permitted.

Methods

Generic Model

To algebraically isolate an unknown value to one side of the equation and have all of the known values on the other, identical functions need to be performed on both sides of the equation.

The following ppm formula will be used to illustrate the generic model.

$$\text{ppm (parts per million)} = \frac{\text{lb Restricted Ingredient (RI)} \times \text{\% Pump} \times 1{,}000{,}000}{\text{lb Pickle}}$$

If all the values in the equation are known except the pounds of RI, isolate the pounds of RI (which is *X*) on one side of the equation and solve for it.

$$\frac{\boldsymbol{X} \times \text{\% Pump} \times 1{,}000{,}000}{\text{lb Pickle}} = \text{ppm}$$

In this instance, move all the known values to the right side of the equation, leaving the *X* on the left side where it is the numerator. First multiply each side of the equation by "lb Pickle". This cancels "lb Pickle" from the *X* side of the equation and removes any denominator.

$$\cancel{\text{lb Pickle}} \times X \times \frac{\text{\% Pump} \times 1{,}000{,}000}{\cancel{\text{lb Pickle}}} = \text{ppm} \times \text{lb Pickle}$$

$$\boldsymbol{X} \times \%\ \text{Pump} \times 1{,}000{,}000 = \text{ppm} \times \text{lb Pickle}$$

Next, to leave *X* by itself, divide both sides of the equation by "1,000,000" x “% Pump”. This cancels "1,000,000" x “% Pump” on the *X* side of the equation.

$$\frac{\boldsymbol{X} \times \cancel{\%\ \text{Pump}} \times \cancel{1{,}000{,}000}}{\cancel{\%\ \text{Pump}} \times \cancel{1{,}000{,}000}} = \frac{\text{ppm} \times \text{lb Pickle}}{\%\ \text{Pump} \times 1{,}000{,}000}$$

$$\boldsymbol{X} = \frac{\text{ppm} \times \text{lb Pickle}}{\%\ \text{Pump} \times 1{,}000{,}000}$$

Now solve for *X.* This same procedure is used to isolate *X* to one side of ***any*** equation.

Example

In the equation on page 28, the unknown is the maximum percent pump and is represented by the *X* in the equation below

$$200 = \frac{1.75 \times \boldsymbol{X} \times 1{,}000{,}000}{1{,}000}$$

In this instance, all the known values are moved to the left side of the equation, leaving “*X*” on the right and keeping it in the numerator. First multiply each side of the equation by 1000. This cancels 1000 from the *X* side of the equation and removes any denominator.

$$200 \times 1{,}000 = \frac{1.75 \times \boldsymbol{X} \times 1{,}000{,}000}{\cancel{1{,}000}} \times \frac{\cancel{1{,}000}}{1}$$

$$200 \times 1{,}000 = 1.75 \times \boldsymbol{X} \times 1{,}000{,}000$$

Next, divide each side of the equation by 1.75 ×1,000,000. This cancels 1.75 ×100,000 on the *X* side of the equation and isolates the unknown to the right side of the equation.

$$\frac{200 \times 1000}{1.75 \times 1{,}000{,}000} = \frac{\cancel{1.75} \times \boldsymbol{X} \times \cancel{1{,}000{,}000}}{\cancel{1.75} \times \cancel{1{,}000{,}000}}$$

Next, solve the equation for *X.*

$$\frac{200 \times 1{,}000}{1.75 \times 1{,}000{,}000} = \boldsymbol{X}$$

$$\frac{200{,}000}{1{,}750{,}000} = \boldsymbol{X}$$

$$0.1142 = \boldsymbol{X}$$

Finally, multiply 0.1142 by 100 to convert to a percent and 11.42% is the maximum percent pump.

Example

In the equation on page 29, the maximum amount of sodium nitrite is the unknown and represented by the *X* in the equation.

$$200 = \frac{\boldsymbol{X} \times 0.12 \times 1{,}000{,}000}{950}$$

In this instance, all the known values are moved to the left side of the equation, leaving "*X*" on the right and keeping it in the numerator. First multiply each side of the equation by 950. This cancels 950 from the *X* side of the equation and removes any denominator.

$$200 \times 950 = \frac{X \times 0.12 \times 1{,}000{,}000}{\cancel{950}} \times \frac{\cancel{950}}{1}$$

Next, divide each side of the equation by 0.12 ×1,000,000. This cancels 0.12 ×100,000 on the *X* side of the equation and isolates the unknown to the right side of the equation.

$$\frac{200 \times 950}{} = \frac{X \times \cancel{0.12} \times \cancel{1{,}000{,}000}}{}$$

0.12 × 1,000,000 ~~0.12 × 1,000,000~~

Next, solve the equation for ***X.***

$$\frac{200 \times 950}{0.12 \times 1{,}000{,}000} = X$$

$\frac{190{,}000}{120{,}000}$ = 1.58 lb is maximum amount nitrite allowed per 100 gal of curing solution

Attachment 2: Non- Food Safety Consumer Protection Tasks Job Aid

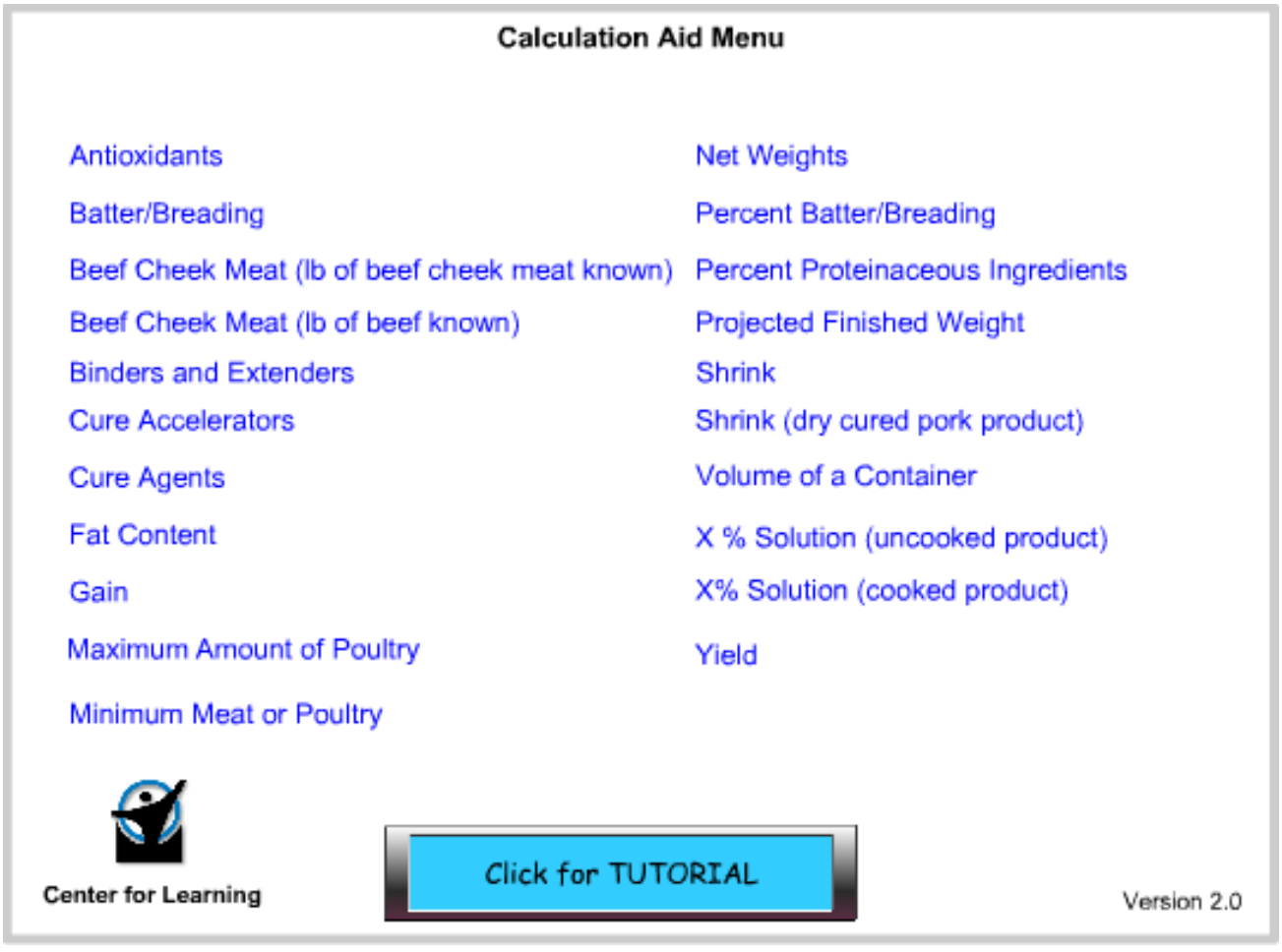
Task Name	9 CFR References	FSIS Issuance References	Inspection Personnel Verification Activities
Percent Yield/Shrink	**9 CFR** §319.107, §319.80, §319.81, §319.100, §319.101, §319.102, §319.103, §319.106, §424.21(c)	FSIS Directive 7620.3 , Chapters 11, 12, & 13; % gain, %shrink & %yield	**Verify certain products that have a specified %Yield/Shrink as part of their Standard of Identity are met and not misbranded**. **1.** **Select** an appropriate product and **2.** **Verify** compliance with regulatory requirements by **reviewing** establishment records and labels, **calculating** the % yield or shrink, and **comparing** the result with the appropriate regulatory requirement. In addition, **3.** **Verify** compliance by weighing a sample of product before and after the appropriate step in the process **calculating** the % yield or shrink and **comparing** the result with the appropriate regulatory requirement.
General Labeling	**CFR** Part 316, Part 317, Part 318, Part 319, §319.6 §327.10(d), §327.26, Part 381, §381.174, Part 412, §424.21, §441.10	**FSIS Directives** 7120.1, 7620.3, 7640.1, 6700.1, 7235.1, 7270.1,	1**. Verify that:** **a. the label contains all required information;** **b. the ingredients statement is accurate, (i.e., that all ingredients are listed in descending order of predominance);** **c. the label declares any proteinaceous substances* used in the ingredients statement;** **d. the establishment used restricted ingredients as per regulatory requirements;** **e. the label is used on appropriate product; and a label approval is on file.** 2. **Verify** the establishment meets the regulatory requirements for pre-stamping of imported product. **When verifying** restricted ingredient requirements or ingredient statement compliance, inspection program personnel are to observe the establishment formulating product and compare to the approved label. *** NOTE:** Proteinaceous substances can cause adverse reactions (i.e., allergic and non-allergic) in certain individuals, and therefore, such substances are of a food safety concern if not clearly declared in the ingredients statement.

Attachment 3: Demonstrating the Use of the Calculation Aid

Accessing the Calculation Aid

Step 1: Click on the Start button (or Windows button) lower left corner computer screen
Step 2: Click on FSIS Applications
Step 3: Highlight and double click on Calculation aid in the menu

Note: The Calculation Aid was created in 1996. It still refers to task codes, e.g., 04B04, which were replaced with the actual NFSCP task names, e.g., General Labeling task.

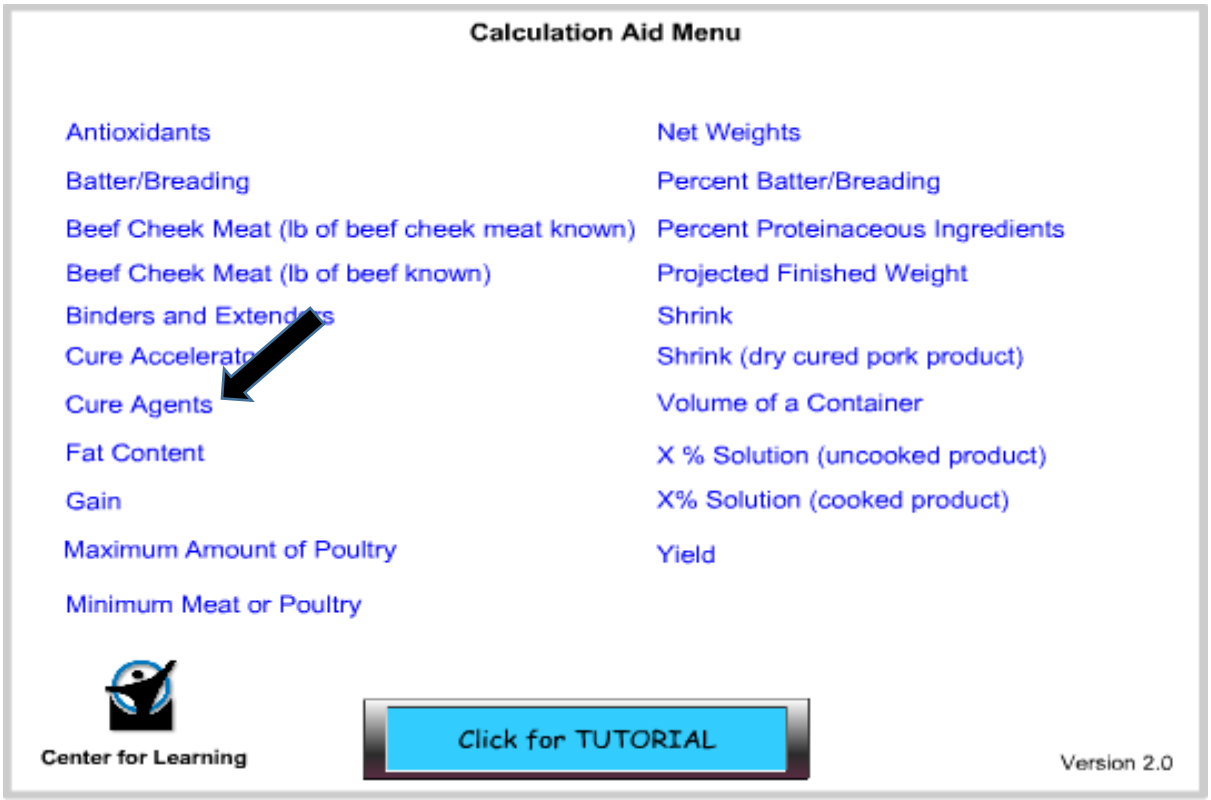


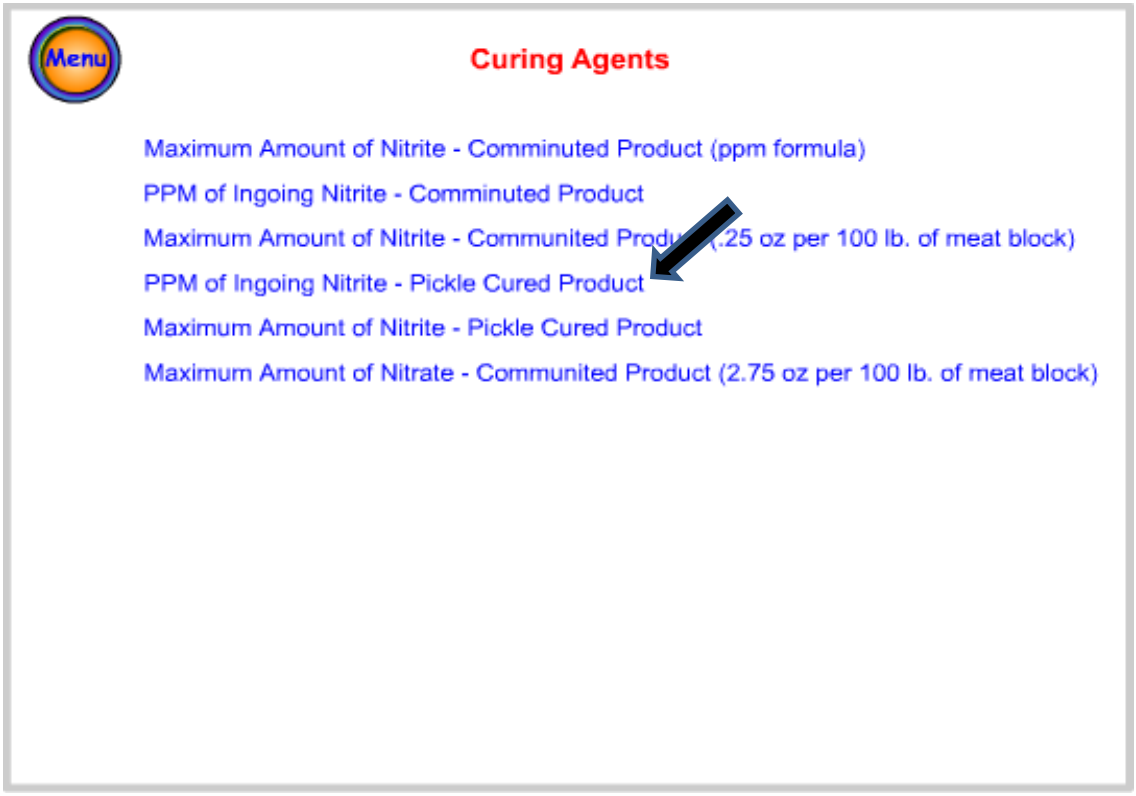
This attachment will cover the following compliance determinations in the Calculation Aid:

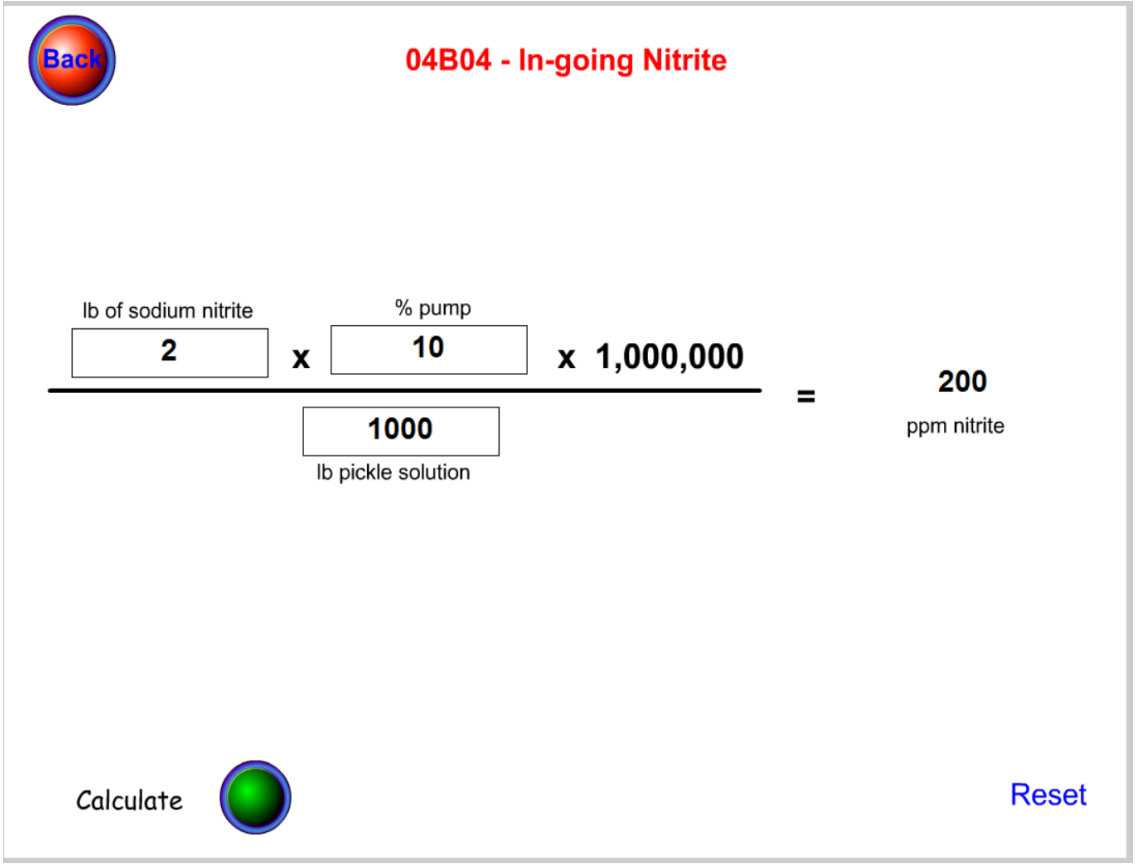
- Ingoing RI PPM (cure agent, cure accelerator and phosphate)
- Maximum amount of RI
- Gain (% added solution, or % pump or % pick-up)
- Smoke house/cooler shrink
- Shrink (dry cured Pork Products)
- Bacon Yield

Pickle Solution Example Problem (Page 28)

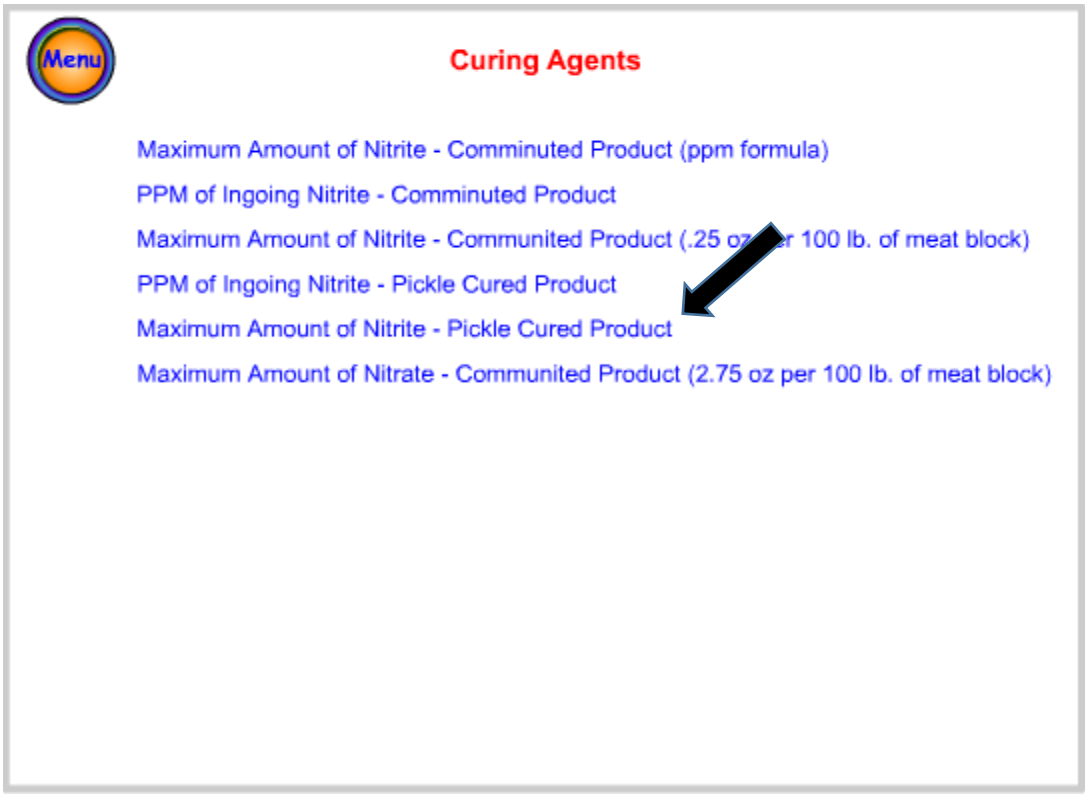
Solving for Ingoing Nitrite PPM

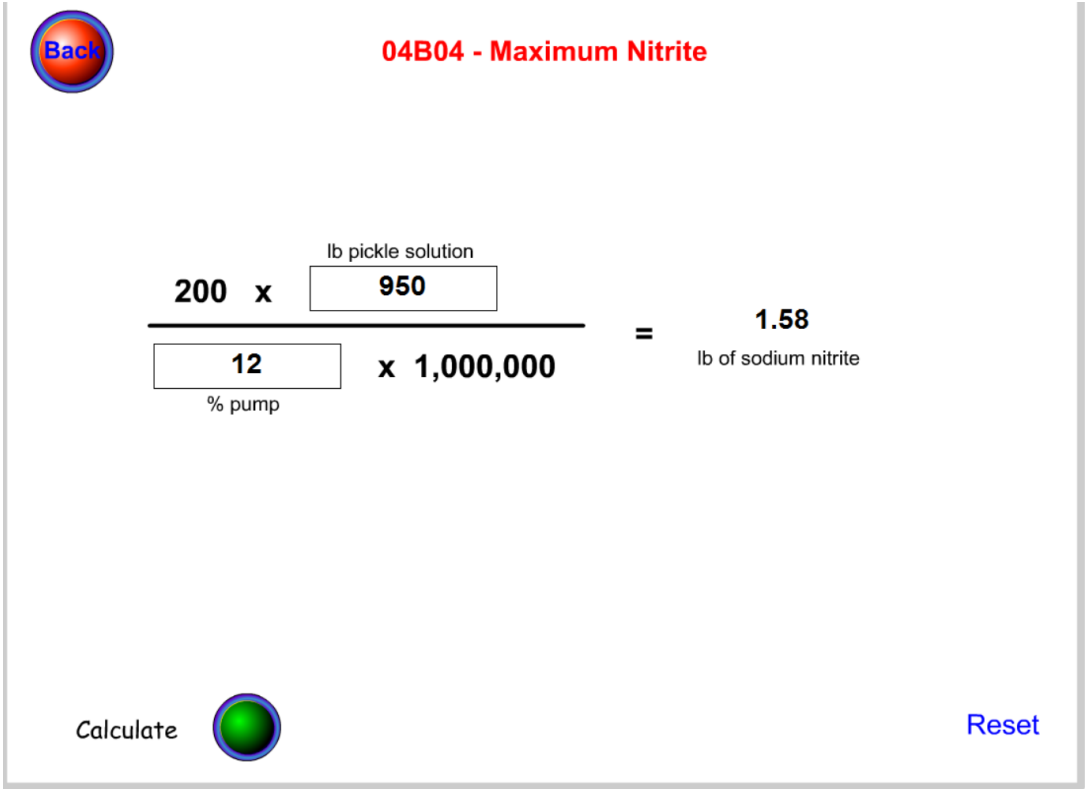



Menu
Curing Agents
Maximum Amount of Nitrite - Comminuted Product (ppm formula)
PPM of Ingoing Nitrite - Comminuted Product
Maximum Amount of Nitrite - Communited Produ (.25 oz per 100 lb. of meat block)
PPM of Ingoing Nitrite - Pickle Cured Product
Maximum Amount of Nitrite - Pickle Cured Product
Maximum Amount of Nitrate - Communited Product (2.75 oz per 100 lb. of meat block)

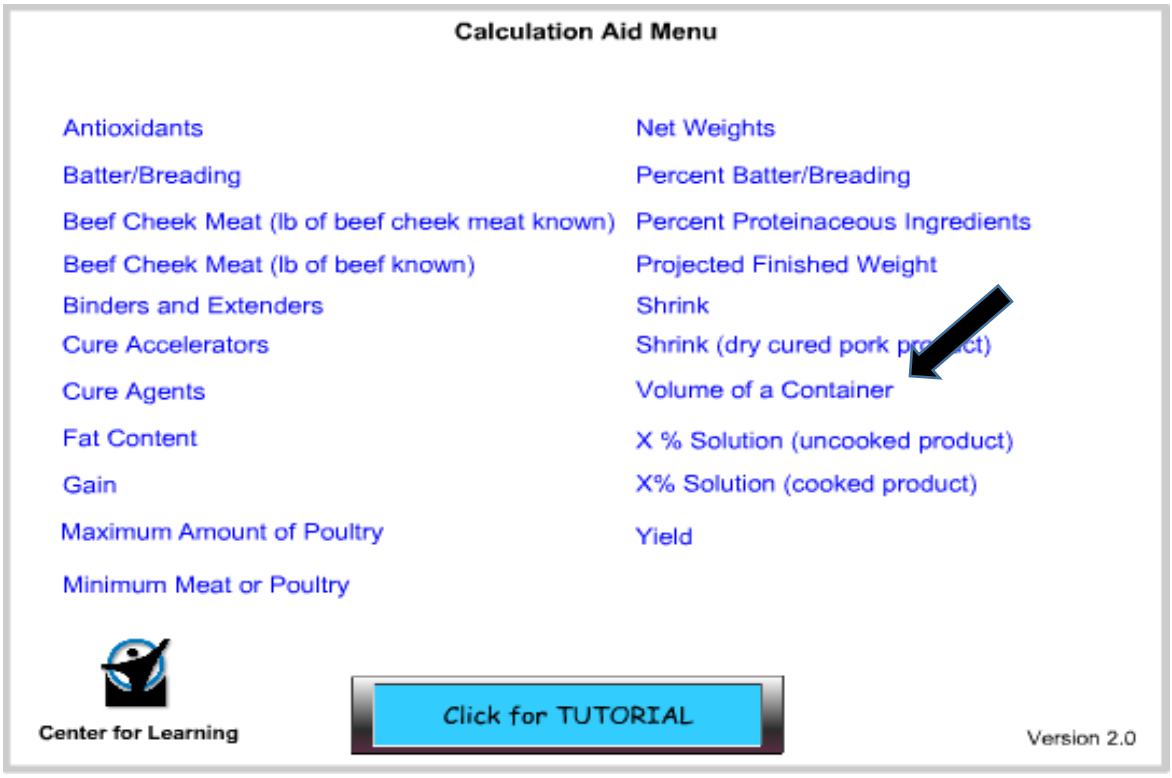

Back
04B04 - In-going Nitrite
lb of sodium nitrite
2
x
% pump
10
x 1,000,000
1000
lb pickle solution
=
200
ppm nitrite
Calculate
Reset

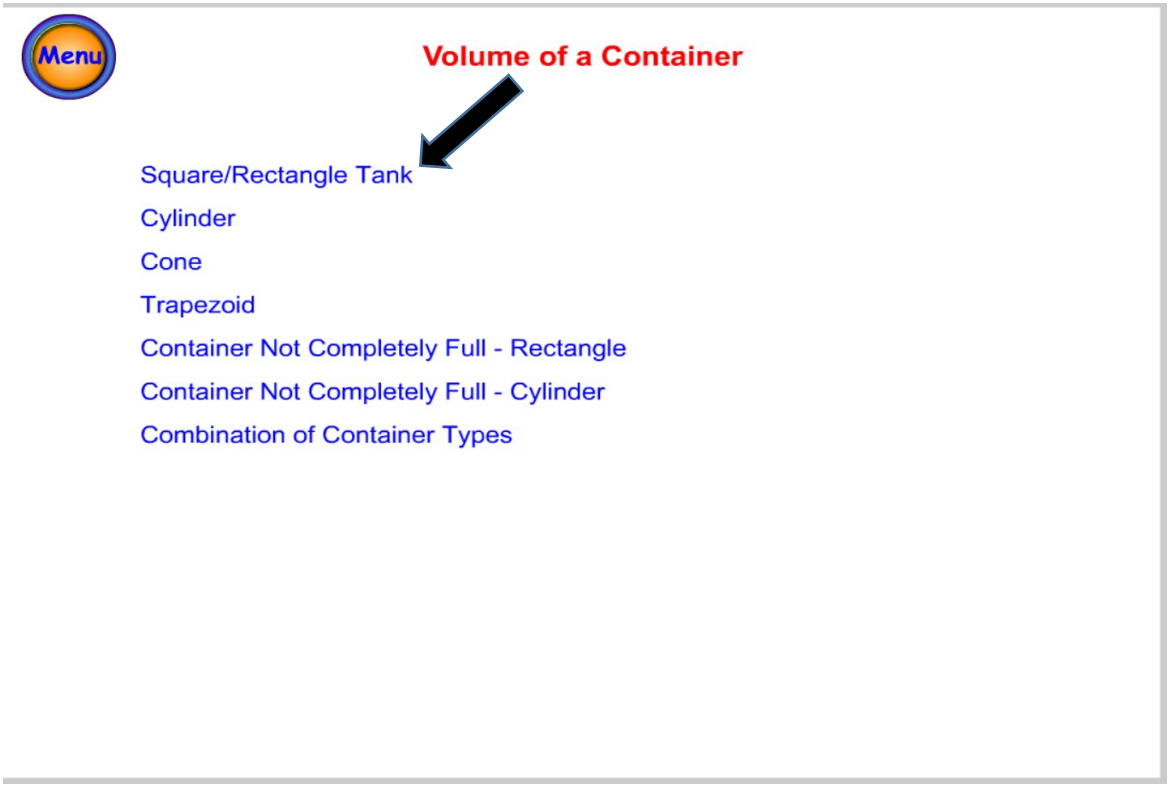
Solving Maximum Amount of Nitrite Allowed (Page 30)

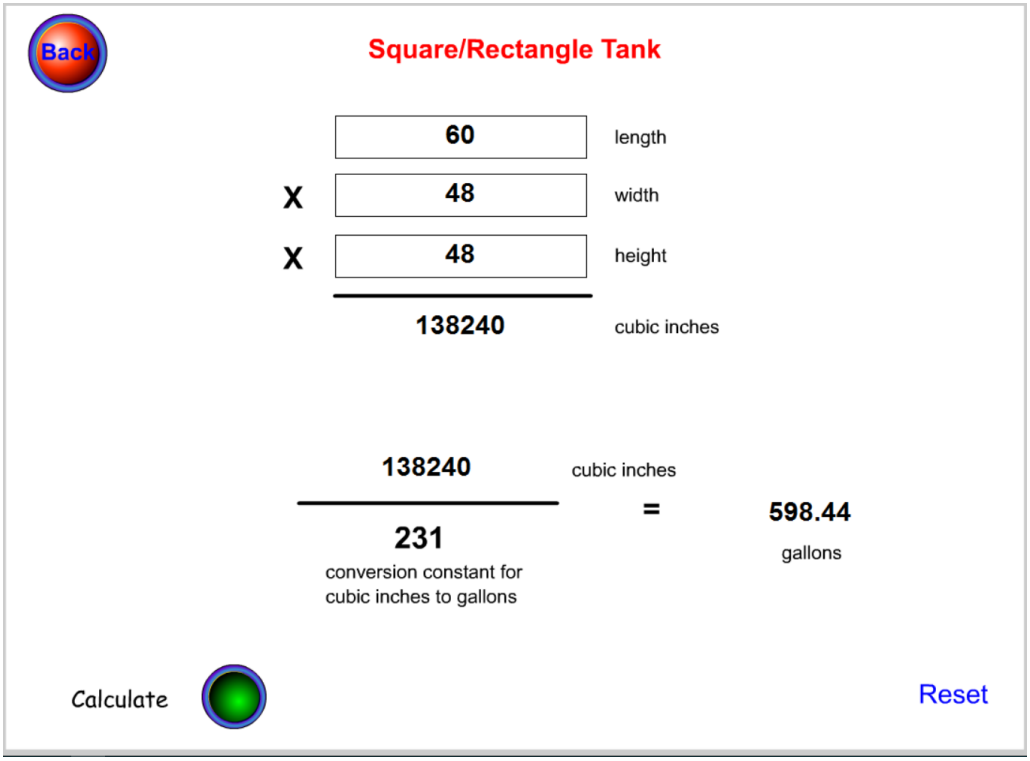




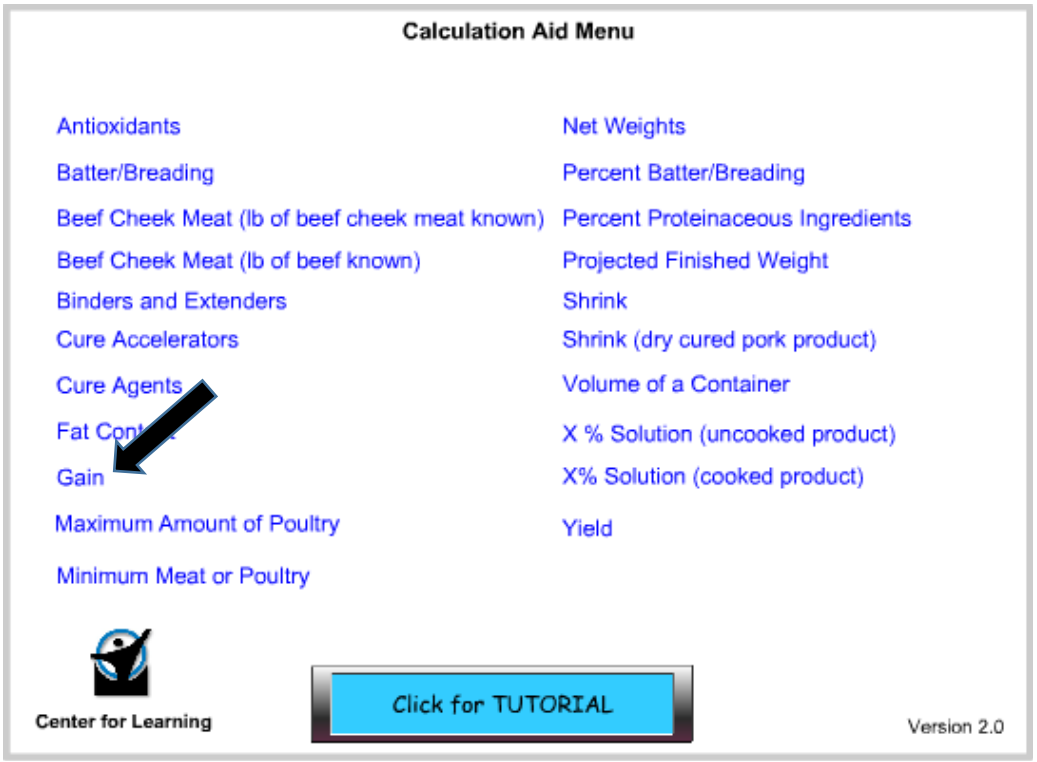
Determining Volume of a Tank (Page 30)

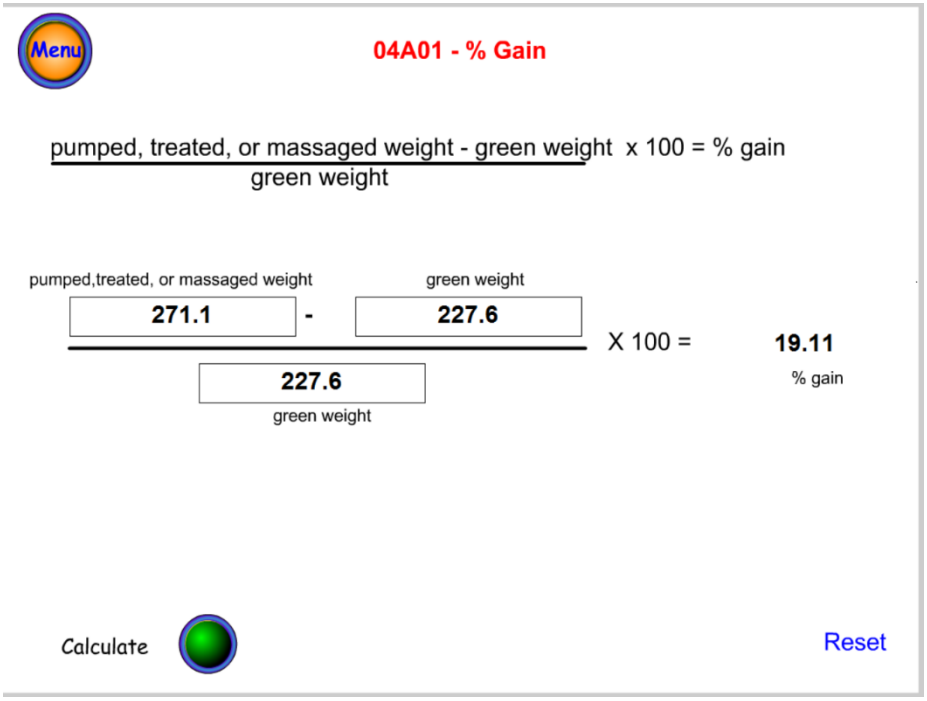




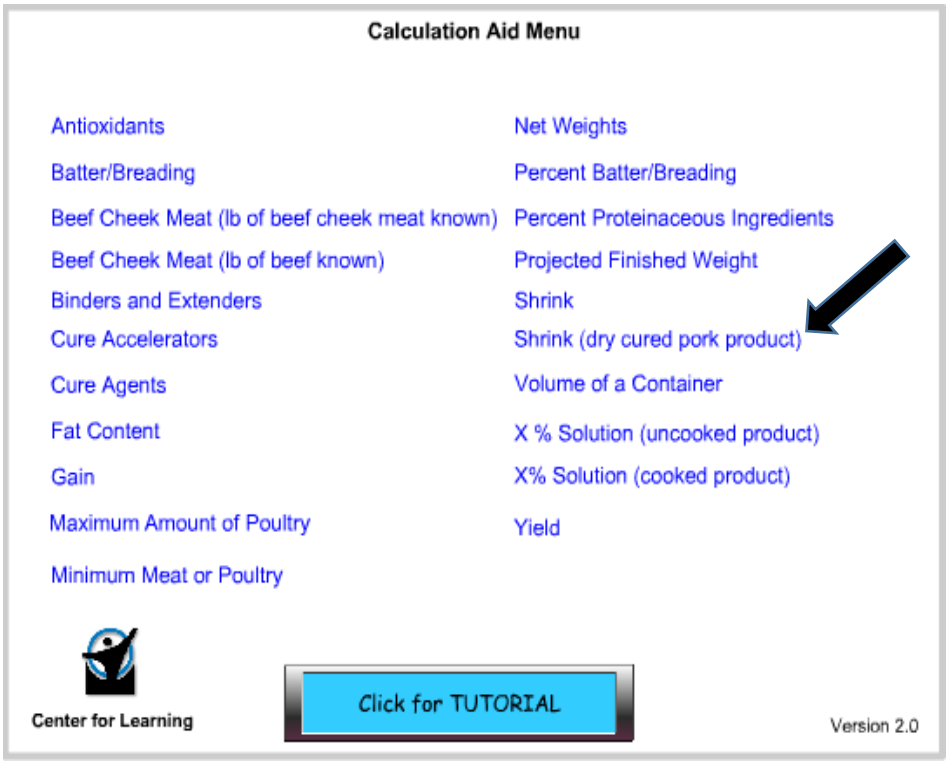


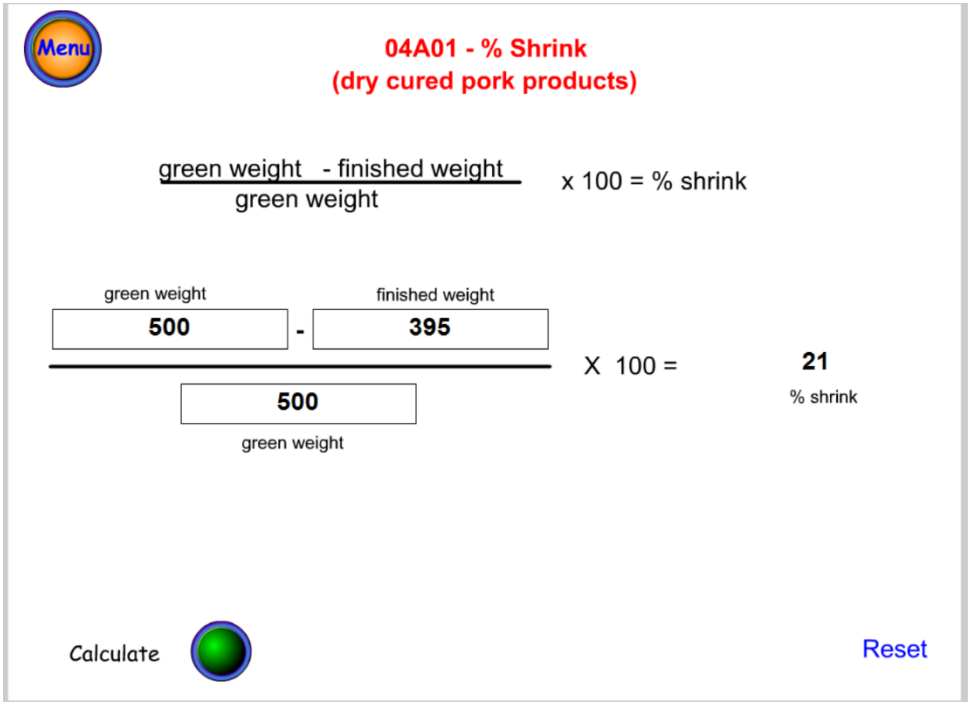
Percent Added Solution (Gain) Example Problem on Page 36



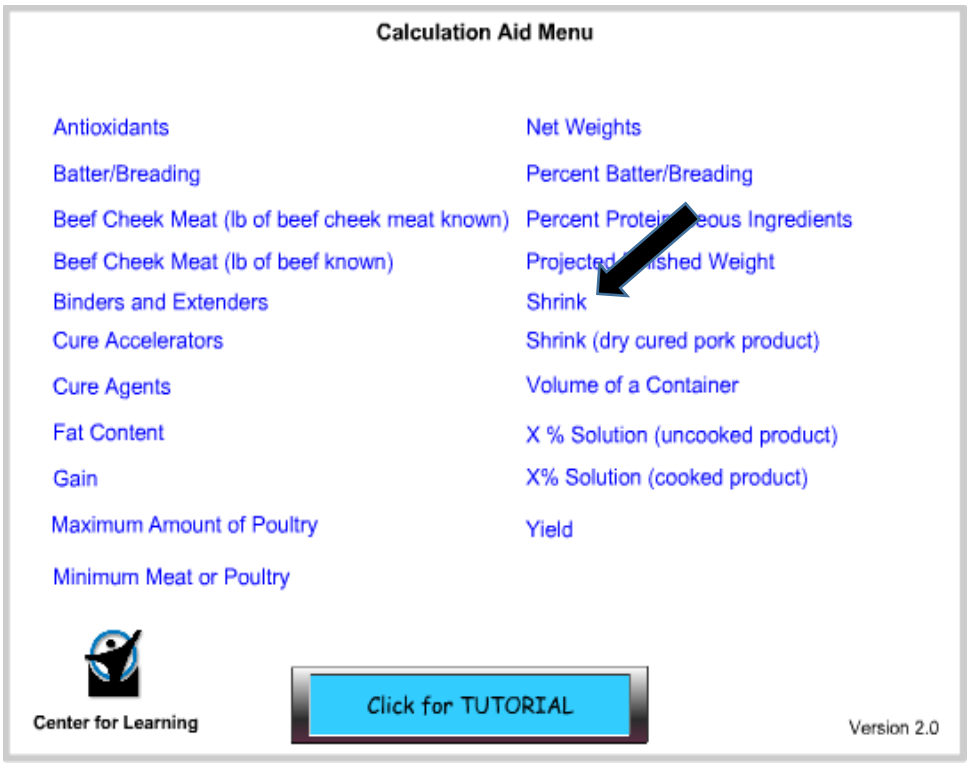


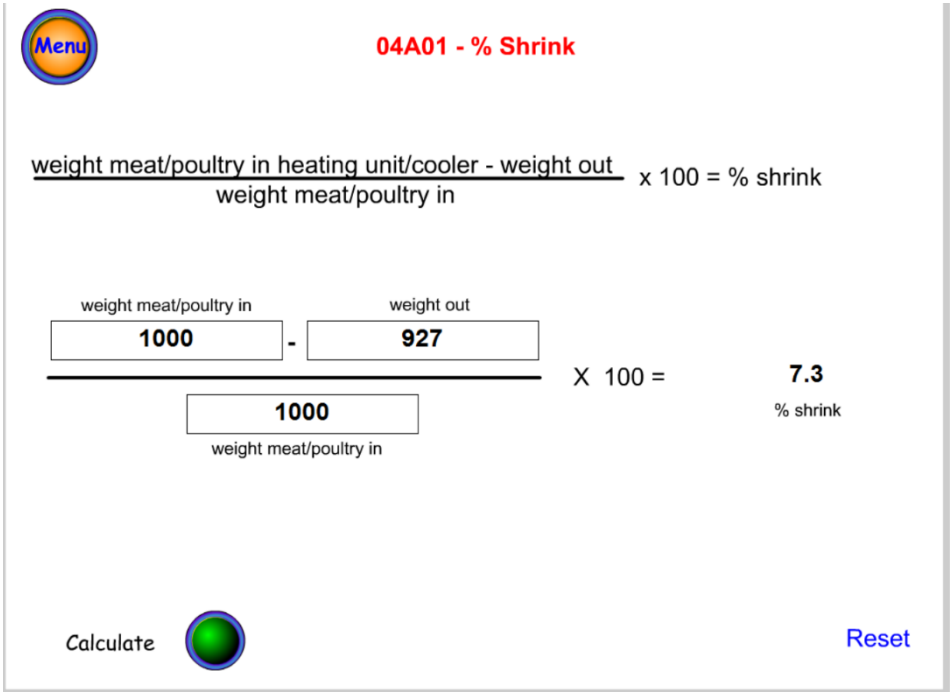
Percent Shrink (Dry Cured Pork Product) Example Problem Page 42



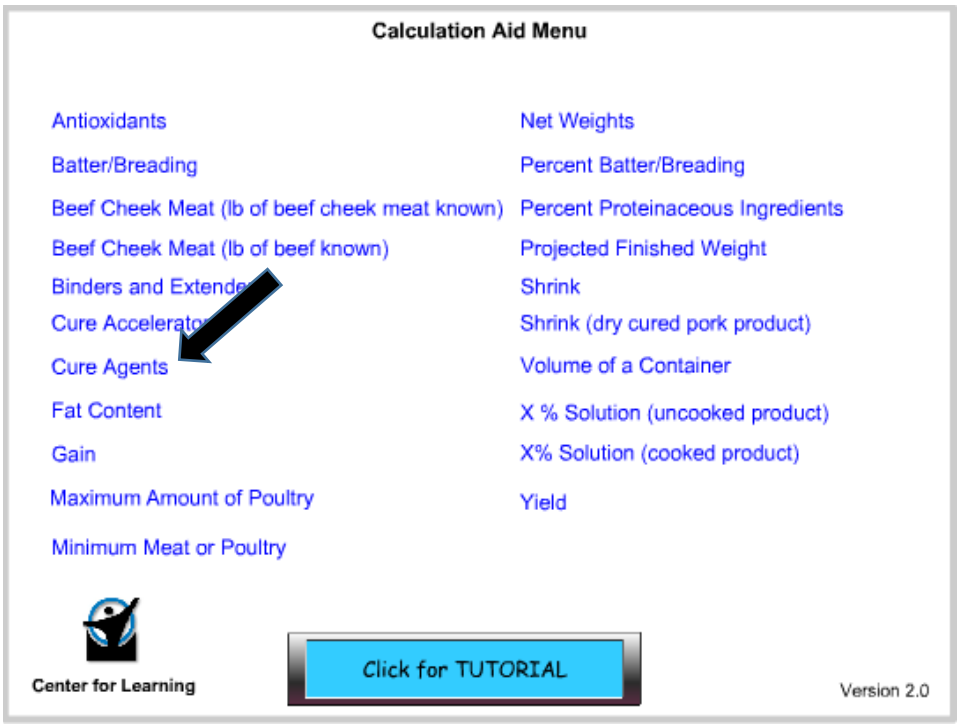


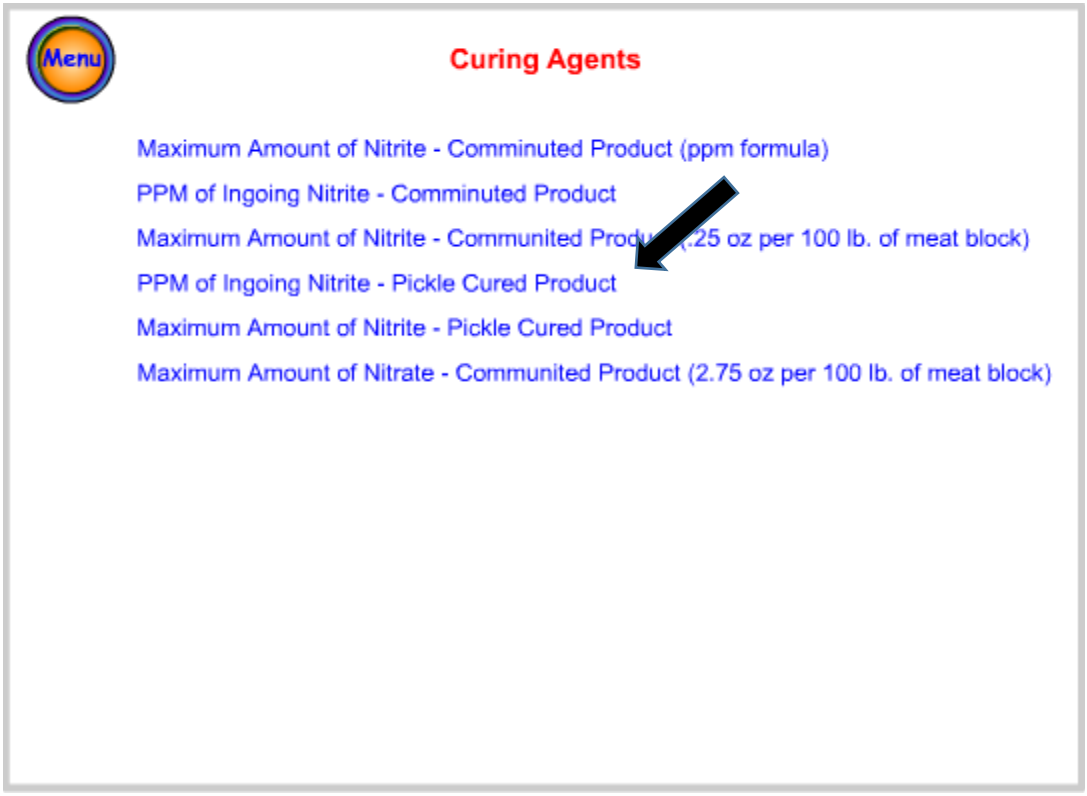
Smoke House/Cooler Shrink Example Problem Page 43

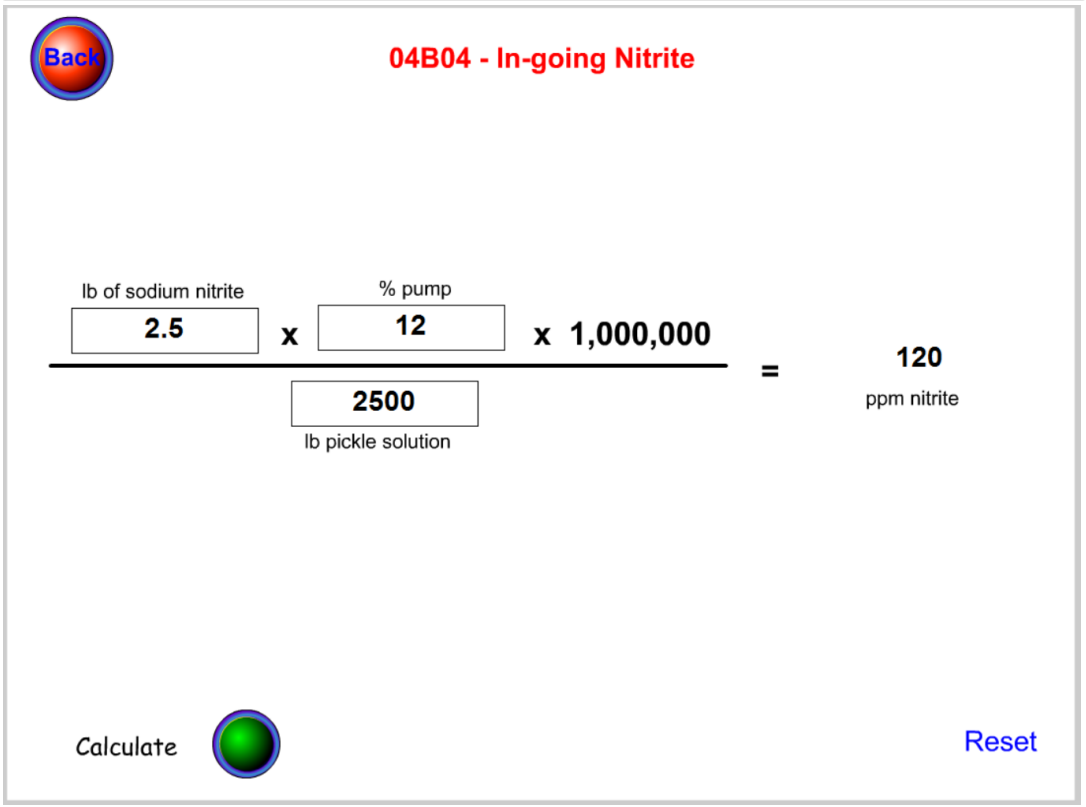




Ingoing Nitrite for a Pumped Bacon Processing Procedure Example Problem Page 54




Menu
Curing Agents
Maximum Amount of Nitrite - Comminuted Product (ppm formula)
PPM of Ingoing Nitrite - Comminuted Product
Maximum Amount of Nitrite - Communited Prod .25 oz per 100 lb. of meat block)
PPM of Ingoing Nitrite - Pickle Cured Product
Maximum Amount of Nitrite - Pickle Cured Product
Maximum Amount of Nitrate - Communited Product (2.75 oz per 100 lb. of meat block)


Back
04B04 - In-going Nitrite
lb of sodium nitrite
2.5
x
% pump
12
x 1,000,000
2500
lb pickle solution
=
120
ppm nitrite
Calculate
Reset

Bacon Yield Example Problem on Page 57