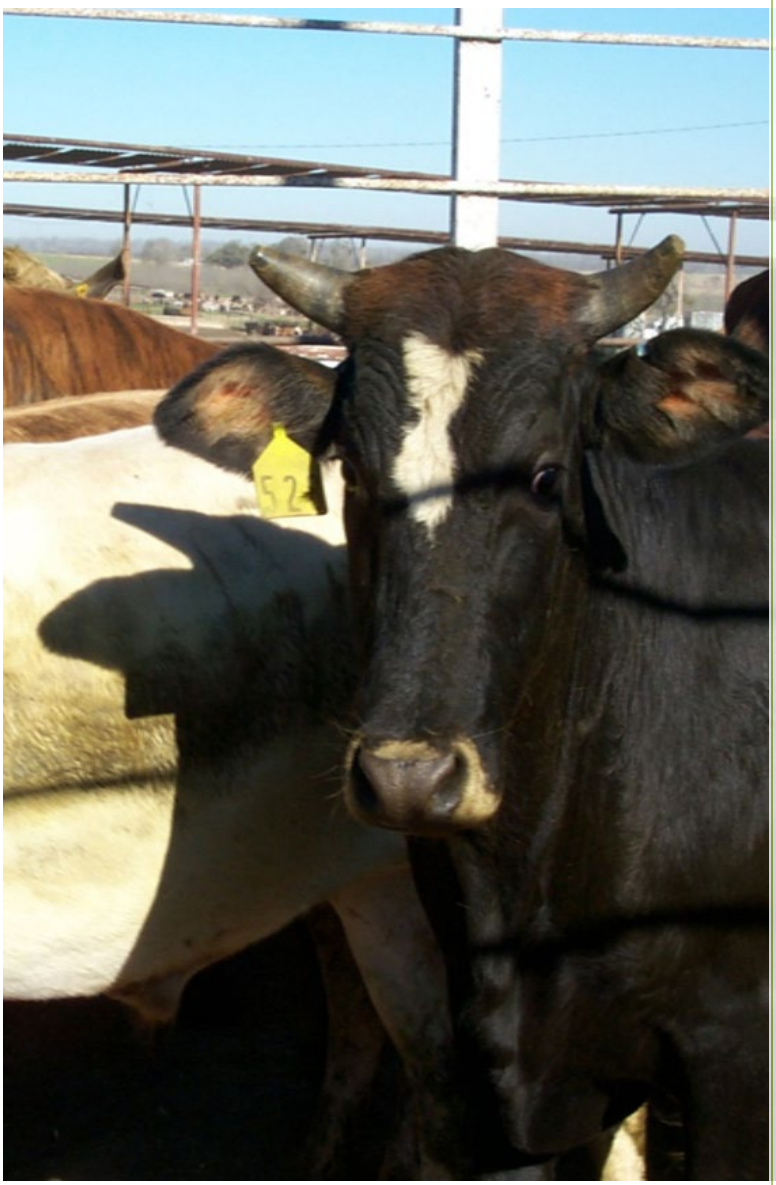
Industry Guideline for Minimizing the Risk of Shiga Toxin-Producing *Escherichia coli* (STEC) in Beef (including Veal) Slaughter Operations 2021 Guideline



This guideline is to assist establishments that slaughter beef (including veal) to:

- **Implement effective sanitary dressing procedures designed to prevent carcass contamination;**
- **Implement effective decontamination and antimicrobial interventions;**
- **Properly assess microbial testing results, including results for indicators of process control, at any point during slaughter; and**
- **Use the results from the implementation of these components of the food safety system to assess the effectiveness of the overall HACCP system.**

Preface

What is the purpose of this Guideline?

The purpose of this guideline is to provide beef (including veal) slaughter establishments information concerning best practices at slaughter that may be used to prevent, eliminate, or reduce levels of fecal and associated microbiological contamination in beef (including veal), specifically (1) Shiga toxin-producing *Escherichia coli* O157:H7 and non-O157(STEC), and (2) *Salmonella*. For the purpose of this guideline, wherever it references beef, it includes veal. This document is not meant to be a comprehensive *Salmonella* control guide, however many of the best practices included in this document may also reduce *Salmonella* contamination that occurs during the slaughter process.

This guideline provides guidance to assist establishments in meeting FSIS regulations. The guidance represents best practice recommendations by FSIS based on the most current science available and practical considerations. It does not represent regulatory requirements that must be met. Establishments may choose to adopt different procedures from those outlined in this guideline to prevent contamination, but they would need to support why those procedures are effective. This guideline represents FSIS' current thinking on this topic and should be considered usable as of the issuance date.

This guideline is focused on assisting small and very small establishments in support of the Small Business Administration's initiative to provide these establishments with assistance under the Small Business Regulatory Enforcement and Fairness Act (SBREFA). However, all FSIS regulated beef slaughter establishments may be able to apply the recommendations in this guideline. It is important that small and very small establishments have access to a full range of scientific and technical support and the assistance needed to establish safe and effective Hazard Analysis and Critical Control Point (HACCP) systems. Although large establishments can benefit from the guidance that FSIS provides, focusing the guidance on the needs of small and very small establishments provides those establishments with information that may be otherwise unavailable to them. FSIS strives to provide small and very small establishments with as much technical knowledge as possible through, in part, publication of best practices in industry guidelines. Establishments can apply this knowledge and best practices to their operations as they see fit to establish a compliant HACCP system.

Key Point

This guideline provides information concerning best practices at slaughter that may be used to prevent, eliminate or reduce levels of STEC in beef (including veal). *Salmonella* is also covered where scientific information is available.

Who is this guideline designed for?

FSIS designed this guideline for beef (including veal) slaughter establishments. The best practices discussed in this guideline may also be useful to establishments that slaughter bison.

Is this version of the guideline final?

Yes. This version of the guideline is final. FSIS responded to public comments received on the previous version of this guideline. Comments were received from two industry groups and one individual. FSIS made the following changes in response to these comments.

- FSIS clarified that the Agency's recommendations are not regulatory requirements;
- FSIS removed information pertaining to lymph node harborage of *Salmonella* and will include it in *Salmonella* specific guidance materials;
- FSIS removed best practice recommendations on the use of chlorophyll to detect contamination on carcasses and air inflation for bunging;
- FSIS clarified the Agency's recommendations on cattle washing to reduce pathogen transfer and added more information on humane handling during cattle washing;
- FSIS added more information on pre-harvest interventions;
- FSIS clarified the Agency's recommendations about when feet, eardrums, and bruises should be removed; and
- FSIS provided more information to support its recommendations on chilling and storage of carcasses and parts;
- After additional internal review, FSIS emphasized that it considers the presence of certain STEC strains to be adulterants when they are present in raw non-intact beef products and raw intact beef source materials intended for use in such non-intact beef products or when the intended use is unclear. These adulterant STEC strains include *E. coli* O157:H7 as well as strains that have certain O groups (O26, O45, O103, O111, O121, and O145) and contain two specific virulence genes (stx and eae). This addition was created to clarify FSIS policy regarding STEC in relation to product recalls; and
- After additional internal review, FSIS added a section on how "dry aging" can be used as an intervention to reduce pathogens, including STEC.

FSIS will update this guideline in response to changes in science and technology and based on public comments, as necessary.

What if I still have questions after I read this guideline?

FSIS recommends that users of this guideline search the publicly posted Questions & Answers (Q&As) in the askFSIS database or submit questions through askFSIS. Documenting these questions helps FSIS improve and refine present and future versions of this guideline and associated issuances.

When submitting a question, use the **Submit a Question** tab, and enter the following information in the fields provided:

Subject Field:	Enter **FSIS Industry Guideline for Minimizing the Risk of Shiga Toxin-Producing *Escherichia coli* (STEC) in Beef (including Veal) Slaughter Operations 2021;**
Question Field:	Enter question with as much detail as possible;
Product Field:	Select **General Inspection Policy** from the drop-down menu;
Category Field:	Select **Sampling** from the drop-down menu; and
Policy Arena:	Select **Domestic (U.S.) only** from the drop-down menu.

When all fields are complete, press **Continue**.

Industry Guideline for Minimizing the Risk of Shiga Toxin-Producing *Escherichia coli* (STEC) in Beef (including Veal) Slaughter Operations

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Industry Guideline for Minimizing the Risk of Shiga Toxin-Producing *Escherichia coli* (STEC) in Beef (including Veal) Slaughter Operations

Why did FSIS develop this guideline?

Since issuing the first version of this guideline in September 2002, FSIS has made significant changes to policies and testing procedures affecting beef slaughter establishments. This guideline has been updated to reflect policy and procedural changes. Some of the more significant changes include:

- In October 2002, FSIS issued a *Federal Register* notice (FRN) 67 FR 62325 that required all establishments producing raw beef products to reassess their HACCP plans in light of new FSIS testing methods and higher prevalence estimates for *E.coli* O157:H7.
- In the September 20, 2011 *Federal Register* (76 FR 58157), FSIS declared six non-O157 STECs (O26, O45, O103, O111, O121, and O145) adulterants in raw, non-intact beef products and product components.
- In November 2011, FSIS issued *FSIS Directive 6410.1, Verifying Sanitary Dressing and Process Control Procedures by Off-line Inspection Personnel (IPP) in Slaughter Operations of Cattle of Any Age* to IPP to verify that cattle slaughter operations are implementing sanitary dressing and process control procedures and that the procedures they are implementing prevent contamination of carcasses and ensure that insanitary conditions are not created. Those instructions are still in place.
- In June 2012, FSIS began testing for non-O157 STEC in addition to *E. coli* O157:H7 in beef manufacturing trimmings (BMT).
- In June 2014, FSIS began analyzing for *Salmonella* in all raw beef samples it collects for STEC analysis. FSIS announced its intention to develop a new ground beef performance standard for *Salmonella* based on these data.
- In August 2014, FSIS began a Beef-Veal carcass baseline study to test carcasses for the presence/absence and levels (enumeration) of STEC, *Salmonella* and certain indicator organisms during the beef slaughter process. FSIS intends to use the results from this study to develop guidance for establishments that slaughter beef-veal to use in assessing their process control of sanitary dressing and other slaughter controls.
- In August 2014, FSIS issued the revised *FSIS Compliance Guideline for Establishments Sampling Beef Trimmings for Shiga Toxin-Producing Escherichia coli (STEC) Organisms or Virulence Markers* concerning the sampling of BMT for STEC. The guidance includes information on the development and implementation of statistical process control procedures that slaughter/fabrication establishments can use to assess (1) the effectiveness of their controls for preventing contamination to the carcass during the slaughter process and (2) to verify they are reducing STEC to a non-detectable level. The guidance also recommends criteria for high event periods (HEPs).
- In January 2015, FSIS issued *FSIS Directive 10,010.3 Traceback Methodology for Escherichia Coli (E.coli) O157:H7 in Raw Ground Beef Products and Bench Trim* to IPP on how to conduct traceback activities from the grinder or bench trim establishment and to verify that an establishment's action in response to an HEP is appropriate.
- In September 2015, FSIS issued *Sanitary Dressing and Antimicrobial Intervention*

Implementation at Veal Slaughter Establishments: Identified Issues and Best Practices. This document identifies best practices for sanitary dressing specific to Veal slaughter establishments.

Cattle have been identified as an important reservoir for pathogens, including STEC and *Salmonella*, which are known causes of foodborne disease. The hides, hooves, and gastrointestinal (GI) tracts of cattle can contain these pathogens. Contamination can be transferred from the hide, hooves, and GI tracts of cattle through poor sanitary dressing procedures. Effective sanitary dressing procedures underpin the interventions that an establishment has in place to prevent, eliminate, or reduce to an acceptable level, the food safety hazards that are reasonably likely to occur in the slaughter process.

FSIS recommends that slaughter operations focus on their sanitary dressing procedures to prevent carcass contamination and the creation of insanitary conditions. Poor sanitary dressing procedures result in carcass contamination (visible or invisible, e.g., fecal or non-visible microbial contamination) and limit the effectiveness of antimicrobial interventions.

FSIS developed this guideline to assist establishments that slaughter beef (including veal) to prevent and minimize the risk of STEC in their operations. This guidance will:

- Help establishments design comprehensive written sanitary dressing programs that focus on preventing contamination of the carcass throughout the slaughter process;
- Describe for establishments how to implement antimicrobial interventions effectively; and
- Assist establishments with developing verification activities to ensure sanitary dressing procedures are consistently performed and effective.

As described in the *FSIS Compliance Guideline for Establishments Sampling Beef Trimmings for Shiga Toxin-Producing Escherichia coli (STEC) Organisms or Virulence Markers*, establishment verification testing results for BMT are likely the best available objective information a slaughter establishment can use to determine the ongoing effectiveness of its slaughter/dressing operation. Establishments that incorporate statistical process control procedures into their testing programs, as described in the beef trimmings sampling guideline, and apply the information and best practices in this guideline should have an improvement to the design and implementation of their slaughter HACCP system.

Further, in the beef trimmings sampling guideline above, FSIS recommends that

Key Points

- Most food safety hazards inherent in raw processes originate with the live animals that enter the slaughter establishment.
- *Salmonella* and *STEC* are commonly found in the GI tract, and on the hides, and hooves of cattle.
- Effective sanitary dressing procedures during slaughter can reduce microbial contamination.

slaughter establishments develop criteria for identifying HEPs or to follow FSIS criteria for identifying HEPs. HEPs are periods of time in which slaughter establishments experience a high rate of positive results for STEC (or virulence markers) in BMT samples from production lots containing the same source materials. That is, the BMT was produced from one or more carcasses slaughtered and dressed consecutively or intermittently within a defined period of time (e.g., shift).

A HEP may mean that a systemic breakdown of the slaughter/dressing operation has occurred and has created an insanitary condition applicable to all parts of the beef carcass (e.g., primal cuts in addition to the BMT and other raw ground beef and patty components). FSIS recommends that establishments identify HEP criteria so that they can determine whether they need to withhold product from commerce when a HEP has occurred. A HEP may indicate more widespread adulteration of product, beyond the specific product found positive. If establishments identify and respond to a HEP, they will minimize the chance that they release adulterated product into commerce. More information on the development and implementation of statistical process control procedures, recommended criteria for identifying a HEP, and guidance for responding to a HEP are included in the *FSIS Compliance Guideline for Establishments Sampling Beef Trimmings for Shiga Toxin-Producing Escherichia coli (STEC) Organisms or Virulence Markers*.

What regulatory requirements are addressed by this guideline?

Regulation	Description
9 CFR 310.18(a)	Requires establishments to handle carcasses, organs, and other parts in a manner to prevent contamination.
9 CFR 416.1 through 416.5	Requires establishments to operate in a manner to prevent the creation of insanitary conditions and prevent product adulteration.
9 CFR 417.2(a)(1)	Requires an establishment to conduct a hazard analysis to identify food safety hazards that might occur in the production process, assess which hazards are reasonably likely to occur, and develop measures to prevent, eliminate, or reduce the identified hazards to an acceptable level.
9 CFR 417.2(c)(3)	Requires the establishment to develop critical limits for critical control points (CCPs) to control hazards that are reasonably likely to occur.
9 CFR 417.4(a)(2)	Requires establishments to verify that the HACCP system is effectively implemented on an ongoing basis.

9 CFR 417.5(a)(1)	Requires establishments to maintain supporting documentation associated with the hazard analysis.
9 CFR 417.5(a)(2)	Requires establishments to maintain decision-making documents associated with the selection and development of CCPs and critical limits, and documents supporting both the monitoring and verification procedures selected and the frequency of those procedures.

How should establishments use this guideline document to incorporate these recommendations into a comprehensive, robust food safety system?

This guideline provides an overview of the slaughter process and includes the best practices at each step in the slaughter process to minimize contamination. As discussed above, FSIS recommends that establishments develop written sanitary dressing procedures designed to prevent contamination from occurring throughout the slaughter process and to develop verification activities to ensure the sanitary dressing procedures are performed consistently and are effective. Establishments can use the information in *Appendix 1, Establishment Self-Assessment Checklist*, to develop written sanitary dressing procedures designed to prevent contamination throughout the slaughter process and design verification activities to ensure that their employees are performing the procedures on an on-going basis.

Establishments can use *Appendix 2, Carcass Sanitary Dressing Audit*, to verify, in real-time using carcass audits, that their sanitary dressing procedures are effectively preventing contamination throughout the slaughter process.

FSIS also recommends that establishments implement antimicrobial intervention treatments, as needed, to reduce contamination to acceptable levels. This guideline discusses antimicrobial intervention treatments, their role in a comprehensive food safety system, and how to design and implement their use effectively.

Key Point

- The goal of this guideline is to help establishments design and implement a robust food safety system to minimize product contamination, specifically with pathogens.
- Establishments that use this guidance can reduce their likelihood of producing adulterated products.

FSIS recommends that establishments test BMT for STEC (or virulence markers) to assess the effectiveness of their controls for preventing contamination during the slaughter operation. As is discussed above, FSIS developed a guidance document, *FSIS Compliance Guideline for Establishments Sampling Beef Trimmings for Shiga Toxin-Producing Escherichia coli (STEC) Organisms or Virulence Markers*, for beef slaughter/fabrication establishments to use to develop and implement statistical process control procedures for STEC (or virulence markers) BMT testing to assess the effectiveness of slaughter operations. The beef trimmings sampling guideline also includes recommended HEP criteria for identifying situations that indicate when a

systemic breakdown of the slaughter operation has occurred and created an insanitary condition applicable to all parts of the beef carcass (e.g., primal cuts in addition to the BMT and other raw ground beef and patty components). FSIS recommends that establishments use the beef trimmings sampling guideline with the information in this guideline to design and implement a robust food safety system to improve their process over time.

Overview of the Beef Slaughter Process

KEY DEFINITIONS:

Sanitary Dressing: The practice of handling carcasses by establishment employees and machinery in a sanitary environment and a manner that produces a safe and wholesome product.

Process Control Procedure: A defined procedure or set of procedures designed by an establishment to provide control of those operating conditions necessary for the production of safe, wholesome food. The procedures typically include some means of evaluating system performance by using process control criteria, actions to take to ensure the system remains under control, and planned measures to take in response to a loss of process control. The procedures can be used as support for decisions made in the hazard analysis.

What are the food safety hazards of concern during beef slaughter and where do they originate?

FSIS considers the presence of certain STEC strain adulterants when they are present in raw non-intact beef products and raw intact beef source materials intended for use in such non-intact beef products. These adulterant STEC strains include *E. coli* O157:H7 as well as strains that have certain O groups (O26, O45, O103, O111, O121, and O145) and contain two specific virulence genes (stx and eae).

The best practices for effective sanitary dressing procedures, antimicrobial intervention strategies, and appropriate use of microbial data in decision-making as outlined in this guideline will assist establishments in reducing these pathogens.

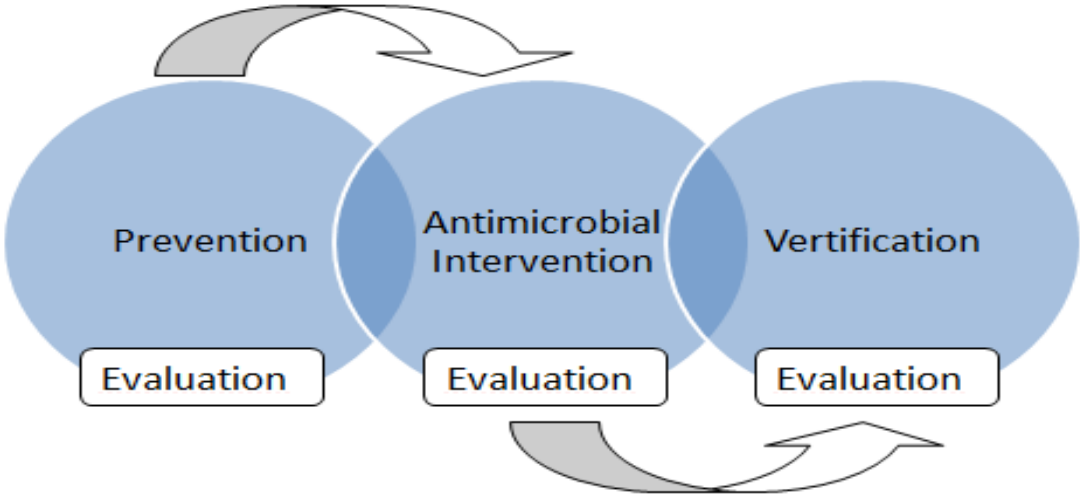
Most of the food safety hazards inherent in raw processes originate with the live animals that enter the slaughter establishment. Common hazards include the ***biological*** hazards of bacterial pathogens, the ***chemical*** hazards of residues and the ***physical*** hazards of foreign material. These hazards could be present in raw product in any step of food production. Enteric organisms, such as *E.coli* and *Salmonella* are commonly found as part of the normal bacteria of the intestinal tract of animals. Some strains, notably the STEC, including *E. coli* O157:H7, and certain *Salmonella* serotypes can cause serious foodborne illness in humans. Cattle may carry STEC and *Salmonella* in their GI tracts and these pathogens may also be present on the hides and hooves of animals presented for slaughter.

What are the guiding principles for minimizing the risk of STEC at slaughter?

The four main guiding principles for minimizing the risk of STEC contamination during the slaughter process are:

1) Effective sanitary dressing procedures;
2) Antimicrobial interventions;
3) Establishment validation and verification that the system is functioning as intended; and
4) Evaluation of slaughter procedures during all steps of the process.

These principles are interrelated and are vital components of an effective slaughter food safety system. A description of each principle follows.



PREVENTION	Slaughter operations should develop and validate sanitary dressing procedures that prevent carcass contamination and the creation of insanitary conditions throughout the slaughter process. Effective and consistently performed sanitary dressing procedures that focus on **preventing** contamination directly impact whether interventions used will effectively reduce pathogens.
VALIDATED ANTIMICROBIAL INTERVENTIONS	Establishments should implement decontamination and validated antimicrobial intervention treatments as needed to reduce STEC to a non-detectable level. Establishments are required to identify and maintain documentation that provides support for their interventions, and identify the critical operational parameters that are necessary for the interventions to be effective (element one of validation), and to

	have in-plant observations, measurements, microbiological test results, or other information demonstrating the control measures in the HACCP system can perform as expected within a particular establishment to achieve the intended food safety objective (element two of validation).
VERIFICATION	Establishments are required to develop and implement verification activities that demonstrate that their slaughter process is effectively reducing hazards. Verification activities should generate real-time data of employees performing procedures as written that verify the procedures were effectively implemented (e.g., carcass audits after points in the slaughter process where carcasses are vulnerable to contamination). Establishments should develop microbiological testing procedures designed to detect contamination in product lots and generate microbiological test results to demonstrate the lots are free of contamination.
EVALUATION	Establishments should be able to demonstrate process control of the slaughter process through review of data collected (i.e., the implementation of their sanitary dressing procedures, antimicrobial interventions, and verification testing results) to determine the overall effectiveness of their food safety system.

As discussed in the *FSIS Compliance Guideline HACCP Systems Validation* best practice documents such as; this FSIS Guideline, the *BIFSCO Best Practices for Beef Slaughter* and *FSIS Directive 6410.1, Verifying Sanitary Dressing and Process Control Procedures by Off-line Inspection Program Personnel (IPP) in Slaughter Operations of Cattle of Any Age,* may be used as scientific support that an establishment's sanitary dressing program prevents contamination with microbiological hazards such as STEC.

Best Practices for Sanitary Dressing and Process Control

NOTE: While the recommendations in this guide apply to both veal and cattle slaughtering establishments, specific recommendations for veal can be found in the September 2015 FSIS document *Sanitary Dressing and Antimicrobial Intervention Implementation at Veal Slaughter Establishments: Identified Issues and Best Practices*.

What is the importance of sanitary dressing and process control procedures?

FSIS sampling has found enteric pathogens, including *Salmonella*, adulterant non-O157 STEC and *E. coli* O157:H7, in BMT. Additionally, FSIS has found these bacteria in other raw ground beef components (including head meat and cheek meat) and raw ground beef. The presence of these enteric pathogens in these beef products can be attributed, in part, to ineffective sanitary dressing and process control procedures that create insanitary conditions during slaughter.

Insanitary practices and conditions during slaughter can introduce microbial and visible contamination (e.g., fecal material, ingesta and milk) to carcasses and parts.

Effective sanitary dressing and process control procedures, coupled with effective decontamination and antimicrobial intervention treatments, are necessary to prevent the creation of insanitary conditions. Establishments create the potential for the contamination of carcasses and parts when they fail to control these procedures and treatments in their food safety systems. Effective sanitary dressing and process control procedures support the CCPs that an establishment has in place to prevent, eliminate or reduce to an acceptable level the food safety hazards identified in the slaughter process and support that the HACCP system is functioning as intended. If sanitary dressing and process control procedures are not properly implemented, the HACCP system may be inadequate.

Key Points

- Effective sanitary dressing measures address multiple points in the slaughter process where carcasses are vulnerable to contamination.
- All controls in slaughter and dressing procedures should be aimed at preventing contamination.
- If sanitary dressing and process control procedures are not properly implemented, the HACCP system may be inadequate.

Insanitary practices can introduce a level of contamination that overwhelms the decontamination and antimicrobial intervention treatments used to reduce pathogens to acceptable levels. FSIS recommends that slaughter establishments should consistently focus on sanitary dressing and process control procedures to prevent carcass contamination and the creation of insanitary conditions in their operations.

Fundamental sanitary dressing practices to prevent carcass contamination and the creation of insanitary conditions.

1. Maintain adequate separation of carcasses, parts and viscera during dressing to prevent cross contamination.
2. Routinely clean and sanitize or sterilize equipment and hand tools that are used to remove contamination or to make cuts into the carcass. Cleaning and sanitizing equipment between each dirty cut and between each carcass are the most effective way to prevent insanitary conditions.
3. Design and arrange equipment to prevent the contact of successive carcasses and parts with contaminated equipment and do not allow the hide during its removal to flap or splatter which could cause contamination of the same or nearby carcasses.
4. Frequently wash hands, gloves, and aprons that come in contact with the carcass and parts.

5. Implement decontamination and antimicrobial intervention treatments such as washes or sprays on carcasses and parts, in accordance with the limits selected by the establishment and documented to be adequate to address contamination.

What verification activities related to sanitary dressing should establishments develop?

Establishments should observe employees to verify that they are performing the sanitary dressing procedures as written. Establishments should verify that the procedures are effective by conducting carcass audits (periodic visual evaluation of the carcass throughout the dressing process, as shown in *Appendix 2*) and by sampling and testing BMT, other raw ground beef components (including head meat and cheek meat), and raw ground beef for microorganisms. Sampling for adulterant STEC (or virulence markers) in the products previously discussed is an important verification activity that demonstrates whether the establishment's HACCP system is effectively reducing STEC to below detectable levels and that hazard analysis decisions concerning STEC are supported on an ongoing basis. As explained in the *FSIS Compliance Guideline for Establishments Sampling Beef Trimmings for Shiga Toxin-producing Escherichia coli (STEC) Organisms or Virulence Markers*, establishment verification testing results for BMT are likely the best available objective information a slaughter establishment can use to determine the ongoing effectiveness of its slaughter/dressing operation.

FSIS recommends that establishments incorporate their sampling and testing of beef products, in addition to their generic *E.coli* testing (9 CFR 310.25), into their process control procedures for sanitary dressing because the results from such testing are a direct reflection of the effectiveness of the slaughter operation. The establishment's process control criteria should define when its process is in control (such as an occasional, sporadic positive result) and when the establishment has lost process control as indicated by many positives over time. If past sample results lead establishment management to believe the process is out of control, the establishment should carefully investigate to find all contributing causes. This type of investigation would be more involved than a follow-up investigation when an occasional positive result is found. Establishments should continually strive to eliminate STEC by tightening their process control criteria as they gain more control over their slaughter operations. FSIS has found that microbiological testing results can drive establishments to enhance their food safety systems when they use the test results to inform their processes and adjust their processes as needed in response to the test results.

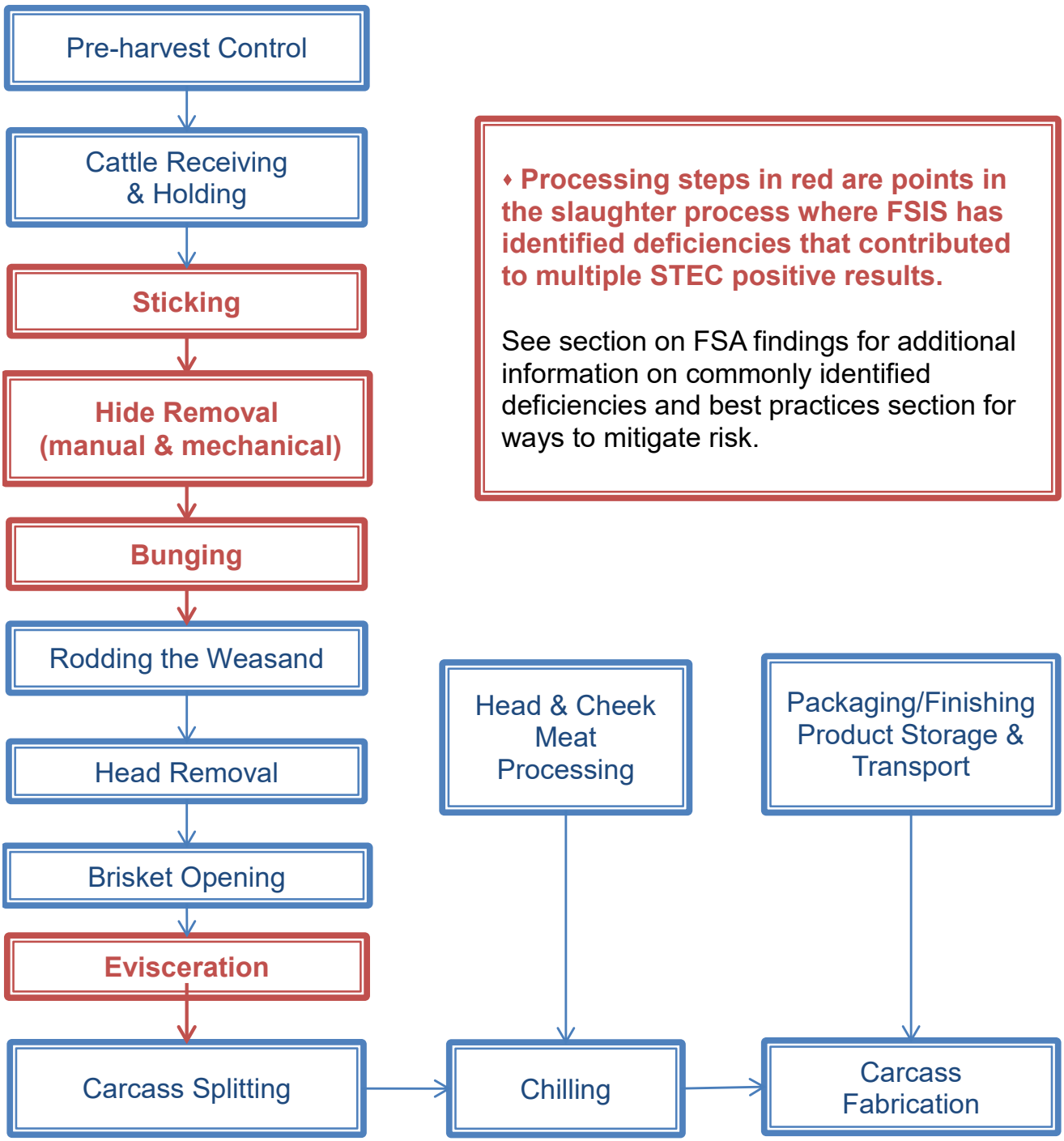
While performing the Beef Sanitary Dressing task, FSIS IPP verify whether cattle slaughter operations are implementing sanitary dressing and process control procedures and that the procedures they are implementing prevent contamination of carcasses and ensure that insanitary conditions are not created. (See *FSIS Directive 6410.1*, *Verifying Sanitary Dressing and Process Control Procedures by Off-line Inspection Personnel (IPP) in Slaughter Operations of Cattle of Any Age*).

FSIS IPP also verify, through microbial sampling, HACCP verification tasks and Hazard Analysis

Verification (HAV) tasks for whether beef slaughter establishments adequately address STEC. (See *FSIS Directive 10,010.1, Sampling Verification Activities for Shiga Toxin-Producing Escherichia coli (STEC) in Raw Beef products*, and *FSIS Directive 10,010.2, Verification Activities for Shiga Toxin-Producing Escherichia coli (STEC) in Raw Beef Products.*)

Enforcement, Investigations, and Analysis Officers (EIAOs) assess and analyze an establishment's food safety system to verify that the establishment is able to produce safe and wholesome meat products. (See *FSIS Directive 5100.4 Enforcement, Investigations and Analysis Officer (EIAO) Public Health Risk Evaluation (PHRE) Methodology* and *FSIS Directive 5100.1, Enforcement, Investigations and Analysis Officer (EIAO) Food Safety Assessment Methodology*.)

Best Practices for Each Beef Slaughter Processing Step



What are pre-harvest considerations and best practices?

FSIS encourages pre-harvest interventions as the first control steps in an integrated beef products food safety system, and the Agency has developed a guidance document, *Pre -Harvest Management Controls and Intervention Options for Reducing Shiga Toxin-Producing Escherichia coli Shedding in Cattle: An Overview of Current Research*, explaining pre-harvest management controls for reducing STEC shedding in cattle. Pre-harvest interventions, adequate sanitary dressing procedures at slaughter, and adequate sanitary conditions during further processing are all part of an integrated approach to reduce the public health impact of STEC.

Below are additional recommendations not covered in this pre-harvest guidance document.

What are mud scores and how can establishments use them to improve their food safety system?

Mud scores are classifications concerning the overall cleanliness of cattle lots at receiving. For example, establishments can classify cattle into four groups:

1) Cattle that are less than 25% covered by dirt or mud;
2) Cattle that are greater than 25% and less than 50% covered by dirt or mud;
3) Cattle that are greater than 50% and less than 75% covered by dirt or mud; and
4) Cattle that are greater than 75% covered by mud.

After classifying cattle at receiving into one of these four groups, establishments can develop specific measures they will take based on the classification of the cattle for the lot or lots. For example, if the cattle are in the third and fourth classification groups, the establishment may decide to slow the line speed to give its employees more time to effectively dress the cattle that have higher gross contamination. The establishment may also add more trimmers or interventions, such as a hide-on carcass wash. It is important for the establishment to use the information it gathers at cattle receiving and develop measures to react to the information that is collected. Other factors should be considered when using mud scores to modify production processes. For instance, during certain times of the year, cattle may have higher mud scores than at other times of the year (e.g., winter months versus summer months) when seasonal animal handling practices may influence the mud score. Therefore, different scoring criteria and trend analysis that varies by season may be needed to identify outliers.

What are best practices during cattle transport, receiving, and holding?

This is the point where cattle arrive at the slaughter establishment and are held before slaughter. There is an increased potential for contamination with enteric pathogens such as adulterant STEC and *Salmonella* during this time because of the presence of these microorganisms on the hide and hooves, and in the feces of cattle. Additionally, transportation to the slaughter facility, handling during transport and unloading, and interaction with other cattle may cause stress and increased shedding of pathogens.

Best Practices during Cattle Transport, Receiving and Holding

- Identify and obtain cattle from farms or feedlots that employ one or more production system or feedlot controls shown to reduce the carriage of STEC and *Salmonella*. Effective farm and feedlot management and control can reduce fecal shedding of the organism, as well as reduce the microbial load on the animals, and in the intestinal tract. More information can be found in *Pre-Harvest Management Controls and Intervention Options for Reducing Shiga Toxin-Producing Escherichia coli Shedding in Cattle: An Overview of Current Research.*

- Clean the unloading areas and pens periodically to reduce the contamination of animals.

- Washing cattle may be considered to reduce visible contamination which in turn may reduce pathogen transfer to the carcass. If an establishment decides to wash livestock pre-slaughter, they should ensure the washing is done in a humane manner.

- Apply a water mist in the holding pens to reduce dust and dirt particles.

- Use a mud scoring system (a system to quantify the amount of mud on live animals) to identify cattle that may present an increased likelihood of contamination during hide removal.

- Apply an approved bacteriophage treatment to incoming cattle and allow the bacteriophage appropriate contact time (a list of approved bacteriophages can be found in *FSIS Directive 7120.1*).

- Determine the incoming bacterial load on animals through microbiological sampling and testing of incoming cattle hides.

- Determine whether the age, type of cattle received (e.g. veal calves), or season (i.e., high prevalence season) represent a concern relative to pathogen load and whether adjustments to the food safety system need to be made as a result.

What are the best practices during sticking?

This is the point in the process where the animal is bled. Regardless of the slaughter method, it is important for the establishment to minimize contamination of the carcass during any cut conducted at this step.

Best Practices during Sticking

- Keep the "dry landing" area where the stunned animals exit from the knocking box clean and dry of all blood, feces, ingesta, and mud between each animal.
- Use one knife to cut through the hide, and another knife (or the same knife sanitized) to cut the artery.
- Use a dual knife system (i.e., one knife is being used while one knife is being sanitized) and clean the hand between sticking each carcass.
- Use the smallest cut possible to accomplish bleeding.
- Ensure blood collection devices and blood containers for edible blood are clean. Rinse and clean the collection funnel and knife after each carcass and sanitize after each identifiable lot of blood is drawn. Do not save blood from condemned animals.

What are best practices during hide removal?

This is the point in the process where the hide is removed from the animal. Hides are a significant source of contamination, and hide removal represents the greatest opportunity for carcass contamination. Contamination may be visible (e.g., dust, dirt, feces, mud) or invisible (i.e., microbiological). Establishments should take appropriate measures to prevent contamination during the de-hiding process.

The fact that hides are a significant source of contamination, and that hide removal represents the greatest opportunity for carcass contamination, is clearly illustrated in the study described in Nou et. al. 2004. This study sampled two groups of cattle at lairage and after de-hiding. One group of cattle underwent a typical de-hiding procedure. Sampling of these carcasses immediately after de-hiding showed that 50% were positive for *E. coli* O157:H7. The other group of cattle was subjected to a chemical dehairing process prior to hide removal. Carcasses in this group showed only a 1% positive rate for *E. coli* O157:H7 and a significantly lower level of other indicator organisms as compared to the other group of cattle. This study demonstrates that transfer of contamination from the hide is a major contributor to the microbiological load onto carcasses.

Best Practices during Hide Removal

- Apply a validated hide-on intervention prior to hide removal. If cattle hides are wet after the antimicrobial treatment, remove excess moisture because run-off can contaminate exposed tissue during hide opening. Sanitized squeegees can be used to remove excess moisture from the hides to reduce the chance of contamination.
- Mud balls on hides can also be a source of contamination. Establishments can use whizzard knives with dull blades or curry combs to remove the mud balls and other dirt from the hide prior to hide opening.
- When using a bed or cradle for hide removal, remove the front and hind feet before making any other incisions through the hide. Minimize the amount of foreshank tissue exposed.
- Ensure the skinning bed (for bed operations) is clean before lowering the carcass.
- Prevent the neck and shoulders from contacting the floor when lowering the carcass into the skinning bed. If this is not possible, install a surface on the floor that can be sanitized where the neck and shoulders contact.
- Prevent fecal matter that is expressed as the carcass is laid on the bed from contacting the exposed carcass.
- Direct the knife toward the hair side of the skin when opening the hide to prevent contaminating the carcass.
- Remove visible contamination at the cut line.
- Steam vacuum or apply another validated antimicrobial treatment to pattern lines (cut lines where the hide is opened) even if visible contamination is not present.
- Remove visible fecal contamination as soon as possible after it occurs to prevent microbial attachment.
- Use a dual knife system or, if not possible, dip the knife in the sterilizer after each incision through the hide.
- Space carcasses a sufficient distance apart to prevent contamination of skinned parts with adjacent carcasses.
- Design facilities to provide sufficient spacing between carcasses and walls, platforms and other fixed objects.

Best Practices during Hide Removal (Continued)

- Remove lactating udders in a manner to prevent carcass contamination with udder contact.
- Trim any contamination from udder content immediately.
- Reflect the hide away and preferably downward from the carcass as skinning proceeds. Skin each area back far enough to permit the hide to stay in a rolled-back position before the skinner proceeds to another skinning location.
- Prevent hides from flapping and contacting exposed carcass. Using hide clips is one way to prevent hide flaps from contact with the exposed carcass. Clean and sanitize hide clips as necessary to prevent the creation of insanitary conditions.
- Prevent contamination to the tail or carcass while skinning the tail. Frequently clean hands and equipment at this step because the tail and switch are highly contaminated with urine and manure. This is particularly important when the same employee performs other tasks involving carcass contact.
- Clean and sterilize the clamp used to suspend the tail from the overhead spreader between each use or remove and discard the tip of the tail ahead of the clamped portion.
- Remove tail switches and bag the tails before using the tail puller.
- Inject air under the skin of skulls to facilitate hide removal from the head while using the hide puller.
- Ensure that mechanical hide pullers, side pullers, and tail pullers are properly adjusted. If they are not appropriately adjusted (e.g., pulling too fast, hard, or contacting exposed carcass), they can lead to carcass contamination and splatter.
- Monitor pullers on an on-going basis for proper adjustment.
- When using mechanical hide pullers, the tremendous energy exerted during the final removal of the hide can generate aerosols. During this process best practices in preventing cross contamination are to:
    - Establish a maintenance program for the mechanical pullers;
    - Monitor pullers on an on-going basis for proper adjustment;
    - Install shields or devote an employee to hold up a shield; and
    - Direct air flow away from the carcasses being skinned to prevent contamination of carcasses with the aerosols created at this step.

Best Practices during Hide Removal (Continued)

- A simple way to evaluate if the hide, side or tail puller is causing contamination is for an establishment employee to hold up a white piece of cardboard between the hide puller and the carcass during de-hiding and adjacent carcasses (to the side of and behind, if the line wraps around). If the piece of cardboard becomes dirty, the unit is likely causing cross-contamination and needs to be adjusted (i.e., the wheel spin needs to be slowed down) or the establishment should use shields.
- Apply a physical barrier (e.g., paper towels or plastic) to the carcass tissue adjacent to the hide to protect exposed carcass surface in the event the hide turns over when using the hide puller. In this case, if the hide turns over, the hide will touch the barrier rather than the exposed carcass tissue.
- Maintain clean mechanical hide puller contact points with the hide, hands, and garments of the employees handling the hide and the carcass, and knives and other equipment contacting the de-hided carcass.
- Apply antimicrobial treatments (e.g., organic acids) immediately after using the mechanical pullers.
- Place a hide chute where hides are removed from carcasses. Do not spread hides on the slaughter floor.
- Ensure employees maintain proper hygiene practices to prevent carcass contamination and the creation of insanitary conditions. Do not touch the carcass with soiled hands, tools, or garments.

What are best practices during bunging?

This is the point in the slaughter process where a cut is made around the rectum (i.e., terminal portion of the large intestine) to free it from the carcass, and then it is tied off and bagged to prevent spillage of fecal material. If the bung is not tied and bagged properly, the bung can contaminate the carcass.

When bunging is performed before the hide of the rump is removed, the outside of the bag can become contaminated from the hide. Then, when the GI is removed during evisceration and the bagged bung is pulled through the pelvic inlet, the contamination on the outside of the bag can cause carcass contamination and the creation of insanitary conditions.

Best Practices during Bunging

- Drop the bung during the final part of rumping or at a time that minimizes cross contamination to the carcass.
- Bag and tie off bungs to prevent carcass contamination.
- Maintain proper employee hygiene practices to prevent carcass contamination and the creation of insanitary conditions. Do not touch the carcass with soiled hands, tools, or garments.
- Apply a validated decontamination process to the local area (e.g., steam vacuum) or antimicrobial treatment to the entire carcass at this point or a point later in the process, that is effective in reducing the presence or counts of microbial contaminants.

What are best practices during weasand rodding?

This is the point in the process where the establishment uses a metal rod to free the esophagus (weasand) from the trachea and surrounding tissues. Weasand meat may be salvaged from the remainder of the GI tract for use in raw ground beef production. Typically, the weasand is closed (i.e., tied) to prevent rumen spillage. If the weasand is not closed, ingesta and ruminal content can result in carcass contamination. It is important, at this point in the process, that contamination is not transferred from the exterior of the carcass to the interior or onto the weasand. Also, if during the rodding process the GI tract is punctured, ingesta content can contaminate the carcass interior and exterior. Alternatively, establishments could send weasand meat for cooking or other full-lethality treatment (e.g., high pressure processing or irradiation).

Best Practices during Weasand Rodding

- Close the esophagus to prevent leakage of rumen contents.
- Change or sanitize the weasand rod between each carcass.
- Ensure that employees maintain proper hygiene practices to prevent carcass contamination and the creation of insanitary conditions. Do not touch the carcass with soiled hands, tools, or garments.
- Clean and chill the weasand quickly to limit contamination and pathogen multiplication.

What are best practices during head removal?

This is the point in the slaughter process where the head is removed from the carcass. It is important to maintain sanitary conditions because cross contamination can occur if the head comes into contact with insanitary heads, equipment, or employee hands or garments.

Best Practices during Head Removal

- Maintain adequate separation between skinned heads, carcasses, the floor, and fixed objects.
- While skinning the head, the head skinner should sterilize the knife as frequently as necessary to prevent cuts from cross-contaminating the head.
- Remove heads as soon as possible after skinning to further reduce contamination exposure.
- Sanitize the neck breaker or knives as necessary.
- Prevent contamination with rumen contents during head removal. This can usually be accomplished by tying the esophagus and then pulling the head sharply to the side as the gullet is cut. Removal of rumen content contamination is difficult because of its finely textured character, which makes prevention even more important.
- Remove the horns, all pieces of hide and eardrums from each head in a manner to minimize contamination.
- Clean the equipment used to hold heads for trimming and/or dehorning between each head. Disinfect the equipment after use on each suspect, retained or other obviously diseased head.
- Prevent cross-contamination of other heads or adjacent carcasses and limit airborne contaminants.
- Thoroughly flush the oral and both nasal cavities before washing the outer surfaces of each head.
- Head hooks in washing cabinets should be removable to allow for cleaning and sterilizing or sanitizing. Clean hooks between each use and sterilize hooks after handling suspect, retained, or obviously diseased heads. If the head hooks are not removable, the equipment should be designed for in-place sterilization and equipped with an integral thermometer or other temperature-measuring device.
- Have procedures in place to make sure heavily contaminated heads do not cross contaminate other heads in head wash cabinets (e.g., shut off the cabinet before heavily contaminated heads enter the cabinet and recondition or discard affected product after inspection.)
- Clean and sterilize head inspection racks after each use involving a retained head. Since this is impractical to accomplish with hooks installed on a continuous chain, provide all such installations with a suitable wash cabinet or other device that will clean and sterilize each hook prior to its subsequent use.

Best Practices during Head Removal (Continued)

- The minimum temperature for hot water sterilization is 180°F. Use an integral thermometer or other temperature-measuring device for continuous monitoring to ensure a minimum temperature of 180°F is met for hot water sterilization. Maintain proper employee hygiene practices to prevent carcass contamination and the creation of insanitary conditions. Do not touch the head with soiled hands, tools, or garments.
- Address specified risk materials in accordance with 9 CFR 310.22.
- At this point apply to the head a validated decontamination process (e.g., hot water wash) or antimicrobial treatment that is effective in reducing the presence or counts of microbial contaminants.

What are best practices during brisket opening?

This is the point in the process where the brisket is split (i.e., cut along the centerline) to facilitate the easy removal of the thoracic viscera. The thoracic cavity is entered blindly and there is no way of knowing if abscesses or other pathological conditions are present. Therefore, the saw, or other instrument used to split the brisket, should be disinfected after each use, making sure to remove remnant tissue from the saw.

Best Practices during Brisket Opening

- Clean and sanitize the brisket saw and knife between each carcass and ensure the GI tract is not punctured.
- Ensure that employees maintain proper employee hygiene practices to prevent carcass contamination and the creation of insanitary conditions. Do not touch the carcass with soiled hands, tools or garments.
- Apply a validated decontamination process to the local area (e.g., steam vacuum) or antimicrobial treatment to the carcass at this point or a point later in the process that is effective in reducing the presence or counts of microbial contaminants.

What are best practices during evisceration?

This is the point in the process where the removal of the viscera (e.g., the edible offal that includes the heart, intestines, paunch, liver, spleen and kidneys when presented with viscera) occurs. The actual removal of the viscera from the carcass is a critical phase of the dressing operation. Care should be taken to avoid cutting or breaking the paunch and intestines because the GI tract can contain pathogens. If the viscera are not handled properly, or if employee hygiene practices are not being followed, contamination of the carcass and edible offal can occur.

Best Practices during Evisceration

- The boot cleaning compartment should be conveniently located and constructed so as to prevent splash of contaminants onto carcasses or viscera. Thoroughly clean and disinfect contaminated footwear, apron, or knife.
- Thoroughly clean and disinfect the viscera inspection truck, especially if it becomes soiled with visceral contents (e.g., feces, ingesta) or contaminated with purulent material or viscera from a condemned carcass. To prevent fat buildup on the metal pluck pan or paunch and viscera portion of the inspection truck, periodically clean with hot water. Prevent cross contaminating product or equipment when rinsing a viscera inspection truck.
- Ensure that employees maintain proper hygiene practices to prevent carcass contamination and the creation of insanitary conditions. Do not touch the carcass with soiled hands, tools, or garments.
- Address specified risk materials in accordance with 9 CFR 310.22.
- Apply a validated post-evisceration decontamination or antimicrobial treatment to the entire carcass and edible offal.

What are the best practices during head and cheek processing?

This is the point in the process where the meat is removed from the head and cheek. This meat can be used in the production of raw beef products, including ground beef. It is important for the establishment to maintain sanitary conditions when removing meat from the head and cheeks.

Best Practices during Head and Cheek Processing

- Properly maintain and clean knives.
- Provide adequate separation or use compartments or shields to prevent cross contamination of heads.
- Ensure that employees maintain proper hygiene practices to prevent head contamination and the creation of insanitary conditions. Do not touch heads with soiled hands, tools or garments.
- Address specified risk materials in accordance with 9 CFR 310.22.
- Quickly chill head and cheek meat to limit pathogen multiplication.
- Apply any validated decontamination process or antimicrobial intervention treatments to the head and cheek meat that are effective in reducing the presence or counts of microbial contaminants after lymph node incision. Alternatively, send head and cheek meat for cooking or other full-lethality treatment (e.g., high pressure processing or irradiation).
- Conduct microbiological testing (e.g., STEC) for process control to assess the effectiveness of the establishment's sanitary dressing procedures and any antimicrobial intervention treatments that are applied to the head and cheek meat as these products may undergo different interventions than the carcass.

What are best practices during carcass splitting?

This is the point in the process where carcasses are split vertically into two halves. Prior to splitting, the establishment should remove all contamination, bruises, grubs, and tissue damaged by grubs from the midline area of the back. This is necessary to prevent spreading these contaminants to bone and other surfaces by the saw.

Best Practices during Carcass Splitting

- Remove organic material, bruises, grubs, and tissue damaged by grubs from the midline area of the back prior to splitting to reduce potential contamination to the split saw, surrounding tissues, and other surfaces.
- Sanitize saws and knives as necessary. Disinfect the splitting saw after each use on suspect, retained, or obviously diseased carcasses.
- Allow adequate separation between carcasses to limit carcass-to-carcass contact.
- Ensure that employees maintain proper hygiene practices to prevent carcass contamination and the creation of insanitary conditions. Do not touch the carcass with soiled hands, tools, or garments.
- Address specified risk materials in accordance with 9 CFR 310.22.
- When splitting is done at the half-hoist position, take measures to prevent the neck and foreshanks from contacting the floor. If necessary, install a surface that can be sanitized so the neck and foreshanks do not contact the floor.
- Apply any validated decontamination or antimicrobial intervention treatments to the carcass at this point or a point later in the process that are effective in reducing the presence or counts of microbial contaminants.

KEY QUESTION
Carcass Wash Cabinets

Question: How do establishments use carcass wash cabinets appropriately?

Answer: Develop and implement measures, such as those listed directly below, to prevent spreading contamination to adjacent carcasses.

- Remove all visible contamination before carcasses enter the cabinet.
- Prevent overspray of water from the cabinet onto adjacent carcasses.
- Prevent carcasses with conditions such as open abscesses, septic bruises, or the presence of parasites and parasitic lesions from entering the cabinet.
- Wash from the top of the carcass in a downward direction so that contaminants gravitate away from the clean areas.
- Have procedures in place to make sure heavily contaminated carcasses do not cross contaminate other carcasses (e.g., shut off the cabinet before heavily contaminated carcasses enter the cabinet and recondition or discard affected product after inspection).

- Conduct on-going verification to ensure that any re-circulated hot water used in the cabinet meets 9 CFR 416.2 (g)(3). This regulation states that, "Water, ice, and solutions used to chill or wash raw product may be reused for the same purpose provided that measures are taken to reduce physical, chemical, and microbiological contamination to prevent contamination or adulteration of product. Reuse that has come into contact with raw product may not be used on ready-to-eat product."
- Have procedures in place to prevent carcasses identified with U.S. Suspect or Retained tags from entering the cabinets or have procedures in place to prevent cross-contamination of adjacent carcasses (e.g., shut off the cabinet before U.S. Suspect or Retained carcasses enter the cabinet and recondition or discard affected product).
  NOTE: Establishments can wash U.S. Suspects in these cabinets only with permission of the USDA Public Health Veterinarian (PHV) and in consideration of whether the design of the cabinet prevents cross-contamination of other carcasses.
- Address potential hazards associated with water reuse in non-food processing areas to prevent the creation of insanitary conditions.

What are the best practices during chilling?

This is the point in the process where the temperature of the carcass and parts is reduced. Temperature control and sanitation measures ensure the microbial load reductions affected by the interventions are maintained. Temperature control limits pathogen multiplication and sanitary measures prevent re-contamination.

Best Practices during Chilling

Note: The times and temperatures listed on this page are based upon past industry practices and are not regulatory requirements. Establishments may select other times or temperatures if they maintain scientific support for the selection of those parameters.

- Begin carcass chilling within approximately one hour after bleed-out to limit pathogen multiplication.
- Begin chilling variety meats as quickly as possible after removal from the carcass to limit pathogen multiplication.
- Implement temperature control and sanitation procedures to maintain the microbial reductions achieved by the antimicrobial intervention treatments.
- Define and monitor refrigeration parameters so that carcasses reach a temperature of 40°F (4.4°C) or less within 24 hours and so that this temperature is maintained for all products. Take and record carcass temperature from 5 randomly selected carcasses in various cooler locations, usually 1 mm under fascia on the inside round (see Appendix 4, Chilling of Carcasses).
- Maintain finished product storage areas at 40 °F or lower or have other supporting documentation for the temperature limit chosen.
- Provide adequate distance between carcasses, walls and equipment to prevent cross contamination and allow for efficient air circulation to prevent or minimize condensation.
- Ventilate coolers with negative-pressure systems to prevent cross contamination from airflow from slaughter operations.
- If carcasses are held longer than 7 days in the cooler before fabrication, maintain scientific support for cooler parameters which may include temperature, humidity, and air flow.
- Transport carcasses for hot boning (deboned before chilling) to the boning areas directly from the slaughter department. Do not delay boning. Maintain the boning room environmental temperature at 50 °F (10 °C) or lower.
- At this point apply any validated decontamination or antimicrobial intervention treatments to the carcasses and variety meats to reduce microbiological contamination.
- Ensure that employees maintain proper hygiene practices to prevent the creation of insanitary conditions (e.g., touching the carcass with soiled hands, tools, or garments).
- Prevent cross-contamination from airflow during slaughter operations.
- Establish traffic patterns to eliminate movement of personnel, pallets, and refuse containers between slaughter and further processing. If employees must work in both areas, have procedures in place that require the employees to change outer and other soiled clothing, wash and sanitize hands, and clean and sanitize footwear before moving from slaughter to further processing areas.

What are best practices during carcass fabrication?

This is the point in the process where the carcass is broken down into primal and subprimal cuts and trimmings. Temperature control limits pathogen multiplication and sanitary measures prevent re-contamination.

Best Practices during Carcass Fabrication

- Implement temperature control and sanitation procedures to maintain the microbial reductions achieved by the antimicrobial intervention treatments.
- Maintain processing room temperature at 50°F (10°C) or lower.
- Provide for efficient air circulation to prevent or minimize condensation.
- Ventilate coolers with negative-pressure systems to prevent cross contamination from airflow from slaughter operations.
- Ensure that employees maintain proper hygiene practices to prevent the creation of insanitary conditions. Do not touch the carcass with soiled hands, tools or garments.
- Clean and sanitize knives, saws, slicers, and other food contact surfaces as frequently as necessary to prevent the creation of insanitary conditions.
- Establish traffic patterns to eliminate movement of personnel, pallets, and refuse containers between slaughter and further processing. If they must work in both areas, have procedures in place so employees change outer and other soiled clothing, wash and sanitize hands, and clean and sanitize footwear before moving from slaughter to further processing areas.
- At this point in the process, employ any validated decontamination or antimicrobial intervention treatments that are effective in reducing the presence or counts of microbial contaminants on the carcasses.
- Conduct microbiological testing (e.g., STEC) of BMT as per the establishment's HACCP Plan, Sanitation SOPs, Good Manufacturing Practices (GMPs), or other prerequisite programs, to verify pathogens have been eliminated.

What are best practices during packaging, product storage, and product transport?

These are the points in the process where products are packaged, stored, and transported for further distribution. Temperature control limits pathogen multiplication while sanitary measures prevent product re-contamination.

Best Practices during Packaging, Product Storage and Product Transport

- Implement temperature control and sanitation procedures to maintain the microbiological reductions achieved by the antimicrobial intervention treatments applied during the slaughter process.
- Maintain storage room and transportation vehicles at 40°F (4.4°C) or lower.
- Maintain the average internal meat temperature during storage at 40°F (4.4°C) or lower.
- Monitor and record environment and product temperature during product storage and product transport.
- Provide for efficient air circulation to prevent or minimize condensation.
- Prevent contamination from airflow, traffic, people, and other environmental sources.
- Ensure employees maintain proper hygiene practices to prevent the creation of insanitary conditions. Do not touch the product with soiled hands, tools or garments.

Beef Slaughter Interventions

How do antimicrobial intervention treatments fit into the HACCP regulatory framework?

Establishments implement antimicrobial interventions as needed to reduce STEC and *Salmonella*. The HACCP regulations require establishments to provide scientific support for their interventions and to implement their interventions according to that support.

9 CFR 417.2(a) requires that an establishment identify any food safety hazards that might occur in the production process, assess which hazards are reasonably likely to occur, and develop measures to prevent, eliminate, or reduce to an acceptable level those hazards. The establishment must maintain documents to support the decisions it makes during its hazard analysis (9 CFR 417.5(a)(1)).

Establishments may incorporate the use of interventions in their HACCP plan, sanitation SOPs, or other prerequisite program. Establishments may incorporate the use of interventions in their HACCP plan and apply the intervention as a CCP to control hazards that are reasonably likely to occur (9 CFR 417.2(c)(3)). Alternatively, an establishment may determine that a hazard is not reasonably likely to occur because the establishment maintains preventive measures as part of a prerequisite program that prevents the hazard from occurring. In either case, the establishment should identify the critical operating parameters for any antimicrobial interventions used in its

supporting documentation. HACCP plans ***control*** hazards; prerequisite programs (including sanitation SOPs) ***prevent*** hazards from entering the establishment's food safety system.

What are critical operating parameters and how do they fit into the establishment's HACCP system?

As described in the *FSIS Compliance Guideline HACCP Systems Validation*, critical operating parameters are the specific conditions (e.g., time, concentration, temperature, full product, or carcass coverage) that the intervention must operate under for it to be effective. The establishment should incorporate the critical operating parameters into its critical limits if the establishment applies the intervention as part of a CCP. Alternatively, the establishment should incorporate the critical operating parameters into appropriate procedures if it implements the intervention as part of a sanitation SOP or other prerequisite program. To be effective, the process procedures should be consistent with the critical operational parameters in the scientific support. If the establishment's specific parameters do not closely match the scientific documentation, the establishment should consider developing a decision-making document that explains the scientific rationale for why the different level would not affect the efficacy of the intervention or process.

Why is it important for establishments to incorporate antimicrobial interventions into their HACCP systems?

Despite good slaughter and dressing practices, contamination of carcasses can occur. Thus, the use of effective antimicrobial intervention strategies is an important component of an integrated food safety system. FSIS recommends that establishments implement antimicrobial interventions throughout the slaughter and fabrication processes, specifically just after points in the process where carcasses are most vulnerable to contamination (e.g., during hide removal and post-evisceration), as part of a multi-hurdle approach. Further, FSIS recommends that establishments identify the typical microbial loads introduced into their slaughter process and develop a multi-hurdle approach that is designed to reduce microbial hazards to acceptable levels. FSIS also recommends that establishments account for the higher prevalence season for STEC (April - October) and make necessary adjustments to their food safety system to address STEC.

Can dry aging be used as an intervention to reduce STEC in a HACCP system?

Yes. Dry aging can be used as an intervention to reduce pathogens, including STEC. It is the process of reducing the bacterial load on the carcass through surface desiccation. This process

is not to be confused with the product quality process of dry aging, which is used to improve tenderness and/or flavor. To desiccate the surface of the carcass to reduce pathogens, the carcasses are maintained in a cooler for a time, usually days or weeks, under specific environmental conditions that may vary, depending upon the support used by the establishment. Proper temperature, air flow, and relative humidity are needed to desiccate the surface of the carcass and minimize mold growth. Using the scientific support provided in Tittor et al., an establishment can develop an aging program as an intervention to reduce STEC to non-detectable levels. In this study, beef lean and beef fat were inoculated with multiple strains of *E. coli* O157:H7. The dry aged samples were suspended in a cooler that had the following parameters: 37.4ºF, 80% relative humidity and 0.0 to 0.25 m/s air velocity. A decrease in *E. coli* O157:H7 14 days to 28 days in lean tissue and from 7 days to 28 days in fat tissue was reported in the study. These specific parameters could be implemented, and an establishment could validate that they are able to consistently meet the critical operating parameters from the study.

NOTE: FSIS does not object to establishments using the Tittor et al. final report as support until a peer reviewed journal article is published.

Alternately, the establishment may implement other specific parameters for dry aging using other scientific supporting documentation or additional in-house validation data to support the alternative procedures, provided the same or better results as Tittor et al. are achieved. The *FSIS Compliance Guideline HACCP Systems Validation* describes how establishments can conduct in plant validation monitoring.

In addition to the critical operating parameters, establishments using dry aging to address pathogens may need to monitor for mold growth and develop procedures to reduce the growth of mold and remove mold from the carcass when growth occurs.

FSIS has reviewed the article by Algino, et al. (2007) and determined that this article does not provide sufficient scientific support alone for the use of dry aging beef carcasses as an effective intervention to reduce STEC to non-detectable levels.

> Algino R.J., Ingham S.C., and Zhu J. 2007. Survey of Antimicrobial Effects of Beef Carcass Intervention Treatments in Very Small State-Inspected Slaughter Plants. Journal of Food Science. Vol 72: 173-179

FSIS made this determination because the authors used indicator organisms, (e.g., generic *E.coli*) as a surrogate for *E.coli* O157:H7 or non-O157 STEC. FSIS is not aware of any supporting documentation that demonstrates a strong correlation to support the use of generic *E. coli* testing as a surrogate for *E.coli* O157:H7 or non-O157 STEC. If an establishment chooses to use this article as support for its dry aging intervention, additional data (e.g., microbiological data gathered in-plant) would be needed to support the dry aging intervention to reduce STEC to a non-detectable level.

How do establishments identify critical operating parameters?

As explained in the *FSIS Compliance Guideline HACCP Systems Validation*, establishments are required to identify and maintain supporting documentation that closely matches their interventions and should identify, implement and monitor the critical operating parameters from the scientific supporting documentation relevant to their interventions. Critical operating parameters are the specific conditions under which an intervention must be used for it to be effective. These critical operating parameters should be incorporated into the establishment's HACCP system (including prerequisite programs). As part of validation, establishments must also maintain documentation showing that they have effectively implemented these parameters in their operations. The critical operating parameter may or may not be incorporated into the establishment's HACCP plan as a critical limit for a CCP. If an establishment uses a scientific study as its supporting documentation, the critical operating parameters from the scientific study should match the intervention implemented by the establishment as closely as possible. In some circumstances, establishments may be able to support using critical operating parameters that are different from those in its supporting documentation (e.g., different concentrations of antimicrobial agents or temperature of the antimicrobial).

Key Points

Establishments are required to maintain supporting documentation that closely matches their interventions, identify the critical operating parameters that are necessary for the interventions to be effective, and maintain documentation showing that they have effectively implemented their interventions so that they meet these critical operating parameters.

In cases where critical operating parameters are different from the supporting documentation, establishments should provide justification to support that the critical operating parameters chosen are at least as effective as those in the supporting documentation. This justification is needed because deviating from the critical operating parameters in supporting documentation may not always provide an equally effective result. For example, antimicrobial agents may only be effective within a certain concentration range; above or below that the efficacy may decrease. In addition to ensuring that the concentration range of interventions chosen are at least equally effective, establishments should ensure the concentrations are also safe and suitable. *FSIS Directive 7120.1, Safe and Suitable Ingredients used in the Production of Meat, Poultry, and Egg Products* is updated monthly and includes a list of antimicrobial agents that are safe and suitable for certain products under certain conditions of use.

Establishments have flexibility in how they verify that they are implementing the critical operating parameters for applying antimicrobial interventions.

What are examples of critical operating parameters for applying antimicrobial or hot water interventions on carcasses and fabricated raw beef products?

Examples of critical operating parameters for applying antimicrobial or hot water interventions to carcasses and fabricated raw beef products include the following:

- Product coverage
- Contact time
- Temperature
- Equipment settings or calibration
- pH
- Dwell time
- Pressure
- Concentration

There are simple verification procedures an establishment can use to ensure its antimicrobial intervention achieves carcass/product coverage. For example, the establishment could apply the intervention using fluorescein dye instead of the antimicrobial to evaluate carcass/product coverage. Alternatively, the establishment could apply paper towels or an edible spray cream before the intervention and evaluate the carcass/product for full coverage after the intervention. FSIS developed the *FSIS Compliance Guideline HACCP Systems* Validation to assist establishments in complying with initial validation requirements that address validation of critical operating parameters for antimicrobial or hot water interventions.

What are examples of antimicrobial interventions?

Antimicrobial intervention strategies are designed to reduce microbial contamination on carcasses and parts and usually involve the application of organic acids, hot water, steam, removal by physical means, such as knife trimming, or a combination of these, in a sequence, referred to as a multi-hurdle approach. The integration of established intervention methods, such as knife trimming, in combination with other antimicrobial decontamination methods, such as steam vacuuming, steam pasteurization cabinets, acid or hot water spray washing systems, can help to improve the microbial safety of beef carcasses immediately post-slaughter. Dry aging can be used as an intervention as part of a multi-hurdle approach or as a stand-alone intervention. Establishments should apply these interventions according to their scientific support. The table below shows the antimicrobial interventions that can be used during the beef slaughter process.

Intervention Type	Intervention Description
Hide-on carcass washes	Hide-on carcass washes are an effective means to significantly reduce bacterial populations on the hide, a significant source of contamination in slaughter operations. Hide-on carcass washes commonly used include

	hypobromous acid; sodium hydroxide and a proprietary surfactant with a sodium hypochlorite rinse; and water washes with chlorine.
Steam vacuum systems	The hot water sprayed onto a carcass kills bacteria and detaches contamination, such as ingesta or feces, which is then vacuumed off. Many establishments utilize the steam vacuum system at multiple points in the slaughter process. For example, there may be a steam vacuum location after each part of the carcass de-hiding process.
Pre-evisceration wash and final carcass organic acid wash	The pre-evisceration wash consists of using a carcass spray immediately after hide removal and serves to remove bacteria before they have the opportunity to attach themselves to the carcass surface and begin growing. The final carcass organic acid rinse provides a significant kill step for any bacteria that remain on the carcass surface at the end of the slaughter process. This intervention is commonly applied after the slaughter process is complete and before the carcasses enter the cooler. The organic acids commonly used are acetic and lactic, although citric acid is also approved for this purpose. The concentration of the organic acid is normally between 1.5% and 2.5% and can be as high as 5% in the case of lactic acid. Hypobromous acid is another effective acid that is commonly used in the industry. Organic acids may be applied as a mist, fog, or a small droplet rinse. Studies have shown that washing followed by an organic acid rinse is significantly more effective in reducing bacterial numbers than washing alone.
Pre-evisceration and final carcass hot water washes	High temperature water sprayed on the carcass (hot water rinse) as a pre-evisceration wash and a post-evisceration wash prior to chilling have been shown to be effective in substantially reducing STEC and *Salmonella*.
Steam pasteurization	Steam pasteurization is a process in which the carcasses are placed in a slightly pressurized, closed chamber at room temperature and sprayed with steam that blankets and condenses over the entire carcass, raising the surface temperature (generally to 185º F) and killing up to 95-99% of all bacteria. Carcasses are then sprayed with cold water.
Dry aging	Dry adding intervention reduces pathogens on the surface of the carcass through desiccation under specific environmental conditions.

Why is it important for establishments to conduct verification testing?

FSIS requires that establishments perform ongoing verification activities to ensure that their food safety systems are functioning as intended (9 CFR 417.4(a)(2)) and to support decisions made in their hazard analyses, including their sampling locations (9 CFR 417.2 and 417.5(a)(1)). FSIS recommends that establishments incorporate statistical process control procedures into their testing programs to assess the effectiveness of their controls for preventing contamination during slaughter and dressing operations and to verify that they are reducing pathogen levels, including STEC to below detectable levels. Establishments are required to support the frequency of their verification activities (9 CFR 417.5(a)(2)). Establishments can use microbial test results to support decisions made in their HACCP systems and to verify that their food safety system is functioning as intended. Establishment sampling and testing programs can be supplemented with other types of verification activities associated with the production of other raw ground beef and patty components.

NOTE: Generic *E. coli* data required under 9 CFR 310.25 should not be used to verify whether the establishment's HACCP system is addressing STEC. Differences in laboratory method sensitivity demonstrate that STEC can still be recovered from a sample when below the limit of detection of direct plate generic *E. coli* methods. Further, detectable levels of generic *E. coli* do not mean STEC specifically is present. Therefore, testing for generic *E. coli* is not an effective verification procedure for assessing STEC controls.

Beef Slaughter Processing Deficiencies

What are common deficiencies that FSIS identified in beef slaughter establishments?

FSIS conducted a review of food safety assessments (FSAs) and onsite visits to beef slaughter establishments with a history of multiple positive STEC results from FSIS testing.

During the review, FSIS identified the following common deficiencies:

- Inadequate sanitary dressing;
- Ineffective implementation of antimicrobial intervention; and
- Failure to use microbial data appropriately in decision making.

Key Point

With any antimicrobial intervention, carcass/product coverage is important.

What are examples of sanitary dressing deficiencies FSIS observed repeatedly at beef slaughter establishments?

FSIS identified that some beef slaughter establishments repeatedly failed to do the following relative to sanitary dressing:

- Implement a comprehensive sanitary dressing program that includes: written procedures designed to prevent contamination from occurring throughout the process, adequate employee training concerning these written procedures, and a management commitment to the program.
- Verify that the sanitary dressing procedures are performed as written, effective, and consistently performed.
- Properly design facilities and equipment to: prevent carcasses from contacting each other

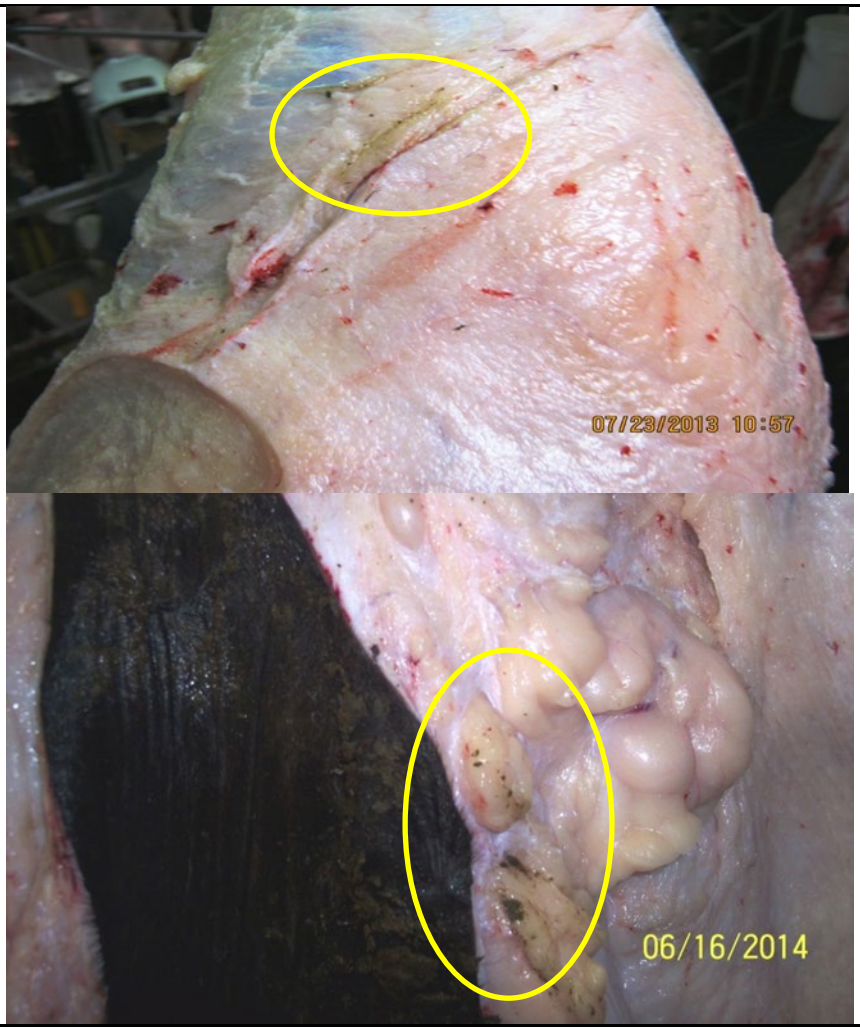
or non-food contact surfaces, prevent overspray of antimicrobial treatments or aerosolization of particulate matter, and allow adequate visualization of dressing procedures (e.g., through proper lighting or access).

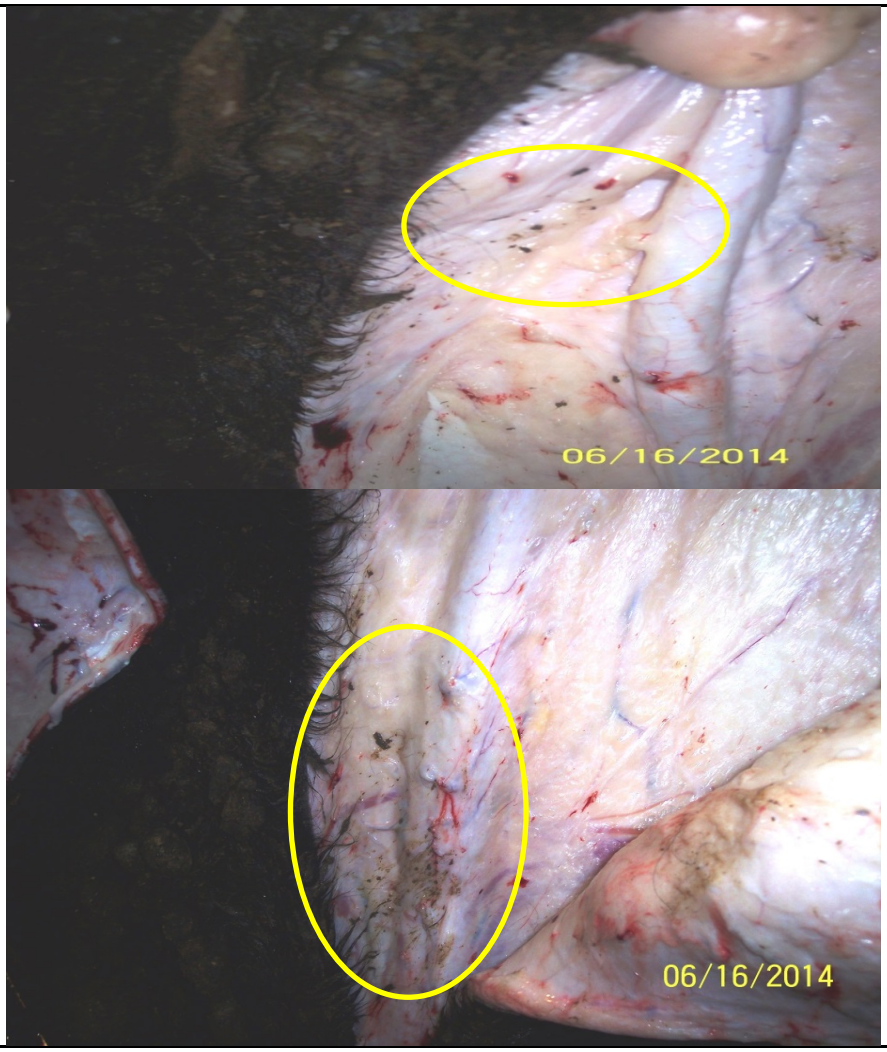
- Perform robust sampling and testing, according to their supporting documentation, to obtain reliable results to verify their slaughter operation is addressing hazards.
- Adequately respond to FSIS or establishment positive test results with effective and sustainable corrective actions that identify the cause, eliminate it and prevent recurrence.
- Apply antimicrobial interventions according to supporting documentation.

Examples of Sanitary Dressing Deficiencies

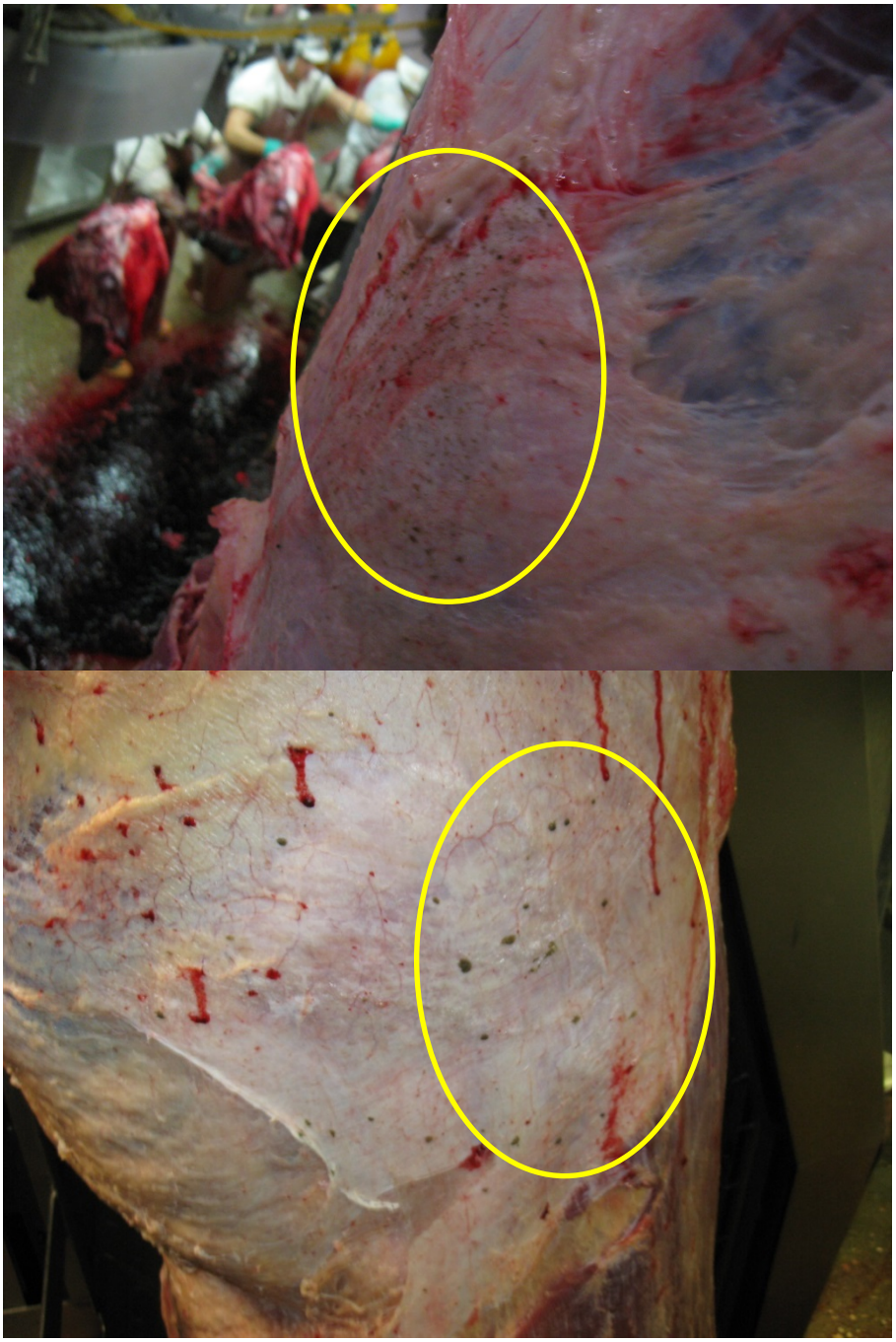
Cutting through the hide and into the carcass without sanitizing knives, gloves, and equipment, resulting in carcass contamination.

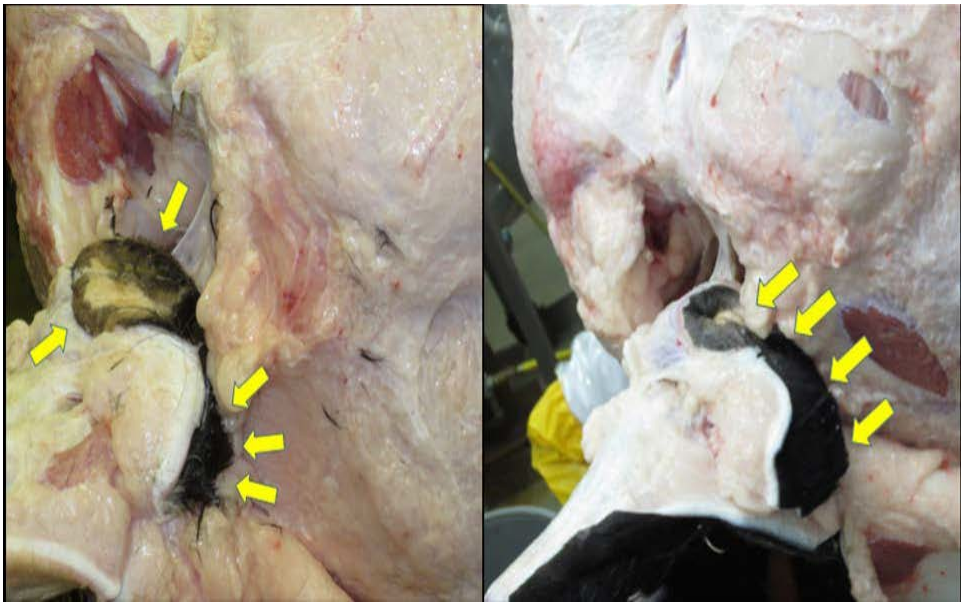
Note how grossly contaminated the hide is, further increasing the risk of contamination. Proper hide removal is a critical step in preventing carcass contamination and the creation of insanitary conditions.

Inadequately sanitizing knives, gloves, and equipment resulting in carcass contamination along pattern lines during hide removal (part 1 of 2).	

Inadequately sanitizing knives, gloves, and equipment resulting in carcass contamination along pattern lines during hide removal (part 2 of 2).	

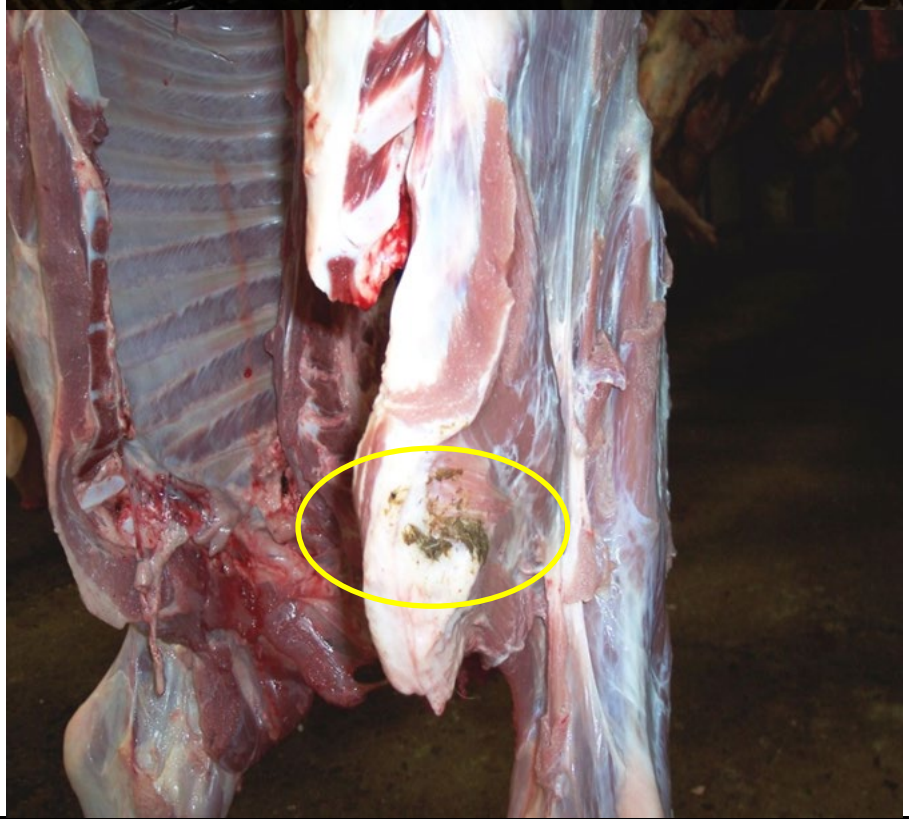
Contaminated carcass as a result of contact with non-food contact surfaces. (circled in yellow).	
Carcass contamination from the hide flaps during hide removal. This photo shows hide flaps that have curled under after hide removal and are contaminating the carcass.	

Splatter contamination resulting from improperly adjusted hide pullers. Improperly adjusted hide pullers can cause carcass contamination.	

Bagged bung contacting hide resulting in carcass contamination. This photo shows the bagged bung contacting the hide (yellow arrow) while the employee is tying the bagged bung. Bunging performed before the hide of the rump is removed results in contamination of the carcass. This occurs because the bagged bung will likely contact the hide and later contaminate the carcass as the gastrointestinal tract is removed during evisceration and the bagged bung is pulled through the pelvic inlet.	
Failing to bag and tie the bung. The contaminated bung is contacting the exposed carcass (yellow arrows). When establishments apply hot water or antimicrobial interventions to an exposed bung, they may further spread contamination.	

Contamination during evisceration.

Punctured paunch and intestines during evisceration causing carcass contamination with ingesta (second photo).



What are examples of antimicrobial intervention deficiencies FSIS has observed repeatedly at beef slaughter establishments?

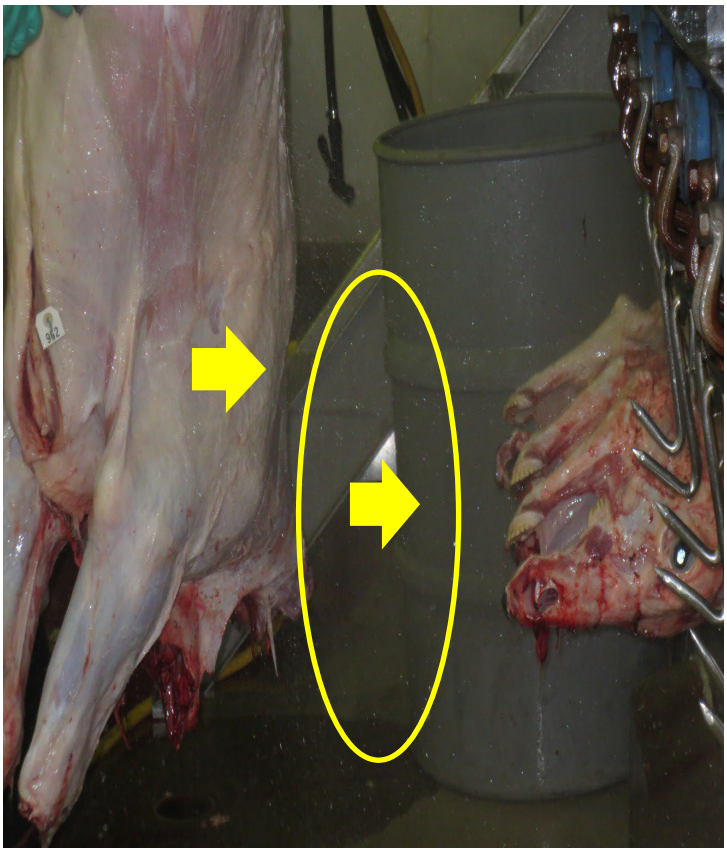
FSIS identified that some beef slaughter establishments repeatedly failed to do the following:

- Apply antimicrobial interventions according to their supporting documentation;
- Identify critical operational parameters in their supporting documentation;
- Incorporate the critical operational parameters into their HACCP system; and
- Implement the antimicrobial treatments so that critical operational parameters are met.

Examples of Antimicrobial Intervention Implementation Deficiencies

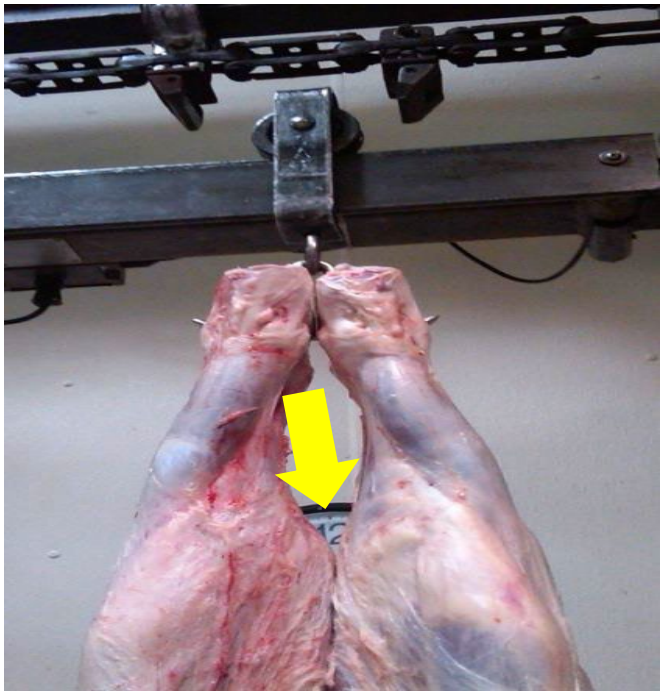
Cross-contamination during antimicrobial intervention treatment.

- Cross contamination of heads from carcass intervention overspray. (Water sprayed onto the carcass in the direction of the arrows, water spray seen within the yellow oval.)
- Cross contamination (not shown in image) when employees spray equipment, the floor, and other surfaces, establishments do not take appropriate precautions to prevent overspray from contacting carcasses.
- Carcasses with visible contamination entering a wash cabinet or when manual application of water or antimicrobial sprays occurs on visibly contaminated carcasses, this can result in cross contamination.



Failing to achieve full carcass coverage with intervention, thus reducing the intervention's effectiveness.

This photo shows the practice of suspending a carcass from a single hook, which prevents antimicrobial and hot water interventions from achieving full carcass/product coverage. Ensuring that the entire carcass surface is treated, is necessary for the intervention to operate effectively and as intended.



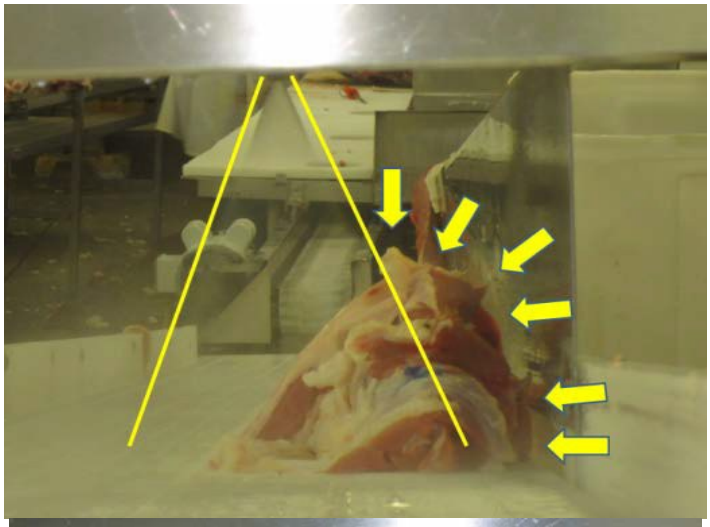
Failing to achieve full product coverage with intervention, thus reducing the intervention's effectiveness.

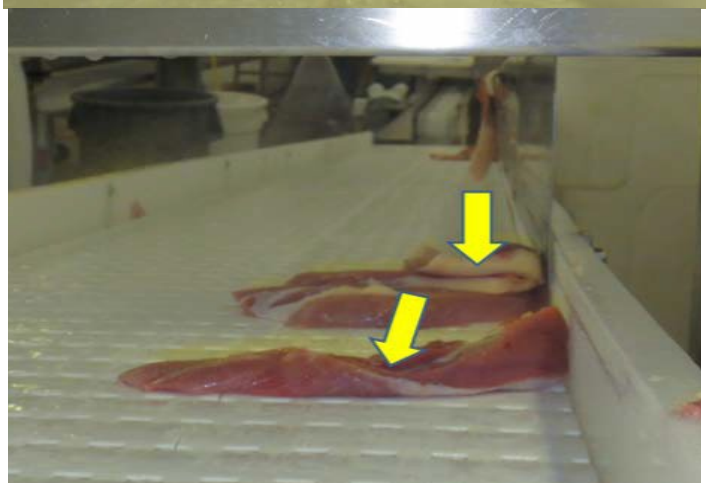
Product coverage is essential for the intervention to be effective.

The top photo shows that the arc of the spray nozzles (inside each yellow line) is not sufficient to reach product on the sides of the conveyor belt (yellow arrows).

Both pictures show that the spray intervention is being applied only to one side of the trim.

These pictures also show product that is folded on top of itself so that the intervention is not applied to all product surfaces (the top photo shows the trim is piled up and the bottom photo shows that each piece has a single fold).





What are examples of FSIS observations regarding establishments that fail to properly use microbial data in decision-making?

Some establishments that had multiple STEC positive samples from FSIS testing failed to properly assess the impact the test results had on their slaughter operations. Test results reflect the effectiveness of the establishment's slaughter operation, including the effectiveness of its sanitary dressing procedures and antimicrobial treatments. In response to the test results, establishments failed to take meaningful corrective actions designed to identify and eliminate the cause of the positive test results and prevent recurrence. The scope of the corrective actions was limited to ensuring that lots contaminated with STEC received appropriate disposition. Corrective actions were not aimed to improve the design and implementation of slaughter operations.

Additionally, some establishments did not conduct robust sampling, which could have provided them meaningful information concerning the effectiveness of their slaughter operations. In some situations, establishments had designed rigorous sampling programs but were not implementing them effectively. Specifically, establishments were not properly collecting N60 samples. Sample slices were smaller in size than the N60 method requires. Additionally, external surfaces were not targeted for N60 sampling and, in some cases, the tissues were thicker, which reduces the sensitivity of the method. Establishments that conduct proper robust sampling have ongoing information concerning the effectiveness of their slaughter operations and can respond to the microbial data to improve their operations. FSIS recognizes some establishments may utilize other sample collection methods (e.g. surface sampling or core shaving methods) that have received a No Objection from FSIS as being at least equal to the N60 sample collection method for the detection of low levels of STEC.

APPENDICES

Appendix 1. Establishment Self-Assessment Checklist for Sanitary Dressing Procedures

Live Receiving/Holding			
Questions	**Yes**	**No**	**Comment**
Do we take measures, such as periodic cleaning of the unloading areas and pens, to reduce the contamination of animals during unloading and holding?			
Do we apply a bacteriophage to cattle?			
Do we conduct cattle washing?			
Do we have data showing that washing decreases incoming bacterial loads?			
Do we monitor the cattle washing process to ensure that contamination is minimized?			
Do we use water mist as a means to reduce airborne dust and dirt particles in the holding area?			
Do we use a “mud-scoring” system to identify cattle that may present an increased likelihood of contamination during hide removal?			
Do we react to cattle showing increased loads of contamination on their hides?			
Do we determine the incoming bacterial load on animals?			
Do we consider differences in the age or type of cattle we receive (e.g. veal calves, sale barn cattle, feedlot cattle, hide condition) and does that indicate a concern related to pathogen load that we address?			

Sticking			
Questions	**Yes**	**No**	**Comment**
Do we use the smallest cut possible to accomplish the bleeding?			
Do we use a two-knife system for sticking and clean the hand between sticking each carcass?			
Do we sanitize knives between animals?			
Do we employ any validated decontamination or antimicrobial intervention treatments at this point in the process that are effective in reducing the presence or counts of microbial contaminants?			

Hide Removal			
Questions	**Yes**	**No**	**Comment**
Do we use a validated hide-on carcass wash?			
Do we use a two-knife system for the entire de-hiding process?			
Do we remove the udder in a manner to prevent contamination of the carcass with milk, and to prevent contamination of the exposed carcass by the hide, or by a soiled knife or employee hand?			
Do we remove visible contamination from the pattern (cut line)?			
Do we trim or steam vacuum pattern lines?			
Do we prevent wicking of moisture into hide openings?			
Are carcasses or parts of carcasses touching or banging into each other?			
Are there excessive turns or switchbacks in the de-hiding line such that hide-on cattle are passing by carcasses with the hide partially removed?			
Do we have shields between the carcasses and hide puller to minimize potential contamination?			
Do we remove the tail switch when using the hide puller to minimize the possibility that contaminants can become airborne from splattering or flapping the hide?			
Is the hide puller causing carcass contamination or cross contamination of adjacent carcasses?			
If we use a cradle, are live animals in such close proximity to the partially dressed animal on the cradle that airborne contamination is a concern?			
If we use mechanical hide pullers, do they pull away from the carcass (e.g., downward or backward and not upward), thereby reducing the potential for contamination from drip splatter?			
When the hide is pulled from the carcass, does it splatter the dressed carcass or adjacent carcasses?			
If employees are handling carcasses during hide pulling, does the hide cross-contaminate the carcass or employees' equipment and clothing? If so, is the contamination removed from employee's equipment and clothing before continuing dressing procedures?			
Does the exterior side of the hide touch or slap the carcass as the hide is removed?			

Do we maintain clean mechanical hide puller contact points with the hide, hands, and garments of the employees handling the hide and carcass, and knives and other equipment contacting the de-hided carcass?			
Do our employees maintain proper employee hygiene practices to prevent the creation of insanitary conditions (e.g., touching the carcass with soiled hands, tools, or garments)?			
In the process of reflecting the hide from the carcass, do our employees intentionally or accidentally cut through the hide? Do we clean and sanitize knives, air knives, or other equipment and clothing before proceeding to reflect the hide away from the carcass any further?			
Do we allow for adequate distance between carcasses throughout the slaughter dress process to minimize carcass-to-carcass contact and cross contamination?			
Do we allow adequate separation of carcasses, parts, and viscera during dressing? This would include at switchbacks (sharp turns) and areas where carcasses in the hide-on area pass by in close proximity to carcasses in the hide-off area.			
Are the hides (especially of feet, legs, tails) of carcasses in the hide-on area cross contaminating equipment and clothing of the employees (aprons, scabbards, steels, gloves)? If so, do we clean and sanitize contaminated equipment or clothing?			
Do we apply a carcass wash cabinet at this point or any other point in the slaughter process? If so, do we ensure that cabinets do not spread contamination to adjacent carcasses?			
Do we control overspray from the carcass wash cabinet?			
Do we address conditions such as open abscesses, septic bruises, or the presence of parasites and parasitic lesions before carcasses enter the carcass wash cabinet?			
Do we address pooling of water around the anus of the carcass prior to dropping the bung?			
Do we ensure that carcasses with excessive contamination do not cross contaminate other carcasses (i.e., create an insanitary condition)?			
Do we ensure that carcasses identified with U.S. Suspect or Retained tags, that should be removed from the slaughter line at a further point in the process, do not enter the carcass wash cabinets unless measures are in place to prevent cross contamination of equipment or other carcasses? *U.S. Suspects are to be washed in these cabinets only with permission of the PHV, and in consideration of whether the design of the cabinet prevents cross contamination of other carcasses.			
Do we employ any validated decontamination or antimicrobial intervention treatments at this point in the process that are effective in reducing the presence or counts of microbial contaminants?			

Bunging			
Questions	**Yes**	**No**	**Comment**
Do we put plastic bags and ties on the bung in a sanitary manner?			
Do we maintain proper employee hygiene practices to prevent the creation of insanitary conditions (e.g., touching the carcass with soiled hands, tools, or garments)?			
Do we employ any validated decontamination or antimicrobial intervention treatment that is effective in reducing the presence or counts of microbial contaminants at this point in the process?			

Brisket Opening			
Questions	**Yes**	**No**	**Comment**
Do we clean and sanitize the brisket saw and knife between each carcass, and ensure that we do not puncture the gastrointestinal tract?			
Do employees maintain proper hygiene practices to prevent the creation of insanitary conditions (e.g., touching the carcass with soiled hands, tools, or garments)?			
Do we employ any validated decontamination or antimicrobial intervention treatments at this point in the process that are effective in reducing the presence or counts of microbial contaminants?			

Rodding the Weasand (Esophagus)			
Questions	**Yes**	**No**	**Comment**
Do we close the esophagus to prevent leakage of rumen contents?			
Do we maintain proper employee hygiene practices (e.g., wash hands and arms often enough to prevent contamination of the carcass)?			
Do we change or sanitize the weasand rod between each carcass?			
Do we properly maintain and clean knives?			
Do we clean and chill the weasand quickly to limit contamination and pathogen multiplication?			
Do we employ any validated decontamination or antimicrobial intervention treatments at this point in the process that are effective in reducing the presence or counts of microbial contaminants?			

Evisceration			
Questions	**Yes**	**No**	**Comment**
Do we remove visible contamination from the area to be cut (e.g., by trimming, by using air knives, or by steam vacuuming) before the cut is made?			
Do we remove the uterus in a manner that prevents contamination of the carcass and viscera?			
Do we properly use knives to prevent damage (i.e., puncturing) to the paunch and intestines?			
Do we remove contamination in a timely manner and in accordance with accepted reconditioning procedures?			
Do our employees on moving evisceration lines use footbaths and separate footwear to prevent the footwear from contaminating other parts of the slaughter and dressing operation?			
Do we employ any validated decontamination or antimicrobial intervention treatments at this point in the process that are effective in reducing the presence or counts of microbial contaminants?			

Carcass Splitting			
Questions	**Yes**	**No**	**Comment**
Do we clean and sanitize the saws and knives between each carcass?			
Do we allow for adequate distance between carcasses (i.e., limit carcass-to-carcass contact)?			
Do we employ any validated decontamination or antimicrobial intervention treatments at this point in the process that are effective in reducing the presence or counts of microbial contaminants?			
Do we address the removal of spinal cords in accordance with 9 CFR 310.22?			

Head and Cheek Meat Processing			
Questions	**Yes**	**No**	**Comment**
Do we properly maintain and clean knives?			
Do we prevent cross contamination of heads?			
Do we maintain proper employee hygiene practices to prevent the creation of insanitary conditions (e.g. touching the head with soiled hands, tools, or garments)?			
Do we quickly chill head and cheek meat to limit pathogen multiplication?			
Do we employ any validated decontamination or antimicrobial intervention treatments at this point in the process that are effective in reducing the presence or counts of microbial contaminants?			

Appendix 2. Carcass Sanitary Dressing Audit

DATE:		CARCASS MONITORING (THREE TIMES PER PRODUCTION PERIOD) Effective Prevention of Contamination at Slaughter Steps		
TIME:		AUDIT LOCATION: ❑ AFTER LEGGING ❑ AFTER HIDE PULLER ❑ PRIOR TO PRE-EVIS ❑ POST EVIS ❑ PRIOR TO OTHER WASHES ❑ ZERO TOLERANCE ❑ COOLER		
CARCASS #	CONTAMINATION OBSERVED	CONTAMINATION TYPE **F** fecal **I** ingesta **H** hair **O** other (e.g. milk, abscess) **GHM** grease/hook marks **RF** rail fallout	CONTAMINATION LOCATION **H** hock **RD** round **RP** rump **SR** sirloin **SL** short loin **R** rib **C** chuck **FS** foreshank **B** brisket **SP** short plate **F** flank **N** neck	DEGREE OF CONTAMINATION **MILD** **MOD** moderate **SEV** severe
1.	❑ YES ❑ NO	❑ F ❑ I ❑ H ❑ O ❑ GHM ❑ RF	❑ H ❑ RD ❑ RP ❑ SR ❑ R ❑ C ❑ FS ❑ B ❑ SP ❑ F ❑ N	❑ MILD ❑ MOD ❑ SEV
2.	❑ YES ❑ NO	❑ F ❑ I ❑ H ❑ O ❑ GHM ❑ RF	❑ H ❑ RD ❑ RP ❑ SR ❑ R ❑ C ❑ FS ❑ B ❑ SP ❑ F ❑ N	❑ MILD ❑ MOD ❑ SEV
3.	❑ YES ❑ NO	❑ F ❑ I ❑ H ❑ O ❑ GHM ❑ RF	❑ H ❑ RD ❑ RP ❑ SR ❑ R ❑ C ❑ FS ❑ B ❑ SP ❑ F ❑ N	❑ MILD ❑ MOD ❑ SEV
4.	❑ YES ❑ NO	❑ F ❑ I ❑ H ❑ O ❑ GHM ❑ RF	❑ H ❑ RD ❑ RP ❑ SR ❑ R ❑ C ❑ FS ❑ B ❑ SP ❑ F ❑ N	❑ MILD ❑ MOD ❑ SEV
5.	❑ YES ❑ NO	❑ F ❑ I ❑ H ❑ O ❑ GHM ❑ RF	❑ H ❑ RD ❑ RP ❑ SR ❑ R ❑ C ❑ FS ❑ B ❑ SP ❑ F ❑ N	❑ MILD ❑ MOD ❑ SEV
6.	❑ YES ❑ NO	❑ F ❑ I ❑ H ❑ O ❑ GHM ❑ RF	❑ H ❑ RD ❑ RP ❑ SR ❑ R ❑ C ❑ FS ❑ B ❑ SP ❑ F ❑ N	❑ MILD ❑ MOD ❑ SEV
7.	❑ YES ❑ NO	❑ F ❑ I ❑ H ❑ O ❑ GHM ❑ RF	❑ H ❑ RD ❑ RP ❑ SR ❑ R ❑ C ❑ FS ❑ B ❑ SP ❑ F ❑ N	❑ MILD ❑ MOD ❑ SEV
8.	❑ YES ❑ NO	❑ F ❑ I ❑ H ❑ O ❑ GHM ❑ RF	❑ H ❑ RD ❑ RP ❑ SR ❑ R ❑ C ❑ FS ❑ B ❑ SP ❑ F ❑ N	❑ MILD ❑ MOD ❑ SEV
9.	❑ YES ❑ NO	❑ F ❑ I ❑ H ❑ O ❑ GHM ❑ RF	❑ H ❑ RD ❑ RP ❑ SR ❑ R ❑ C ❑ FS ❑ B ❑ SP ❑ F ❑ N	❑ MILD ❑ MOD ❑ SEV
10.	❑ YES ❑ NO	❑ F ❑ I ❑ H ❑ O ❑ GHM ❑ RF	❑ H ❑ RD ❑ RP ❑ SR ❑ R ❑ C ❑ FS ❑ B ❑ SP ❑ F ❑ N	❑ MILD ❑ MOD ❑ SEV
CARCASS #	CORRECTIVE ACTION?	CORRECTIVE ACTION	**§417.4 (A)(2)(II) MONITORING DIRECT OBSERVATION**	
1.	❑ YES ❑ NO	❑ TRIMMED ❑RAILED REWORK	VERIFICATION ARE THE PROCEDURES FOR THIS SLAUGHTER STEP EFFECTIVELY PREVENTING CONTAMINATION? IF NOT, STATE WHY IN THE COMMENTS SECTION BELOW. ❑ YES ❑ NO VER. INIT. _____	
2.	❑ YES ❑ NO	❑ TRIMMED ❑RAILED REWORK		
3.	❑ YES ❑ NO	❑ TRIMMED ❑RAILED REWORK		
4.	❑ YES ❑ NO	❑ TRIMMED ❑RAILED REWORK		
5.	❑ YES ❑ NO	❑ TRIMMED ❑RAILED REWORK		
6.	❑ YES ❑ NO	❑ TRIMMED ❑RAILED REWORK		
7.	❑ YES ❑ NO	❑ TRIMMED ❑RAILED REWORK		
8.	❑ YES ❑ NO	❑ TRIMMED ❑RAILED REWORK		
9.	❑ YES ❑ NO	❑ TRIMMED ❑RAILED REWORK		
10.	❑ YES ❑ NO	❑ TRIMMED ❑RAILED REWORK		

COMMENTS:

CORRECTIVE ACTIONS TAKEN:

FURTHER ACTION(S) RECOMMENDED:

How to Use Appendix 2. *Carcass Sanitary Dressing Audit*

AUDIT LOCATION: Indicate at what point in the slaughter process this audit is being performed (check one box).

CARCASS #: Indicate the identifying number of each carcass included in the audit.

CONTAMINATION OBSERVED: Indicate 'yes' or 'no' by checking the correct box.

CONTAMINATION TYPE: Indicate the type of contamination by checking the box by the correct letter.

F = Fecal contamination
I = Ingesta
H = Hair
GHM = Grease/hook marks, also oil
RF = Rail fallout or rail dust
O = other (such as milk, abscess or any other form of contamination)

CONTAMINATION LOCATION: Indicate the location of contamination on the carcass by checking the box by the correct letter (see diagram below for reference)

H = Hock	RD = Round	RP = Rump
SR = Sirloin	SL = Short Loin	R = Rib
C = Chuck	FS = Foreshank	B = Brisket
SP = Short Plate	F = Flank	N = Neck

DEGREE OF CONTAMINATION: Indicate how much contamination is found on the carcass by checking the correct box. Multiple mild or moderate contaminations or one or two severe contaminations indicate a significant loss of process control. All slaughter establishments should develop process control criteria for each slaughter step and identify criteria for when the process is out of control.

Establishments should use those criteria to determine the effectiveness of their slaughter dressing procedures. The following are examples only. Establishments will want to develop their own criteria for each slaughter step to define when their process is out of control.

- MILD = mild. Contamination is limited to a small area in one location on the carcass. For example, a cluster of 3-4 hairs, a speck of fecal contamination, or a few small pieces of rail fallout in a small area.
- MOD = moderate. Contamination is over one medium sized area, or is small, but in 3-4 locations on the carcass. For example, multiple clusters of 3-4 hairs over the carcass or one larger cluster of hair.
- SEV = severe. Contamination is spread over multiple locations on the carcass, or in one large location. For example, a large streak of fecal contamination, such as may occur from a hide slap.

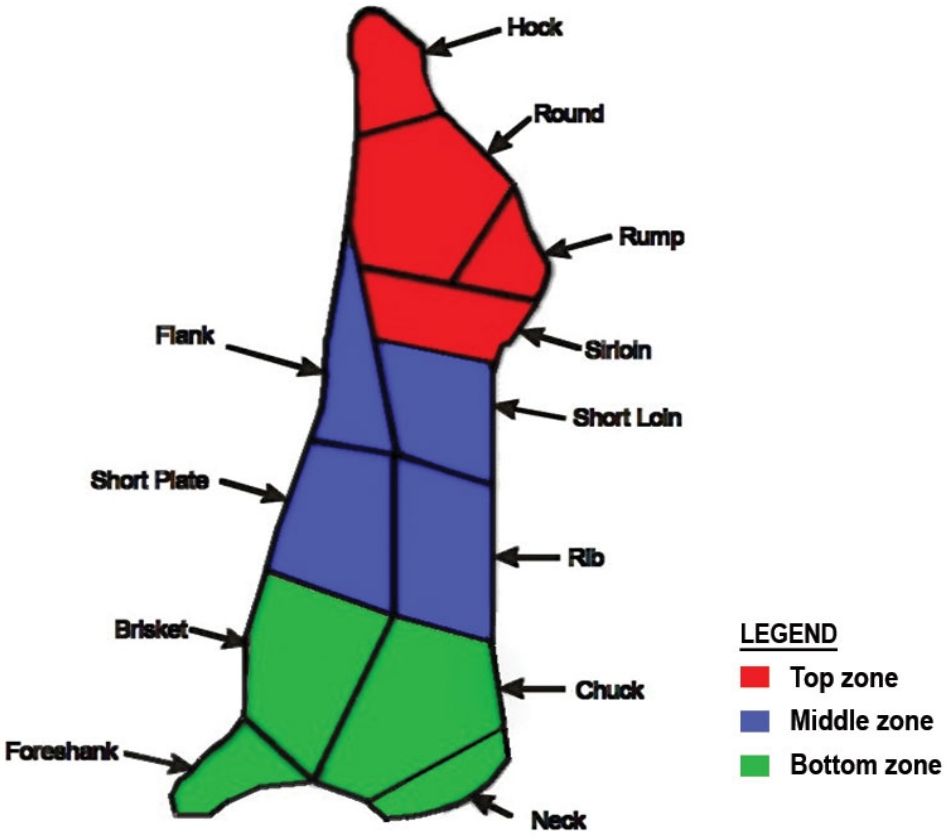
CORRECTIVE ACTION: Indicate 'yes' or 'no' by checking the correct box.

CORRECTIVE ACTION TAKEN: Indicate whether the carcass was trimmed or railed out and reworked.

VERIFICATION: Indicate whether the procedures in the slaughter process selected as the audit location effectively prevent contamination by checking 'yes' or 'no' and initial. Establishments should use their process control criteria for determining whether the sanitary dressing procedures at the process step/audit location effectively prevented contamination.

COMMENTS: Record further comments, corrective actions (including preventive measures) and recommended actions in the space available.

DIAGRAM TO ASSIST WITH IDENTIFICATION OF CONTAMINATION LOCATION



Appendix 3. Guidance Documents Developed by Industry that include Beef Slaughter and Microbiological Sampling Best Practices

Best Practices for Beef Harvest (https://www.bifsco.org/Media/BIFSCO/Docs/harvest_best_practice_final.pdf) This document provides best practices to control microbial contamination throughout the slaughter operation. The implementation of these best practices, with current science and technology, would allow slaughter operators to produce visibly clean carcasses and reduce the incidence level of pathogenic contamination.
Best Practices for Spinal Cord Removal (https://www.bifsco.org/Media/BIFSCO/Docs/spinal_cord_removal2002.pdf) This document provides Good Manufacturing Practices (GMPs) to improve process control for assuring the removal of spinal cord from vertebral bone.
Industry Best Practices for Holding Tested Products (https://www.bifsco.org/Media/BIFSCO/Docs/holding_tested_products_sept2005.pdf) This document describes effective best practices to help establishments develop and implement an optimal system for sampling and testing their own products and for holding products when government agencies take a sample.
Best Practices for Using Microbiological Sampling (https://www.bifsco.org/Media/BIFSCO/Docs/microbiological_sampling_bp_march2008.pdf) This document provides best practices for developing procedures to use microbiological testing to verify process control.
Antimicrobial Interventions Reference Document (https://www.bifsco.org/Media/BIFSCO/Docs/antimicrobial-interventions-for-beef.pdf) This document, funded by the beef checkoff, describes the actions that can be taken by industry to reduce the potential for carcass contamination including scientifically proven antimicrobial interventions that can be applied individually or in combination with other treatments to reduce pathogens on carcass surfaces.
Sampling, Lotting and Sample Analysis Guidance (https://www.bifsco.org/Media/BIFSCO/Docs/lotting_and_sampling_of_beef_products_for_pathogens_analysis_update_april_-2019.pdf) This document provides industry best practices for developing and implementing components (lotting, sampling and laboratory analysis) of a pathogen-testing program as a part of an overall food safety system.

Appendix 4. References

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Pre-Evisceration Wash and Final Carcass Organic Acid Wash:

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Chilling of Carcasses

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    - For *E.coli* was used to predict the growth of *E. coli*. if the bacterium was deposited onto the sterile carcass surface during the hide removal/dressing steps. The Growth Predictor Model predicts the response of a range of pathogens and spoilage microorganisms characterizing the food environment.
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