

CODEX ALIMENTARIUS

INTERNATIONAL FOOD STANDARDS



Food and Agriculture
Organization of
the United Nations



World Health
Organization

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GUIDELINES FOR THE CONTROL OF NONTYPHOIDAL *SALMONELLA* SPP. IN BEEF AND PORK MEAT

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1. INTRODUCTION

Salmonellosis is one of the most frequently reported foodborne diseases worldwide, with beef and pork meat considered important food vehicles. The burden of the disease and the cost of control measures are significant in many countries and contamination with zoonotic nontyphoidal *Salmonella*¹ has the potential to disrupt trade between countries.

The large degree of variation exhibited by *Salmonella* in their biological properties, host preferences, and environmental survival presents a particular challenge for controlling the presence of *Salmonella* in animal production. In practice, this means that there is no “one size fits all” solution, and different production systems may require different approaches to control the various serovars of *Salmonella*.

These Guidelines apply a risk management framework (RMF) approach as advocated in [Principles and Guidelines for the Conduct of Microbiological Risk Management \(MRM\) \(CAC/GL 63-2007\)](#). “Preliminary Risk Management Activities” and “Identification and Selection of Risk Management Options” are represented by the guidance developed for control measures at each step in the food chain. The following sections on “Implementation” and “Monitoring” complete the application of all the components of the RMF.

The Guidelines build on general food hygiene provisions already established in the Codex system and propose potential control measures specific for *Salmonella* strains of public health relevance in beef and pork meat. In this context, the Codex Alimentarius Commission (CAC) is committed to develop standards that are based on sound science². Potential control measures for application at single or multiple steps of the food chain are presented in the following categories:

- **Good hygienic practice (GHP) – based:** They are generally qualitative in nature and are based on empirical scientific knowledge and experience. They are usually prescriptive and may differ among countries.
- **Hazard – based:** They are developed from scientific knowledge of the likely level of control of a hazard at a step (or series of steps) in a food chain. They are based on a quantitative base estimate in the prevalence and/or concentration of *Salmonella*, and can be validated as to their efficacy in hazard control at a specific step. The benefit of a hazard-based measure cannot be exactly determined without a specific risk assessment; however, any significant reduction in pathogen prevalence and / or concentration is expected to provide a certain level of human health benefit.

Examples of control measures that are based on quantitative levels of hazard control have been subjected to a rigorous scientific evaluation in development of the Guidelines. Such examples are illustrative only and their use and approval may vary amongst member countries. Their inclusion in the Guidelines illustrates the value of a quantitative approach to hazard reduction throughout the food chain.

The Guidelines are presented in a flow diagram format so as to enhance practical application of a primary production-to-consumption approach to food safety.

This format:

- Demonstrates the range of the approaches of control measures for *Salmonella*.
- Illustrates relationships between control measures applied at different steps in the food chain.
- Highlights data gaps in terms of scientific justification / validation for control measures.
- Facilitates development of hazard analysis and critical control points (HACCP) plans at individual establishments and at national levels.
- Assists in judging the equivalence³ of control measures for beef and pork meat applied in different countries.
- Illustrates the interdependent relationship between Codex guidelines and OIE standards throughout the food chain. These Guidelines do not deal with matters of animal health unless directly related to food safety or suitability.

In doing so, the Guidelines provide flexibility for use at the national (and individual processing) level.

¹ Human pathogens of public health relevance only. For the purposes of this document, all references to *Salmonella* relate only to human pathogens.

² Strategic Goal 2 of the Strategic Plan of the Codex Alimentarius Commission is to “Ensure the application of risk analysis principles in the development of Codex standards” and the CAC Procedural Manual states that “Health and safety aspects of Codex decisions and recommendations should be based on a risk assessment, as appropriate to the circumstances” – 23rd Edition, page 218.

³ *Guidelines on the Judgement of Equivalence of Sanitary Measures Associated with Food Inspection and Certification Systems* (CAC/GL 53-2003).

2. OBJECTIVES

These Guidelines provide information to governments and industry on the control of nontyphoidal *Salmonella* in beef and pork meat that aim to reduce foodborne disease whilst ensuring fair practices in the international food trade. The Guidelines provide a scientifically sound international tool for robust application of GHP- and hazard-based approaches for control of *Salmonella* in beef and pork meat according to national risk management decisions. The control measures that are selected can vary between countries and production systems.

The Guidelines do not set quantitative limits for *Salmonella* in beef and pork meat in international trade. Rather, the Guidelines follow the example of the overarching [Code of Hygienic Practice for Meat \(CAC/RCP 58-2005\)](#) and provide an “enabling” framework which countries can utilize to establish control measures appropriate to their national situation.

3. SCOPE AND USE OF THE GUIDELINES

3.1. Scope

These Guidelines are applicable to all nontyphoidal *Salmonella* that may contaminate beef and pork meat and cause foodborne disease. The primary focus is to provide information on practices that may be used to prevent, reduce, or eliminate nontyphoidal *Salmonella* in fresh⁴ beef and pork meat. Other measures, in addition to those described here, may be needed to control *Salmonella* in offal.

These Guidelines in conjunction with the relevant OIE standards can apply from primary production-to-consumption for beef and pork meat produced in commercial production systems.

3.2. Use

The Guidelines provide specific guidance for control of nontyphoidal *Salmonella* in beef and pork meat according to a primary production-to-consumption food chain approach, with potential control measures being considered at each step, or group of steps, in the process flow. The Guidelines are supplementary to and should be used in conjunction with the [General Principles of Food Hygiene \(CAC/RCP 1-1969\)](#), the [Code of Hygienic Practice for Meat \(CAC/RCP 58-2005\)](#), the [Code of Practice on Good Animal Feeding \(CAC/RCP 54-2004\)](#) and the [Guidelines for the Validation of Food Safety Control Measures \(CAC/GL 69-2008\)](#).

These general and overarching provisions are referenced as appropriate and their content is not duplicated in these Guidelines.

The primary production section of these Guidelines is supplementary to and should be used in conjunction with relevant chapters of the OIE *Terrestrial Animal Health Code*⁵.

The Guidelines systematically present GHP-based control measures. GHPs are pre-requisites to making choices on hazard-based control measures. Hazard-based measures will likely vary at the national level and therefore these Guidelines only provide examples of hazard-based controls. Examples of hazard-based control measures are limited to those that have been scientifically demonstrated as effective. Countries should note that these hazard-based control measures are indicative only. The quantifiable outcomes reported for control measures are specific to the conditions of particular studies and would need to be validated under local commercial conditions to provide an estimate of hazard reduction⁶. Government and industry can use choices on hazard-based control measures to inform decisions on critical control points (CCPs) when applying HACCP principles to a particular food process.

Several hazard-based control measures as presented in these Guidelines are based on the use of physical, chemical and biological decontaminants to reduce the prevalence of *Salmonella* positive carcasses and/or its concentration on positive carcasses. The use of these control measures is subject to approval by the competent authority, where appropriate. Also these Guidelines do not preclude the choice of any other hazard-based control measure that is not included in the examples provided herein, and that may have been scientifically validated as being effective in a commercial setting.

Provision of flexibility in application of the Guidelines is an important attribute. They are primarily intended for use by government risk managers and industry in the design and implementation of food safety control systems. The control measures are articulated in this guideline at appropriate steps, however if they could be performed hygienically and effectively they could be applied in other steps in the food chain.

⁴ *Code of Hygienic Practice for Meat* (CAC/RCP 58-2005)

⁵ <http://www.oie.int/en/international-standard-setting/terrestrial-code/access-online/>

⁶ FAO/WHO 2009. Risk characterization of microbiological hazards in food. Microbiological risk assessment series 17. Available at <http://www.fao.org/docrep/012/i1134e/i1134e00.htm> and <http://www.who.int/foodsafety/publications/risk-characterization/en/>

The Guidelines should be useful when comparing, or judging equivalence of, different food safety measures for beef and pork meat in different countries.

4. DEFINITIONS

- Cattle:** Animals of the species of *Bos indicus*, *Bos taurus*, and *Bubalus bubalis*.
- Lairage:** Pens, yards and other holding areas used for accommodating animals in order to give them necessary attention (such as water, feed, rest) before they are moved on or used for specific purposes including slaughter.
- Nontyphoidal Salmonella:** Serovars belonging to the species *Salmonella enterica* excluding the typhoidal serovars of subspecies enterica: serovar Typhi, serovar Paratyphi var. A, B and C, and serovar Sendai⁷.
- Pigs:** Animals of the species *Sus scrofa domesticus*.

5. PRINCIPLES APPLYING TO CONTROL OF SALMONELLA IN BEEF AND PORK MEAT

Overarching principles for good hygienic practice for meat production are presented in the [Code of Hygienic Practice for Meat \(CAC/RCP 58-2005\)](#), Section 4: *General Principles of Meat Hygiene*. Two principles that have particularly been taken into account in these Guidelines are:

- a) The principles of food safety risk analysis should be incorporated wherever possible and appropriate in the control of *Salmonella* in beef and pork meat from primary production-to-consumption.
- b) Wherever possible and practical, competent authorities should formulate risk management metrics⁸ so as to objectively express the level of control of *Salmonella* in beef and pork meat that is required to meet public health goals.

6. PRIMARY PRODUCTION-TO-CONSUMPTION APPROACH TO CONTROL MEASURES

7. SPECIFIC CONTROL MEASURES (PRIMARY PRODUCTION)

8. SPECIFIC CONTROL MEASURES (PROCESSING)

9. SPECIFIC CONTROL MEASURES (DISTRIBUTION CHANNELS)

Sections 6 through 9 contain beef and pork specific measures. The beef Sections 6 to 9 are found in Annex I and the pork Sections 6 to 9 are found in Annex II.

10. CONTROL MEASURES

GHP provides the foundation for most food safety control systems. Where possible and practicable, food safety control systems should incorporate hazard-based control measures and risk assessment. Identification and implementation of risk-based control measures based on risk assessment can be elaborated by application of a risk management framework (RMF) process as advocated in the [Principles and Guidelines for the Conduct of Microbiological Risk Management \(MRM\) \(CAC/GL 63-2007\)](#).

While these Guidelines provide generic guidance on development of GHP-based and hazard-based control measures for *Salmonella*, development of risk-based control measures for application at single or multiple steps in the food chain are primarily the domain of competent authorities at the national level. Industry may derive risk-based measures to facilitate application of process control systems.

10.1. Development of risk-based control measures

Competent authorities operating at the national level should develop risk-based control measures for *Salmonella* where possible and practical.

When risk-modelling tools are developed, the risk manager needs to understand the capability and limitations⁹.

When developing risk-based control measures, competent authorities may use the quantitative examples of the likely level of control of a hazard in this document.

⁷ The zoonotic serovars *S. Java* and *S. Miami* share antigenic structure with *S. Paratyphi B* and *S. Sendai*, respectively, and confusion should be avoided.

⁸ [Principles and Guidelines for the Conduct of Microbiological Risk Management \(MRM\) \(CAC/GL 63-2007\)](#).

⁹ [Principles and Guidelines for the Conduct of Microbiological Risk Assessment \(CAC/GL 30-1999\)](#).

Competent authorities formulating risk management metrics¹⁰ as regulatory control measures should apply a methodology that is scientifically robust and transparent.

11. IMPLEMENTATION OF CONTROL MEASURES

Implementation¹¹ involves giving effect to the selected control measure(s), development of implementation plan, communication on the decision on control measure(s), ensuring a regulatory framework and infrastructure for implementation exists, and a monitoring and evaluation process to assess whether the control measure(s) have been properly implemented.

11.1 Prior to Validation

Prior to validation of the hazard-based control measures for *Salmonella*, the following tasks should be completed:

- Identification of the specific measure or measures to be validated. This would include consideration of any measures agreed to by the competent authority and whether any measure has already been validated in a way that is applicable and appropriate to specific commercial use, such that further validation is not necessary.
- Identification of any existing food safety outcome or target, established by the competent authority or industry. Industry may set stricter targets than those set by the competent authority.

11.2 Validation

Validation of measures may be carried out by industry and/or the competent authority.

Where validation is undertaken for a measure based on hazard control for *Salmonella*, evidence will need to be obtained to show that the measure is capable of controlling *Salmonella* to a specified target or outcome. This may be achieved by use of a single measure or a combination of measures. The [Guidelines for the Validation of Food Safety Control Measures \(CAC/GL 69-2008\)](#) (Section VI) provides detailed advice on the validation process.

11.3 Implementation

Refer to the Section 9.2 of the [Code of Hygienic Practice for Meat \(CAC/RCP 58-2005\)](#).

11.3.1 Industry

Industry has the primary responsibility for implementing, documenting, applying and supervising process control systems to ensure the safety and suitability of beef and pork meat, and these should incorporate GHP and hazard-based measures for control of *Salmonella* as appropriate to national government requirements and industry's specific circumstances.

The documented process control systems should describe the activities applied including any sampling procedures, specified targets (e.g. performance objectives or performance criteria) set for *Salmonella*, industry verification activities, and corrective and preventive actions.

11.3.2 Regulatory systems

The competent authority should provide guidelines and other implementation tools to industry as appropriate, for the development of the process control systems.

The competent authority may approve the documented process control systems and stipulate verification frequencies. Microbiological testing requirements should be provided for verification of HACCP systems where specific targets for control of *Salmonella* have been stipulated.

The competent authority may use a competent body to undertake specific verification activities in relation to the industry's process control systems. Where this occurs, the competent authority should stipulate specific functions to be carried out.

11.4 Verification of control measures

Refer to Section 9.2 of the [Code of Hygienic Practice for Meat \(CAC/RCP 58-2005\)](#) and Section IV of the [Guidelines for the Validation of Food Safety Control Measures \(CAC/GL 69 -2008\)](#).

¹⁰ [Principles and Guidelines for the Conduct of Microbiological Risk Management \(MRM\) \(CAC/GL 63-2007\)](#).

¹¹ See Section 7 of the [Principles and Guidelines for the Conduct of Microbiological Risk Management \(MRM\) \(CAC/GL 63-2007\)](#).

11.4.1 *Industry*

Industry verification should demonstrate that all control measures for *Salmonella* have been implemented as intended. Verification should include observation of monitoring activities, documentary verification, and sampling for *Salmonella* and other microbiological testing as appropriate.

Verification frequency should vary according to the operational aspects of process control, the historical performance of the establishment and the results of verification itself.

Record keeping is important to facilitate verification and for traceability purposes.

11.4.2 *Regulatory systems*

The competent authority and/or competent body should verify that all regulatory control measures implemented by industry comply with regulatory requirements, as appropriate, for control of *Salmonella*.

12. MONITORING AND REVIEW

Monitoring and review of food safety control systems is an essential component of application of a risk management framework (RMF)¹². It contributes to verification of process control and demonstrating progress towards achievement of public health goals.

Information on the level of control of *Salmonella* at appropriate points in the food chain can be used for several purposes, e.g. to validate and/or verify outcomes of food control measures, to monitor compliance with hazard-based and risk-based regulatory goals, and to help prioritize regulatory efforts to reduce foodborne illness. Systematic review of monitoring information allows the competent authority and relevant stakeholders to make decisions in terms of the overall effectiveness of the food safety control systems and make improvements where necessary.

12.1 *Monitoring*

Monitoring should be carried out at appropriate steps throughout the food chain using a validated diagnostic test and randomized or targeted sampling as appropriate¹³.

For instance the monitoring systems for *Salmonella* and/or indicator organisms, where appropriate, in beef and pork may include testing at the farm and animal level, in the slaughter and processing establishments, and the retail distribution chains.

Regulatory monitoring programmes should be designed in consultation with relevant stakeholders, taking into account the most cost-efficient resourcing option for collection and testing of samples. Given the importance of monitoring data for risk management activities, sampling and testing components should be standardized on a national basis and be subject to quality assurance.

The type of samples and data collected in monitoring systems should be appropriate for the outcomes sought. Enumeration and sub-typing of microorganisms generally provides more information for risk management purposes than presence or absence testing.

Monitoring information should be made available to relevant stakeholders in a timely manner (e.g. to producers, processing industry, consumers).

Monitoring information from the food chain should be used to affirm achievement of risk management goals. Wherever possible, such information should be combined with human health surveillance data and food source attribution data to validate risk-based control measures and verify progress towards risk-reduction goals. Activities supporting an integrated response include:

- Surveillance of clinical salmonellosis in humans
- Epidemiological investigations including outbreaks and sporadic cases

¹² See Section 8 of the [Principles and Guidelines for the Conduct of Microbiological Risk Management \(MRM\) \(CAC/GL 63-2007\)](#).

¹³ Refer to the relevant Chapters of the OIE Manual and Code on the OIE website: *Manual of Diagnostic Tests and Vaccines for Terrestrial Animals* at <http://www.oie.int/en/international-standard-setting/terrestrial-manual/access-online/> and the OIE *Terrestrial Animal Health Code* at <http://www.oie.int/en/international-standard-setting/terrestrial-code/access-online/>.

12.2 Review

Periodic review of monitoring data at relevant process steps should be used to inform the effectiveness of risk management decisions and actions, as well as future decisions on the selection of specific control measures, and provide a basis for their validation and verification.

Information gained from monitoring in the food chain should be integrated with human health surveillance, food source attribution data, and withdrawal and recall data, where available to evaluate and review the effectiveness of control measures from primary production to consumption.

Where monitoring of hazards or risks indicates that regulatory performance goals are not being met, risk management strategies and/or control measures should be reviewed.

12.3 Public health goals

Countries should consider the results of monitoring and review when reevaluating and updating public health goals for control of *Salmonella* in foods, and when evaluating progress. Monitoring of food chain information in combination with food source attribution data and human health surveillance data are important components¹⁴.

¹⁴ International organizations such as WHO provide guidance for establishing and implementing public health monitoring programmes. WHO Global Foodborne Infections Network (GFN) <http://www.who.int/gfn/en/>

ANNEX I

**SPECIFIC CONTROL MEASURES FOR BEEF
(For Sections 6 to 9)****6. PRIMARY PRODUCTION-TO-CONSUMPTION APPROACH TO CONTROL MEASURES**

These Guidelines incorporate a “primary production-to-consumption” flow diagram that identifies the main steps in the food chain where control measures for *Salmonella* may potentially be applied in the production of beef. While control in the primary production phase can decrease the number of animals carrying and/or shedding *Salmonella*, controls after primary production are important to prevent the contamination and cross-contamination of carcasses and meat products. The systematic approach to the identification and evaluation of potential control measures allows consideration of the use of controls in the food chain and allows different combinations of control measures to be developed. This is particularly important where differences occur in primary production and processing systems between countries. Risk managers need the flexibility to choose risk management options that are appropriate to their national context.

6.1. Generic flow diagram for application of control measures

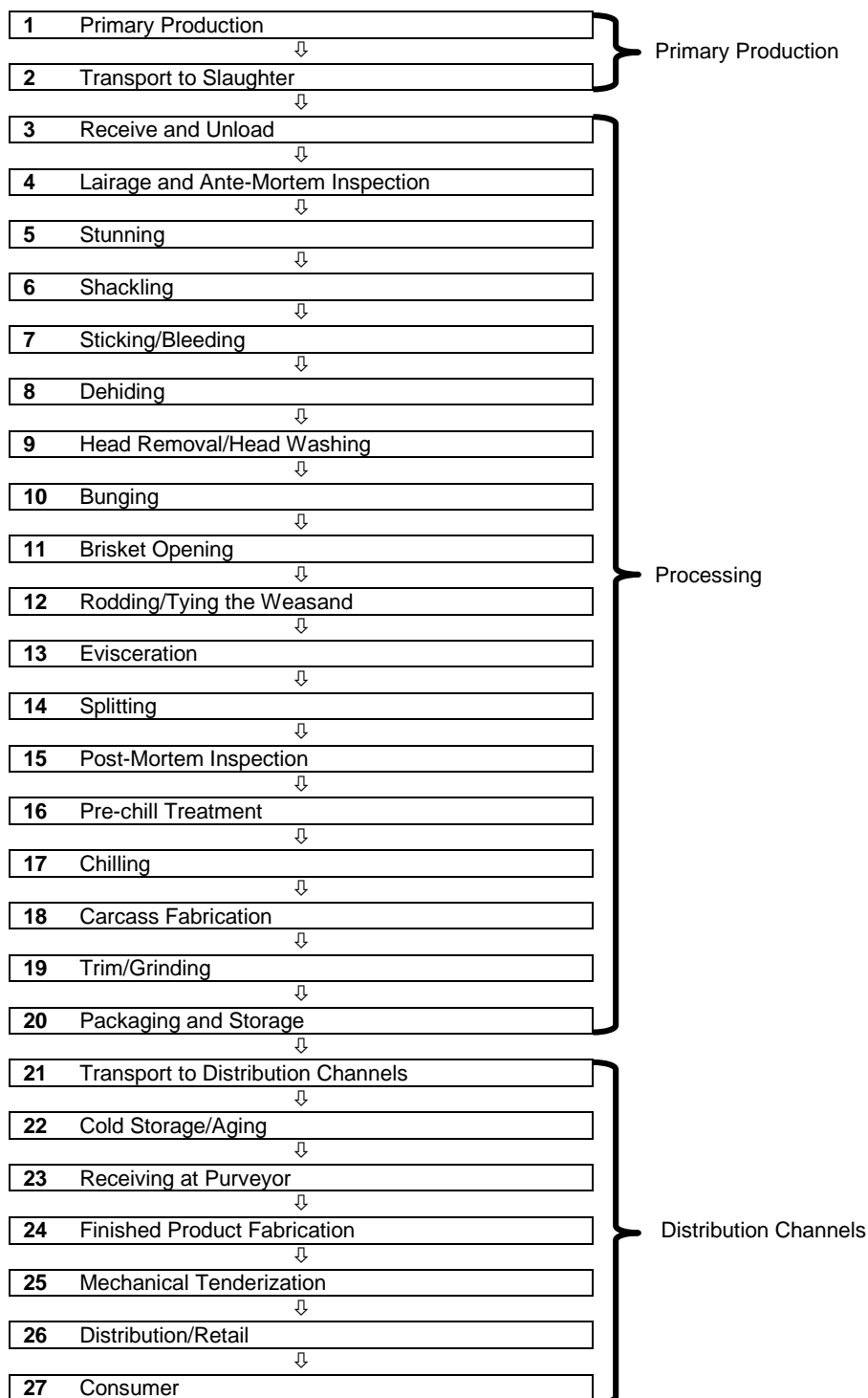
A generic flow diagram of the basic beef production processes is presented on the following pages. GHP- or hazard-based interventions that may be applied during processing have been identified at the appropriate process step(s) in the flow diagram.

Individual establishments will have variations in process flow and, if possible or required by national law, should develop and adapt HACCP plans accordingly. In countries where HACCP is not widely used, the fundamental principles and practices of HACCP may still be applicable.

The basic steps in the slaughter process are to a large extent common but they may be carried out differently in different slaughterhouses or countries. Therefore the necessity to use supplementary mitigation steps will also vary among individual slaughterhouses and countries. The use of supplementary mitigation steps will depend on the food safety targets set, for example, by the competent authorities or customers (e.g. retail chains) and will be influenced by a range of factors, e.g. animal feed, hygienic slaughter procedures, age of livestock, farming practices, size of establishment, equipment, automation, slaughter line speed, and the initial *Salmonella* load from incoming animals (e.g. seasonal variation). A variety of interventions may be used to reduce contamination with *Salmonella* throughout processing. While the effect on *Salmonella* of the individual interventions can be variable, there is clear evidence that use of multiple interventions throughout different production and processing steps as part of a “multiple-hurdle” strategy will provide a more consistent reduction of *Salmonella*.

Process Flow Diagram 1: Primary Production-to-Consumption – Beef

These process steps are generic and the order may be varied as appropriate. This flow diagram is for illustrative purposes only. For application of control measures in a specific country or an establishment, a complete and comprehensive flow diagram should be drawn up.



6.2. Availability of control measures at specific process flow steps addressed in these Guidelines

The following table illustrates where specific control measures for *Salmonella* may be applied at each of the process flow steps of the food chain. Control measures are indicated by a check mark and their details are provided in these Guidelines and relevant Chapters of the OIE *Terrestrial Animal Health Code*¹⁵ in the case of GHP. A blank cell means that a specific control measure for *Salmonella* has not been identified for the process flow step.

¹⁵ Refer to the OIE website: <http://www.oie.int/en/international-standard-setting/terrestrial-code/access-online/>

Decontamination treatments may be applied at multiple steps (see following table) within the process flow and may vary among countries, establishments or type of process flow. However, decontamination treatments should not be considered to replace or reduce GHP-based control measures to maintain food safety. Such treatments should not contribute to possible chemical risks.

Availability of Control Measures at Specific Steps in the Process Flow

Process Step	GHP-based Control Measures	Hazard-based Control Measures
1 Primary Production ↓	Refer to ^{15,16}	
2 Transport to Slaughter ↓	Refer to ^{15,16}	
3 Receive and Unload ↓	✓Refer to ^{15,16}	
4 Lairage and Ante-Mortem Inspection ↓	✓Refer to ^{15,16}	
5 Stunning ↓	✓	✓
6 Shackling ↓	✓	✓#
7 Sticking/Bleeding ↓	✓	✓#
8 Dehiding ↓	✓	✓
9 Head Removal/Head Washing ↓	✓	✓*
10 Bunging ↓	✓	
11 Brisket Opening ↓	✓	
12 Rodding/Tying the Weasand ↓	✓	
13 Evisceration ↓	✓	✓*
14 Splitting ↓	✓	✓*
15 Post-Mortem Inspection ↓	✓	
16 Pre-chill Treatment ↓		✓*
17 Chilling ↓	✓	
18 Carcass Fabrication ↓	✓	
19 Trim/Grinding ↓	✓	✓
20 Packaging and Storage ↓	✓	✓
21 Transport to Distribution Channels ↓	✓	
22 Cold Storage/Aging ↓	✓	
23 Receiving at Purveyor ↓	✓	
24 Finished Product Fabrication ↓	✓	
25 Mechanical Tenderization ↓	✓	
26 Distribution/Retail ↓	✓	
27 Consumer	✓	

Details for specific hazard-based controls can be found under Step 5, Stunning

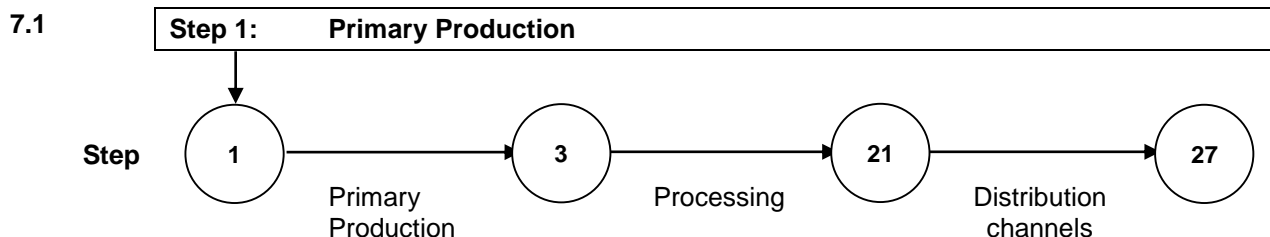
*Details for specific hazard-based controls can be found under Step 8, Dehiding

¹⁶ [Code of Hygienic Practice for Meat \(CAC/RCP 58-2005\)](#).

7. CONTROL MEASURES FOR PRIMARY PRODUCTION (STEPS 1 TO 2)

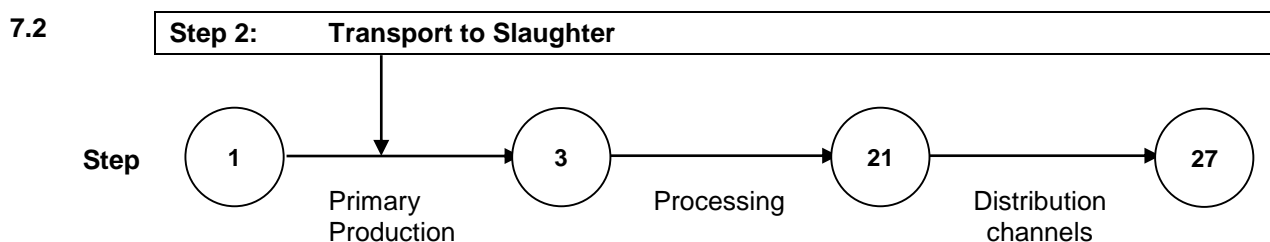
These Guidelines should be used in conjunction with, relevant Chapters of the OIE *Terrestrial Animal Health Code*, the [Code of Practice on Good Animal Feeding \(CAC/RCP 54-2004\)](#) and the [Code of Hygienic Practice for Meat \(CAC/RCP 58-2005\)](#).

It has been shown in some production systems that control of *Salmonella* in beef can begin on the farm. Practical measures to control *Salmonella* during primary production should be implemented.



7.1.1. GHP-based control measures

Refer to relevant Chapters of the OIE *Terrestrial Animal Health Code*.



7.2.1 GHP-based control measures

Refer to relevant Chapters of the OIE *Terrestrial Animal Health Code* and the [Code of Hygienic Practice for Meat \(CAC/RCP 58-2005\)](#).

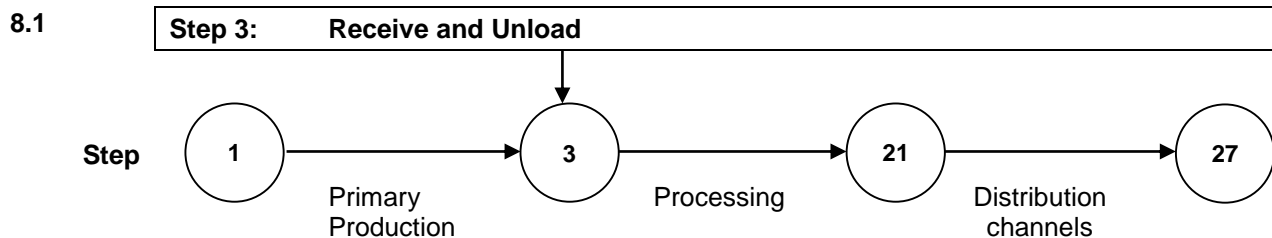
8. CONTROL MEASURES FOR PROCESSING (STEPS 3 TO 20)

General control measures including those identified in the [Code of Hygienic Practice for Meat \(CAC/RCP 58-2005\)](#) should be implemented to prevent the contamination or cross-contamination of carcasses throughout the slaughter process. Control measures that may have particular impact on the control of *Salmonella* include:

- Equipment and the environment should be kept clean and disinfected as required.
- Cleaning and disinfection procedures should be employed regularly and performed in a manner to prevent spread of pathogens.
- Water accumulation on the floor should be avoided and good floor drainage design should be ensured.
- Equipment should be maintained and designed to avoid contamination and build-up of organic material.
- Knives should be cleaned and disinfected between carcasses.
- Personnel should be trained both on operations and food safety aspects of slaughtering. The line speed should leave adequate time to perform all process steps in the operations.
- Proper employee hygiene practices should be maintained to prevent the creation of unsanitary conditions (e.g. touching product with soiled hands, tools, or garments). Hygiene should include the washing of hands to prevent cross-contamination.
- Water used for decontamination or cleaning and disinfection of equipment should be potable¹⁷. In steps prior to stunning clean water may be used.
- Personnel health.

Also refer to relevant Chapters of the OIE *Terrestrial Animal Health Code*.

¹⁷ [General Principles of Food Hygiene \(CAC/RCP 1-1969\)](#).



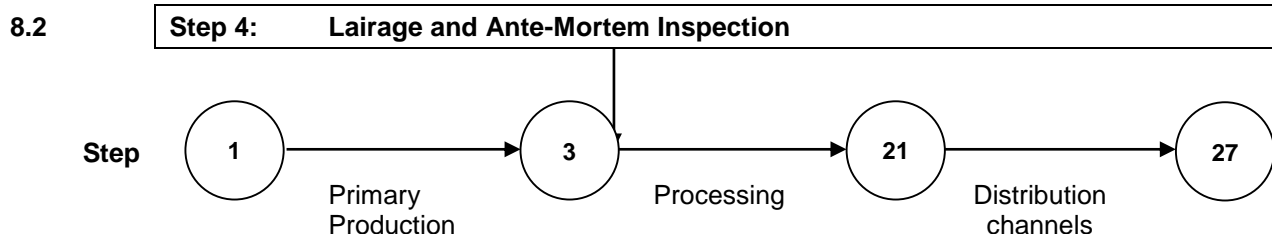
This is the point where cattle arrive at the establishment and the ante-mortem process may begin. There is an increased potential for contamination with enteric pathogens such as *Salmonella* during this time because of their presence on the hide and in faeces of cattle. Additionally, transportation to the slaughter facility, handling during transport and unloading, and interaction with other cattle may cause stress and increased shedding of pathogens. Also refer to relevant Chapters of the OIE *Terrestrial Animal Health Code* and the [Code of Hygienic Practice for Meat \(CAC/RCP 58-2005\)](#).

8.1.1 GHP-based control measures

Loading docks should be maintained clean and should be disinfected as often as practical, taking into account environmental conditions.

When receiving the cattle the slaughterhouse should:

- Consider any information provided by the farm or feedlot, on the production systems or feedlot controls for *Salmonella*. Effective farm and feedlot management and control can reduce faecal shedding of the organism, as well as reduce the microbial load on the animals, and in the intestinal tract.
- The availability of food chain information prior to slaughter, e.g. in the form of electronic or paper records would allow food business operators, meat inspectors and risk managers to take steps to minimize cross-contamination during slaughter. Where the *Salmonella* status is known, this information should be communicated to the slaughterhouse before arrival/receiving. Based on this information for the herd, the establishment may choose to segregate and process cattle at the end of the production day. Additional measures such as reduction of the slaughter speed as well as other control measures could be considered. Consider whether other factors that may contribute to the frequency, quantity and location of *Salmonella* in or on cattle, for example the age, type of cattle received (e.g. veal calves), season (i.e. high prevalence season) or geography represent a concern related to pathogen load and therefore whether adjustments to the food safety system need to be made.
- Establishments should make determinations at receiving/holding about the overall cleanliness of cattle received and classify lots of cattle according to their level of cleanliness. Specific contamination or cross-contamination control measures can be taken based on such determinations. For example, establishments may decide to slow the line speed down to give employees more time to effectively dress the cattle with higher mud scores.



This is the point where the cattle are held before slaughter. There is an increased potential for contamination with *Salmonella* during this time because of their presence on the hide and in faeces of cattle. Additionally, interaction with other cattle may cause stress and increased shedding of pathogens.

8.2.1 GHP-based control measures

Applying a water mist in the holding pens may reduce the accumulation of dust and dirt particles that may carry *Salmonella*.

Routinely cleaning the lairage areas, pens and watering points may help reduce cross-contamination. Cleaning of areas when stock is not in the pens and walkways could avoid contamination of cattle through aerosols.

Care should be taken to control pest animals (e.g. birds and rodents) in the lairage areas in order to reduce

the cross-contamination by these animal vectors.

Hide washing measures can be performed on the live animal or on a slaughtered animal before the hide is removed. To prevent the spread of contamination to the environment and subsequently to carcasses (i.e. cross-contamination of carcasses) the following strategies may be employed:

- Identify or segregate animals with excessive visible contamination.
- Limit the overspray of water.
- Remove excess water from the hide after the wash to decrease cross-contamination during dehidring.
- Avoid pooling of water around the anus of the carcass prior to dropping the bung.

Bacteriophage treatment may be applied to appropriately clean cattle and allowing the bacteriophage appropriate contact time can reduce the bacterial load present on the animal prior to slaughter.

Time spent at lairage and stocking density should be kept to a minimum.

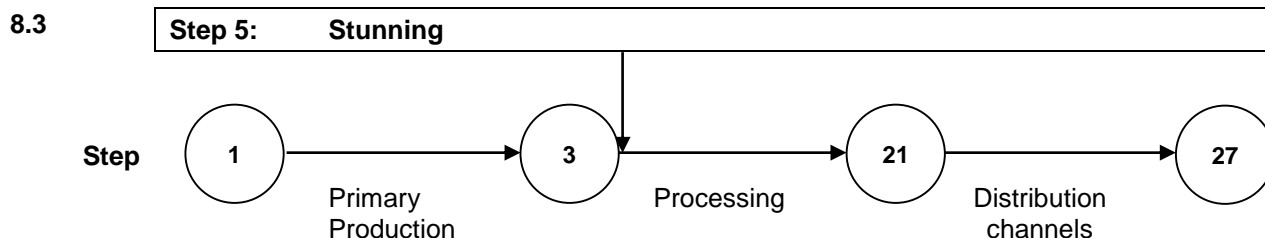
Also refer to relevant Chapters of the OIE *Terrestrial Animal Health Code*.

8.2.2 Ante-mortem Inspection

Ante-mortem inspection should be carried out as soon as practicable after delivery of animals to the lairage. Segregation procedures may be needed for animals designated as potentially infected at the farm level or for animals identified as suspected cases of salmonellosis to minimize contamination.

Ante-mortem inspection may serve as a control step for identifying excessive soiling of the hide with faeces - a risk factor for subsequent cross-contamination from the hide to the carcasses.

Also refer to relevant Chapters of the OIE *Terrestrial Animal Health Code*.



This is the point where the animal is rendered unconscious. This can result in a shedding reflex and become a cross-contamination point due to animal contact with the ground after stunning.

8.3.1 GHP-based control measures

Keep skids outside and inside the stunning box clean.

In case of shedding reflex, faeces should be removed in a sanitary manner.

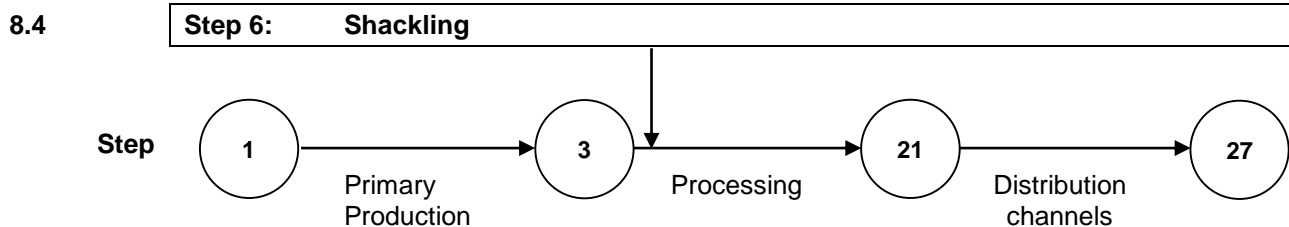
8.3.2 Hazard-based control measures

Decontamination treatments have been shown to be effective in the reduction of pathogens including *Salmonella* on cattle hides. Examples of decontamination treatments are listed below. These hide-on treatments can be used after stunning or at subsequent steps until dehidring. Care should be taken to minimize cross-contamination especially after the hide has been opened at any time.

Washes containing various organic acids, such as lactic acid and acetic acid, may be effective to reduce *Salmonella*. A commercial study found the prevalence of *Salmonella* was reduced following the application of a lactic acid wash(s), for example from 74% to 50% (95% confidence interval 30 - 70)¹⁸.

Washes containing other chemicals, such as peroxyacetic acid and acidified sodium chlorite, may be effective to reduce *Salmonella*. Commercial studies found the prevalence of *Salmonella* was reduced following the application of hydrogen bromide, chlorine, or sodium hydroxide, for example from 62% to 26% (range 18 - 36%).

¹⁸ For all numerical values in hazard-based measures, refer to Interventions for the Control of Nontyphoidal *Salmonella* spp. In Beef and Pork. Report of the Joint FAO/WHO Expert Meeting, 2015 (<http://www.fao.org/3/a-i5317e.pdf>).

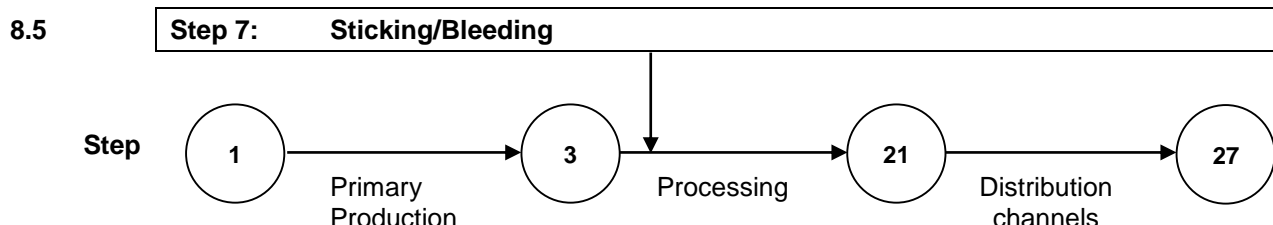


This is the area where the carcass is attached to a device to suspend it to facilitate bleeding and/or dressing.

8.4.1 GHP-based control measures

Animals should be shackled, hung or placed in the bleeding area in such a way that contact between stick wounds and external surfaces of this or other animals (e.g. hide/hoves) is avoided.

Electrical stimulation can be used to hasten the attainment of rigor-mortis and reduction of pH.

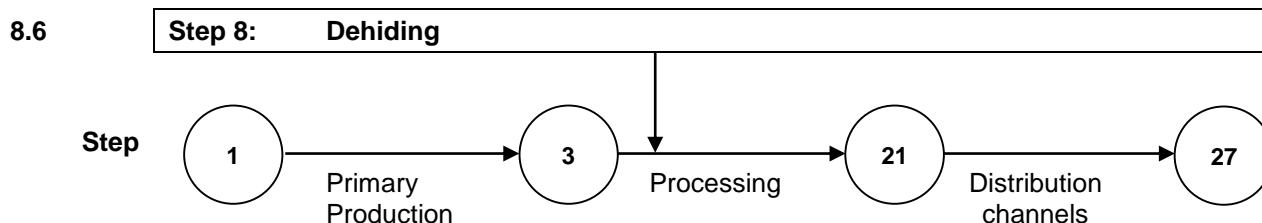


This is the point in the process where the animal is bled. Regardless of the slaughter method, it is important for the establishment to minimize contamination of the carcass during any cut made at this step.

8.5.1 GHP-based control measures

Measures to prevent contamination of the carcass underlying the hide during the initial cut can include:

- Using the smallest effective cut possible to accomplish bleeding.
- Using a validated one- or two-knife system including hand and knife cleaning and knife disinfecting between sticking each carcass as necessary.
- It may be necessary to clean the carcass area prior to sticking. A mechanical process like scraping the hide surface to remove physical contamination can be utilized.
- Be aware of mud-contamination moving downwards into the cut.



This is the point in the process where the hide is removed from the animal. Hides are a significant source of potential contamination with *Salmonella*. It is important to maintain sanitary conditions when handling the hide.

8.6.1 GHP-based control measures

Hide-removal measures to prevent direct contamination of the carcass during the opening of the hide (other than sticking) can include:

- Removing visible contamination at the intended cut line (e.g. with air knives, by using dedaggers or by steam vacuuming).
- Using a two-knife system whereby one knife is used for opening the hide and another disinfected knife is used for dehiding by leading the knife between skin and meat surface.
- Removing the udder in such a way that the surface and the contents do not contaminate the carcass.
- Following procedures to prevent contamination of the exposed carcass from the hide, a soiled knife or other utensils or employee hand, for example.

Measures to limit cross-contamination of carcasses during hide removal can include:

- a) Employing shields/barriers (e.g. papers) to prevent contamination and cross-contamination of carcasses.
- b) Severing or removing the switch on the tail when using hide pullers to minimize the possibility that contaminants become airborne from splattering or flapping of the hide.
- c) When employing a mechanical hide puller:
 - i. ensure mechanical hide pullers pull the hide away from the carcass in a downward or backwards motion (i.e. not upward), thereby reducing the potential for contamination to drip, splatter, or flap onto the carcass or employees handling de-hided carcasses.
 - ii. ensure the exterior side of the hide does not touch, slap, or flap onto the carcass when being removed.
- d) Maintain equipment contacting the de-hided carcass clean including the mechanical hide puller contact points with the hide, hands and garments of the employees handling the hide and the carcass, knives, etc.
- e) Ensuring adequate distance between carcasses throughout the slaughter dressing process to minimize carcass-to-carcass contact and cross-contamination.

Line speed and other process parameters should be monitored and adjusted during instances of excessive hide contamination to ensure proper removal of the hide.

Contamination detection techniques, for example, chlorophyll detection equipment, may be used, at this point or later in the dressing process, as a means to identify faecal material on carcasses.

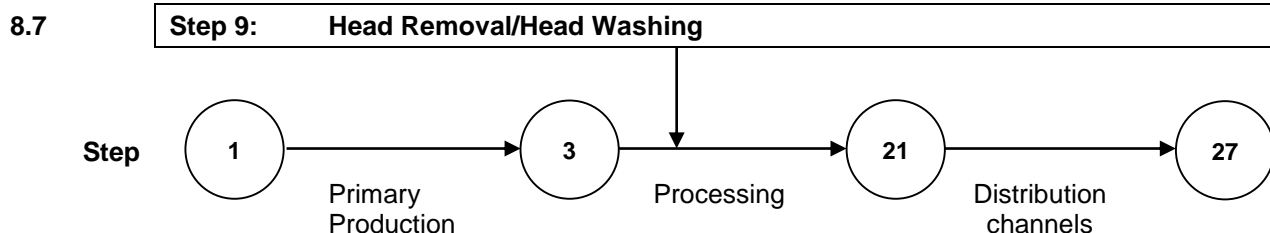
8.6.2 Hazard-based control measures

Decontamination treatments after the hide has been removed have been shown to be effective in the reduction of pathogens including *Salmonella* on carcasses. Examples of decontamination treatments are listed below. These hide-off decontamination treatments can be used immediately after hide removal and at subsequent steps. Equipment for decontamination treatment should be monitored to ensure that the treatment is performed according to the validation parameters.

Thermal treatments (water and steam) in an appropriate combination of temperature and time, have been shown to reduce *Salmonella* prevalence. It is generally accepted that the carcass surface temperature should reach at least 70°C. A commercial study found thermal treatments (hot water at 74-88°C at the pipe for 18-39 seconds) reduced the prevalence of *Salmonella* from 30 to 2%. Reductions between 1 and 2 log₁₀ CFU/cm² could be expected under commercial setting.

Organic acid washes, such as lactic acid and acetic acid at an appropriate temperature, have been shown to reduce *Salmonella* concentration. Challenge studies under laboratory and pilot establishment conditions found organic acid washes reduced *Salmonella* levels from almost no reduction up to 3 log₁₀ CFU/cm² compared to water. Reductions exceeding 1 log₁₀ CFU/cm² would not be expected under commercial settings.

Other chemical washes, such as peroxyacetic acid and acidified sodium chlorite, have been shown to reduce *Salmonella* concentration. Challenge studies under laboratory and pilot establishment conditions found other chemical washes reduced *Salmonella* levels between almost no reduction to 2.6 log₁₀ CFU/cm² compared to water. Reductions exceeding 1 log₁₀ CFU/cm² would not be expected under commercial settings.



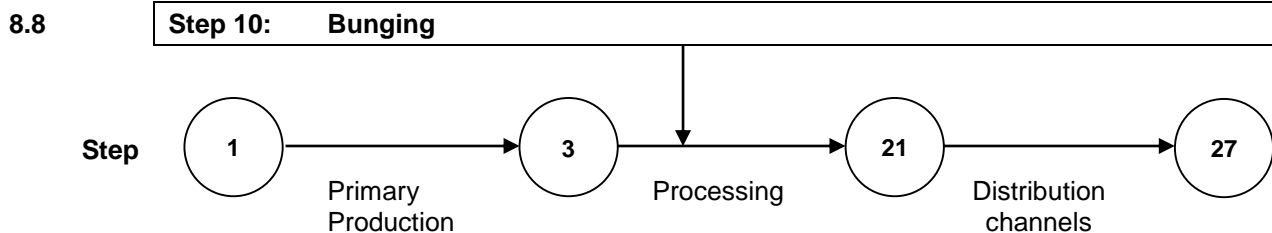
This is the point in the slaughter process where the head is totally or partially removed from the carcass. It is important to maintain hygienic conditions because cross-contamination can occur if the head comes into contact with other carcasses or heads, equipment and employees.

8.7.1 GHP-based control measures

Measures to minimize contamination of heads, equipment, and employees can include:

- a) Removing heads in a manner that avoids contamination with digestive tract contents.
- b) Tying the oesophagus (weasand) as soon as possible after stunning to minimize contamination of buccal cavity and head with ingesta.
- c) If necessary, adequately washing heads, including thoroughly flushing the nasal cavities and mouth, before washing the outside surfaces.
- d) Limiting the splashing of water when washing heads in order to prevent cross-contamination and to limit airborne contaminants.
- e) Properly maintaining, cleaning and disinfecting knives as needed.
- f) Ensuring that:
 - i. excessively contaminated heads do not enter the cabinet,
 - ii. the equipment holding the head does not contaminate the head,
 - iii. spray from the cabinet does not spread contamination to adjacent heads if a head wash cabinet is used at this point in the slaughter process, or
 - iv. if a wash is being used, it does not contaminate the cheek meat and tongue of the head being washed and inspected.
- g) Horns should be removed with surrounding hides to minimize contamination.
- h) De-hided heads should be kept in a manner to minimize contamination with other hides, floors or inner walls.

After dehiding and removal of the head and before passing the carcass on to brisket/midline opening, any visible faecal contamination and residual hairs should be removed. This can be done by knife trimming where visible contamination is cut off and discarded. Knives should be cleaned and disinfected regularly, at least between each carcass trimmed, and hands should also be washed between carcasses as necessary.



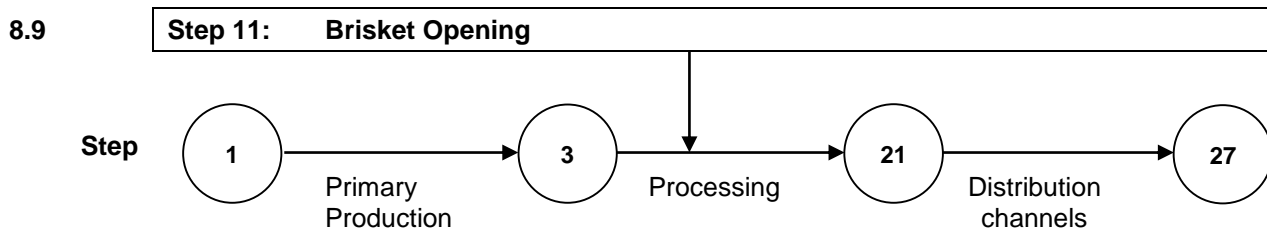
This is the point in the slaughter process where a cut is made around the rectum (i.e. terminal portion of the large intestine) to free it from the carcass, and then it is tied off to prevent spillage of faecal material.

8.8.1 GHP-based control measures

Measures to prevent carcass contamination during bunging can include:

- a) Completing bunging operations prior to hide removal.
- b) Putting plastic bags and ties on the bung in a sanitary manner.

Clean and disinfect equipment between carcasses, for example by using organic acids or heat, where applicable.

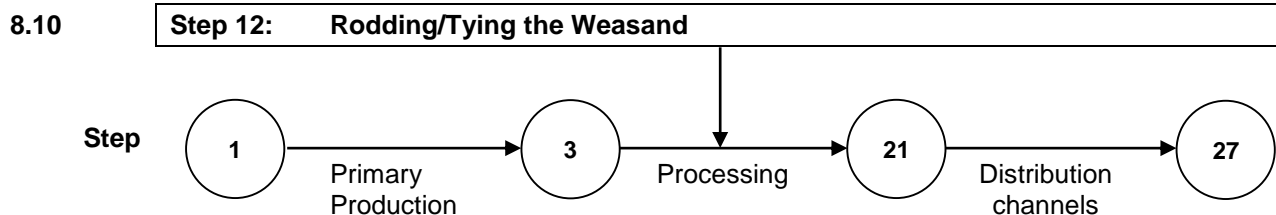


This is the point in the process where the brisket is split (i.e. cut along the centreline).

8.9.1 GHP-based control measures

Measures to prevent the introduction of contamination into the carcass during brisket opening can include:

- Cleaning and disinfecting the brisket saw and knife between each carcass and ensuring that the gastrointestinal tract is not punctured.
- If the gastrointestinal tract has been punctured causing a major contamination, the carcass should be identified and additional procedures to avoid cross-contamination should be performed.



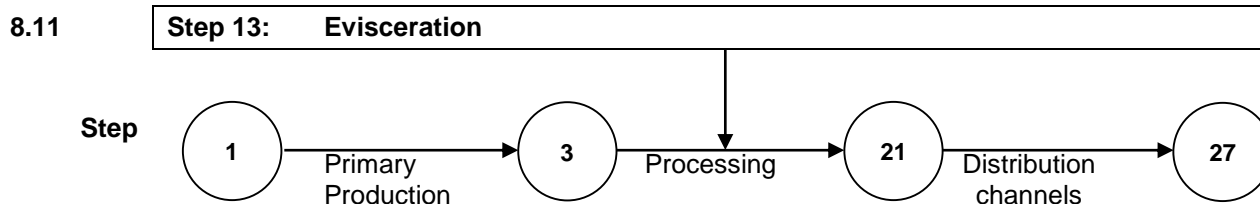
This is the point in the process where the establishment uses a metal rod to free the oesophagus (weasand) from the trachea and surrounding tissues. Weasand meat may be recovered from the gastrointestinal tract for use in raw ground beef production. It is important, at this point in the process, that contamination is not transferred from the exterior of the carcass to the interior or onto the weasand. In addition, if, during the rodding process, the gastro-intestinal tract is punctured, it can cause contamination of the carcass interior and exterior with ingesta content.

8.10.1 GHP-based control measures

The weasand should be closed (i.e. tied) to prevent rumen spillage.

Measures to prevent cross-contamination of the carcass during rodding the weasand can include:

- Changing or disinfecting the weasand rod between each carcass.
- Cleaning the weasand to minimize cross-contamination, and chilling it quickly to prevent the growth of *Salmonella*.
- If the gastrointestinal tract has been punctured causing a major contamination, the carcass should be identified and additional procedures to avoid cross-contamination should be performed.



This is the point in the process where the removal of the viscera (e.g. the edible offal that includes the heart, intestines, rumen, liver, spleen, and kidneys when presented with viscera) occurs. 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.

8.11.1 GHP-based control measures

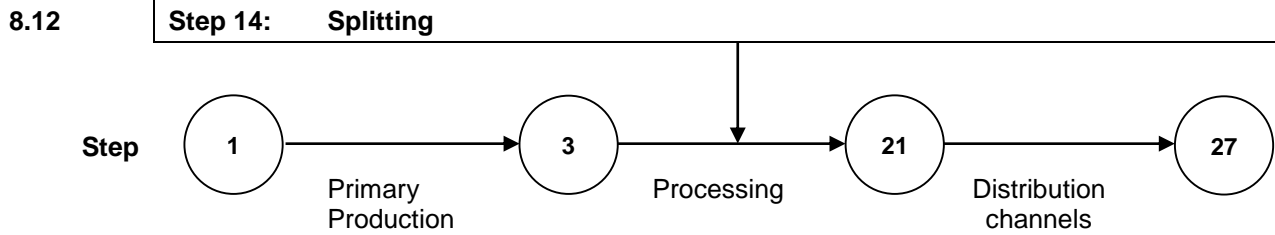
Measures to prevent contamination of the viscera during removal can include:

- Removing 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. This should be done in a timely manner and in accordance with commonly accepted reconditioning procedures.
- If pregnant, removing the uterus in a manner that prevents contamination of the carcass and viscera.
- Cutting through tonsils should be avoided because of the risk of spreading *Salmonella* from tonsil tissue.

Measures to ensure that employees do not contaminate carcasses during evisceration can include:

- Properly using knives to prevent damage (i.e. puncturing) to the rumen and intestines.
- Using footbaths or separate footwear by employees on moving evisceration lines to prevent contaminating other parts of the operation.

- c) Trained and experienced individuals should perform the evisceration; this is particularly important at higher line speeds.
- d) If the gastrointestinal tract has been punctured causing a major contamination no further work should be carried out on the carcass until it has been removed from the slaughter line.

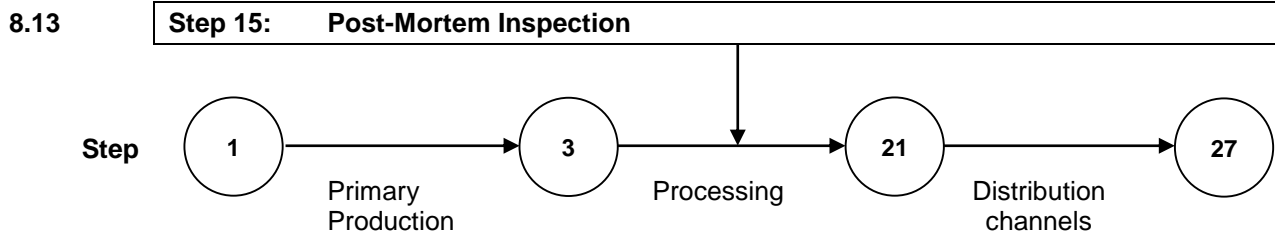


This is the point in the process where carcasses are split vertically into two halves.

8.12.1 GHP-based control measures

Measures to prevent the split carcass from becoming contaminated can include:

- a) Cleaning to remove organic material and disinfecting the saws and knives between each carcass.
- b) Allowing adequate distance between carcasses (i.e. avoid carcass-to-carcass contact) and walls and equipment.



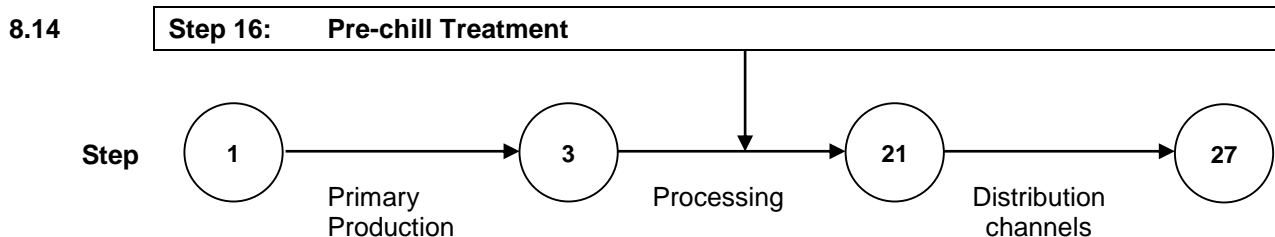
This is the point in the process where detailed inspection of carcasses is carried out.

8.13.1 GHP-based control measures

Line speeds and the amount of light should be appropriate for effective post-mortem inspection of carcasses.

The procedures should be planned to avoid cross-contamination. Touching the carcasses with hands, tools or garments may cause cross-contamination.

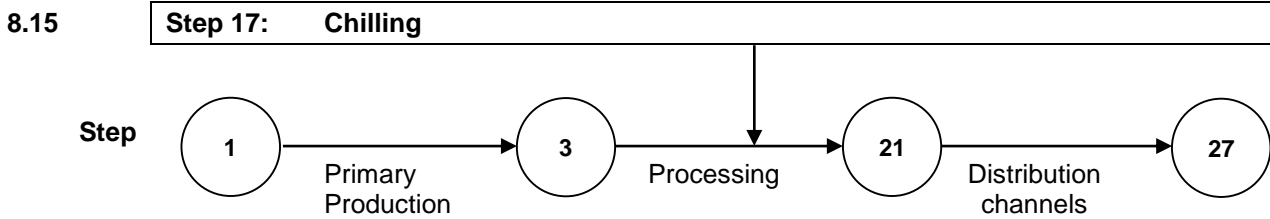
The need for routine palpations and incisions during post-mortem inspection should be weighed against the potential impact on cross-contamination with *Salmonella* through the application of these techniques.



At this stage in the process, the carcass may be subject to a treatment in order to remove *Salmonella* and other contaminants from the surface of the carcass prior to entering the chilling room. The treatment may be also applied at other suitable stages.

8.14.1 Hazard-based control measures

Hazard-based control measures identified in step 8, Dehiding, can be used at this stage in the slaughter process to reduce *Salmonella*.



This is the point in the process where the carcass is chilled.

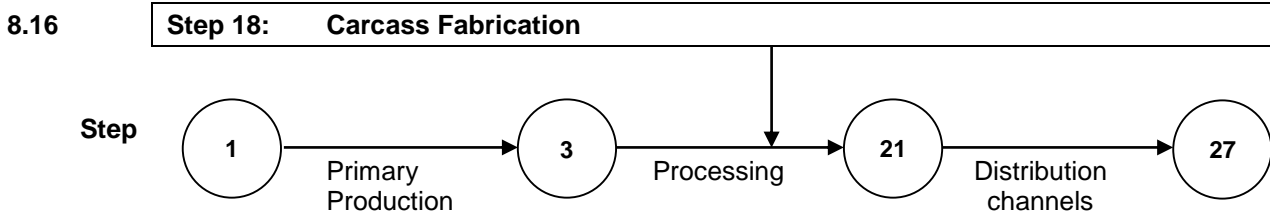
8.15.1 GHP-based control measures

Chilling inhibits the growth of *Salmonella*. The effect of chilling depends on carcass spacing, air flow, and cooling capacity. Carcasses should be adequately spaced to allow for effective cooling and prevention of cross-contamination.

Carcass chilling should begin within one hour of bleed-out.

Effective temperature control should be implemented to achieve and maintain a carcass surface temperature to prevent the growth of *Salmonella*.

Sanitary conditions should be maintained in the chilling room.



These steps include cutting and deboning that can result in wholesale pieces.

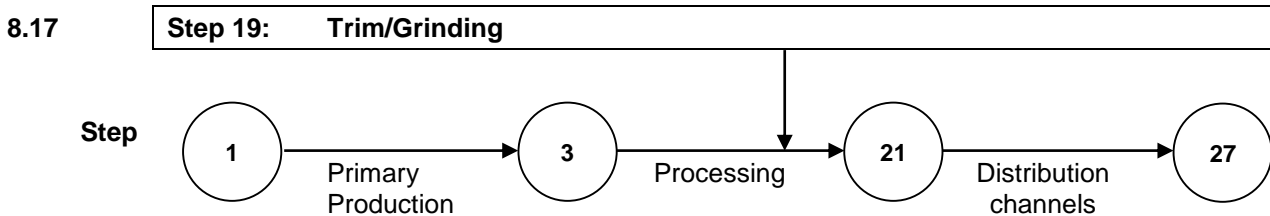
8.16.1 GHP-based control measures

Boning and fabrication rooms should be kept at a temperature that limits the ability for *Salmonella* to grow.

In order to reduce time out of chilling room, and to limit the growth of *Salmonella*, a reasonable flow of products should be ensured.

Knives, saws, slicers, and other food contact surfaces should be cleaned and disinfected as frequently as necessary to prevent the creation of unsanitary conditions.

Airflow should be controlled to prevent cross-contamination from slaughter operations, e.g. positive air pressure in carcass fabrication area relative to other areas in the slaughter operations.



This is the point where during carcass fabrication, trim may be generated and used for the production of ground beef.

8.17.1 GHP-based control measures

Products should be stored at temperatures to prevent the growth of *Salmonella*.

Equipment used for this operation should be adequately maintained and adjusted.

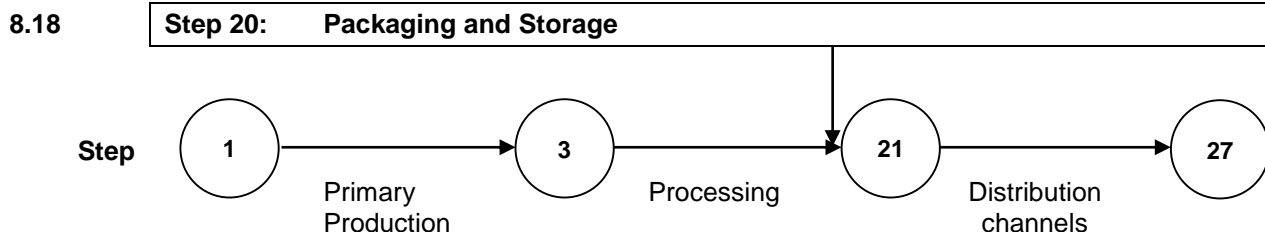
In order to avoid cross-contamination, equipment and environment should be cleaned on a regular basis and good personal hygiene practices should be followed by employees.

Processes such as grinding, may potentially spread contamination in the meat. There should be increased awareness when handling of the meat throughout the rest of the food chain.

If equipment is used to process meat of a different risk profile (e.g. adult beef vs. veal) the equipment should be cleaned when changing from higher risk product to lower risk products. Alternatively lower risk product should be processed first.

8.17.2 Hazard-based control measures

Chemical washes, such as lactic acid and peroxyacetic acid, have been shown to reduce *Salmonella* concentration. Challenge studies under laboratory and pilot establishment conditions found other chemical washes reduced *Salmonella* levels between almost no reduction to 4 log₁₀ CFU/g compared to water. Reductions exceeding 1 log₁₀ CFU/g would not be expected under commercial setting.\



8.18.1 GHP-based control measures

Packaging rooms should be kept at a temperature that limits the growth of *Salmonella*.

Use of various technology packaging may limit the growth of *Salmonella*.

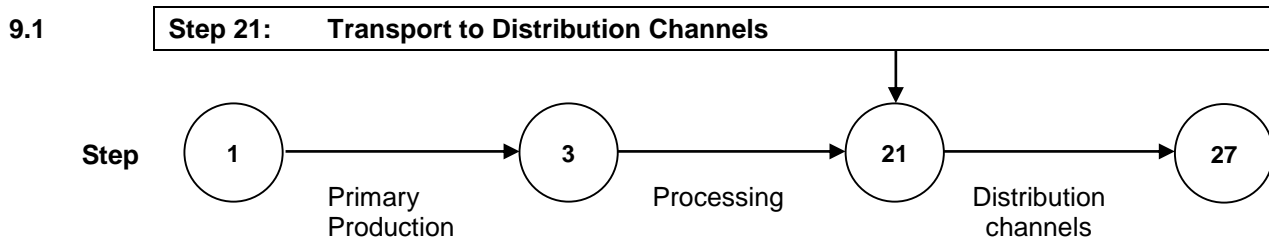
The storage room should be maintained at a temperature that prevents the growth of *Salmonella*.

The temperature of the packaging and storage rooms and meat should be monitored and documented.

8.18.2. Hazard-based control measures

Various doses of ionizing radiation have been shown to be effective at eliminating *Salmonella* in warm, chilled or frozen beef. Application and control of the process should take into consideration the [General Standard for Irradiated Foods \(CODEX-STAN 106-1983\)](#) and the [Code of Practice for Radiation Processing of Food \(CAC/RCP 19-1979\)](#). Irradiation of ground beef resulted in D₁₀ values (kGy) of 0.618-0.661 for *Salmonella*, with differences possible between serovars.

9. CONTROL MEASURES FOR DISTRIBUTION CHANNELS (STEPS 21 TO 27)

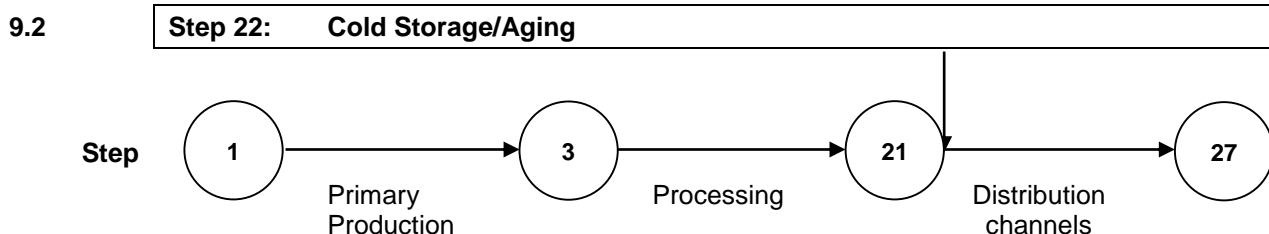


9.1.1 GHP-based control measures

Transportation vehicles should be kept clean and free of pests.

Transportation vehicle should be maintained at a temperature that ensures the temperature of the chilled meat is adequate to prevent the growth of *Salmonella*.

Temperature of vehicle and meat should be monitored and documented. Meat should be chilled before loading onto the vehicle for transport.

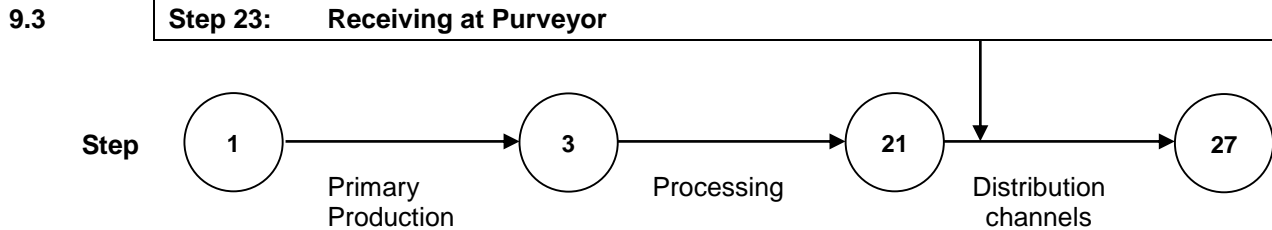


9.2.1 GHP-based control measures

Storage room temperature should be maintained at a temperature that prevents the growth of *Salmonella* in the chilled meat.

Storage room temperature should be monitored and documented.

During dry-aging, the humidity should be kept low to prevent the growth of *Salmonella*.

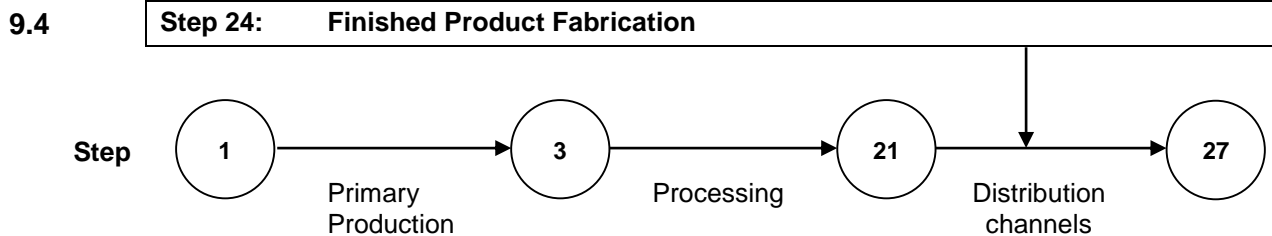


9.3.1 GHP-based control measures

The state of products shipped, the containers, their content and the temperature of the product should be verified.

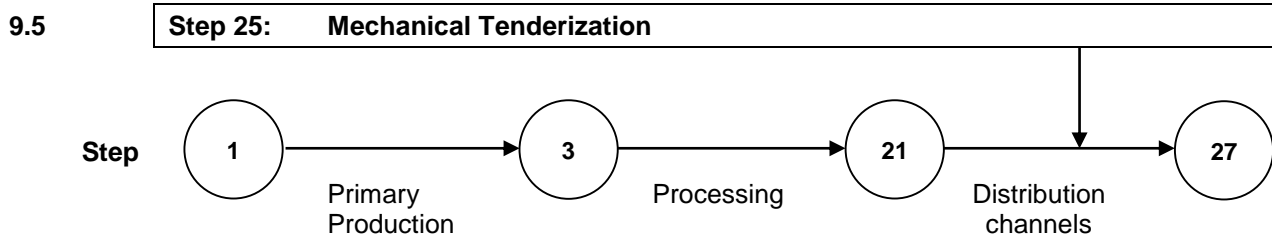
An agreement between the abattoir and the purveyors for sharing microbiological testing results of the material received may need to be established. The agreement could include whether presumptive or confirmed results are required and the actions that will be taken in the event of a positive result.

Products should be kept at a temperature to prevent the growth of *Salmonella*.



9.4.1 GHP-based control measures

Products should be stored at temperatures to prevent the growth of *Salmonella*.



This is the point in the process where the meat is subjected to the process of breaking fibres mechanically or manually. This step can be a cross-contamination point if the procedures and handling are not performed in a sanitary manner and by trained and experienced employees.

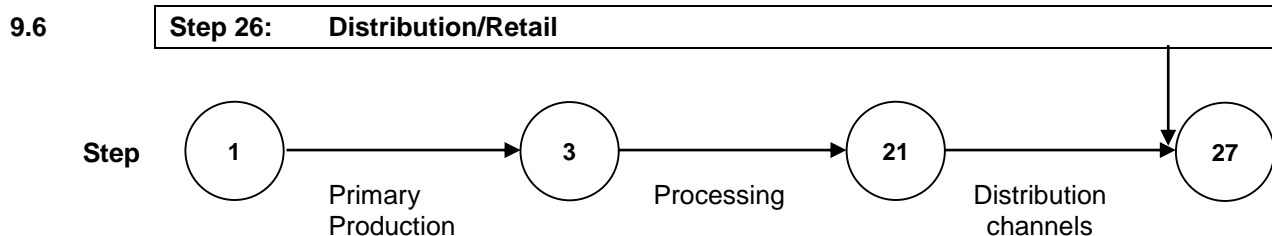
9.5.1 GHP-based control measures

Products should be stored at temperatures to prevent the growth of *Salmonella*.

Equipment used for this operation should be adequately maintained and adjusted.

In order to avoid cross-contamination, equipment and environment should be cleaned on a regular basis and good personal hygiene practices should be followed by employees.

Processes such as mechanical tenderization may potentially increase contamination in the meat. There should be increased awareness when handling of the meat throughout the rest of the food chain.



9.6.1 GHP-based control measures

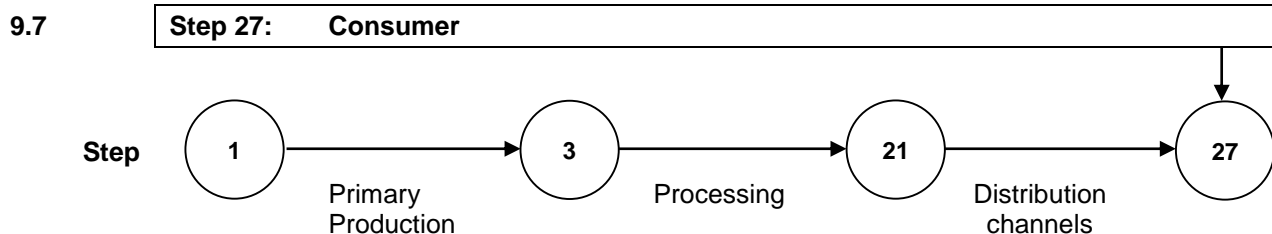
Fresh meat should be held at a temperature that prevents the growth of *Salmonella*.

The temperature of the storage room and display cases should be monitored and documented.

Cross-contamination from or to other food items should be prevented.

Food business operators serving meat for direct consumption to consumers (e.g. caterers, restaurateurs) should take appropriate measures to:

- a) Prevent cross-contamination.
- b) Maintain appropriate storage temperature.
- c) Ensure proper cleaning.
- d) Ensure proper cooking.



9.7.1 GHP-based control measures

Consumers should be informed about the potential risk associated with finished beef product in order to follow instructions and make informed choices on how to avoid the spread and growth of *Salmonella* (e.g. storage, thawing and cooking temperatures, hygiene including hand washing). The WHO Five Keys to Safer Food¹⁹ assists in this process.

Cooking of beef can reduce or eliminate *Salmonella*.

Consumers should be appropriately informed of raw treated meat (e.g. mechanically tenderized, minced meat) so they can take appropriate actions to make sure meat is properly cooked.

Special attention should be paid to the education of all persons preparing food, and particularly to those preparing food for the young, old, pregnant and immuno-compromised.

Consumers should wash and disinfect food contact surfaces and utensils after raw beef preparation to significantly reduce the potential for cross-contamination in the kitchen.

The above information to consumers should be provided by the competent authority, local government, health agencies, manufacturers, retailers or other consumer sources and through multiple channels such as national media, health care professionals, food hygiene trainers, product labels, pamphlets, school curricula and cooking demonstrations.

¹⁹ <http://www.who.int/foodsafety/consumer/5keys/en/>

SPECIFIC CONTROL MEASURES FOR PORK
(For Sections 6 to 9)

6. PRIMARY PRODUCTION-TO-CONSUMPTION APPROACH TO CONTROL MEASURES

These Guidelines incorporate a “primary production-to-consumption” flow diagram that identifies the main steps in the food chain where control measures for *Salmonella* may potentially be applied in the production of pork. While control in the primary production phase can decrease the number of animals carrying and/or shedding *Salmonella*, controls after primary production are important to prevent the contamination and cross-contamination of carcasses and meat products. The systematic approach to the identification and evaluation of potential control measures allows consideration of the use of controls in the food chain and allows different combinations of control measures to be developed. This is particularly important where differences occur in primary production and processing systems between countries. Risk managers need the flexibility to choose risk management options that are appropriate to their national context.

6.1. Generic flow diagram for application of control measures

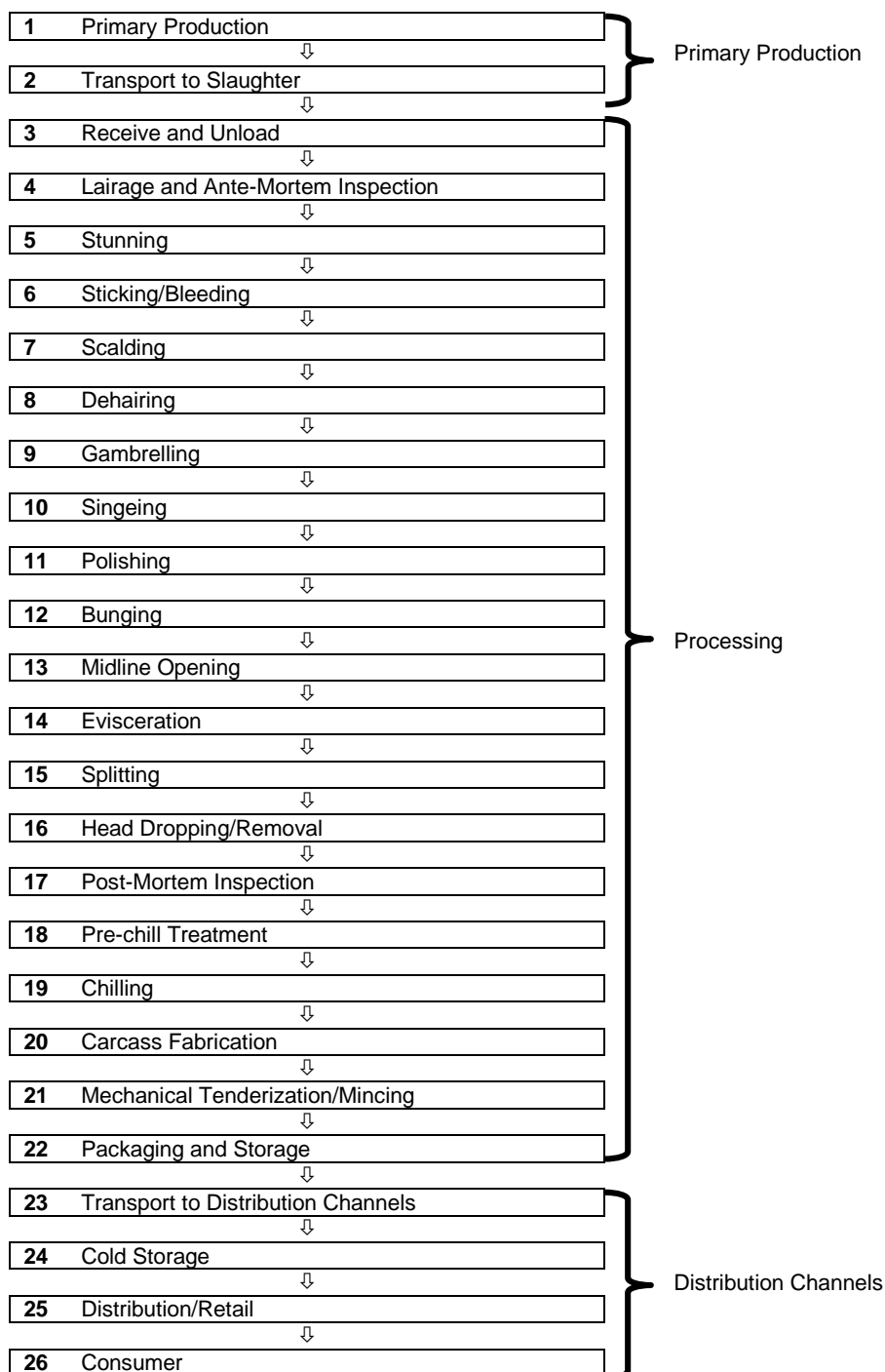
A generic flow diagram of the basic pork production processes is presented on the following pages. GHP- or hazard-based interventions that may be applied during processing skin-on carcasses have been identified at the appropriate process step(s) in the flow diagram.

Individual establishments will have variations in process flow and, if possible or required by national law, should develop and adapt HACCP plans accordingly. In countries where HACCP is not widely used, the fundamental principles and practices of HACCP may still be applicable.

The basic steps in the slaughter process are to a large extent common for processing pigs skin-on, but they may be carried out differently in different slaughterhouses or countries. Therefore the necessity to use supplementary mitigation steps will also vary among individual slaughterhouses and countries. The use of supplementary mitigation steps will depend on the food safety targets set, for example, by the competent authorities or customers (e.g. retail chains) and will be influenced by a range of factors, for example animal feed, hygienic slaughter procedures, age of livestock, farming practices, size of establishment, equipment, automation, slaughter line speed, and the initial *Salmonella* load from incoming animals (e.g. seasonal variation). A variety of interventions may be used to reduce contamination with *Salmonella* throughout processing. While the effect on *Salmonella* of the individual interventions can be variable, there is clear evidence that use of multiple interventions throughout different production and processing steps as part of a “multiple-hurdle” strategy will provide a more consistent reduction of *Salmonella*.

Process Flow Diagram: Primary Production–to-Consumption – Pork

These process steps are generic and the order may be varied as appropriate. This flow diagram is for illustrative purposes only. For application of control measures in a specific country or an establishment, a complete and comprehensive flow diagram should be drawn up.



6.2. Availability of *Salmonella* control measures at specific process flow steps addressed in these Guidelines

The following table illustrates where specific control measures for *Salmonella* may be applied at each of the process flow steps of the food chain. Control measures are indicated by a check mark and their details are provided in these Guidelines and relevant Chapters of the OIE *Terrestrial Animal Health Code*²⁰ in the case of GHP. A blank cell means that a specific control measure for *Salmonella* has not been identified for the process flow step.

²⁰ Refer to the OIE website: <http://www.oie.int/en/international-standard-setting/terrestrial-code/access-online/>

Decontamination treatments may be applied at multiple steps (see following table) within the process flow and may vary among countries, establishments or type of process flow. However, decontamination treatments should not be considered to replace or reduce GHP-based control measures to maintain food safety. Such treatments should not contribute to possible chemical risks.

Availability of Control Measures at Specific Steps in the Process Flow

Process Step	GHP-based Control Measures	Hazard-based Control Measures
1 Primary Production ↓	Refer to ^{20,21}	
2 Transport to Slaughter ↓	Refer to ^{20,21}	
3 Receive and Unload ↓	✓ Refer to ^{20,21}	
4 Lairage and Ante-Mortem Inspection ↓	✓ Refer to ^{20,21}	
5 Stunning ↓	✓	
6 Sticking/Bleeding ↓	✓	
7 Scalding ↓	✓	✓
8 Dehairing ↓	✓	
9 Gambrelling ↓	✓	
10 Singeing ↓	✓	✓
11 Polishing ↓	✓	
12 Bunging ↓	✓	
13 Midline Brisket Opening ↓	✓	
14 Evisceration ↓	✓	
15 Splitting ↓	✓	
16 Head Dropping/Removal ↓	✓	✓#
17 Post-Mortem Inspection ↓	✓	
18 Pre-chill Treatment ↓	✓	✓
19 Chilling ↓	✓	
20 Carcass Fabrication ↓	✓	
21 Mechanical Tenderization/Mincing ↓	✓	
22 Packaging and Storage ↓	✓	✓
23 Transport to Distribution Channels ↓	✓	
24 Cold Storage ↓	✓	
25 Distribution/Retail ↓	✓	
26 Consumer	✓	

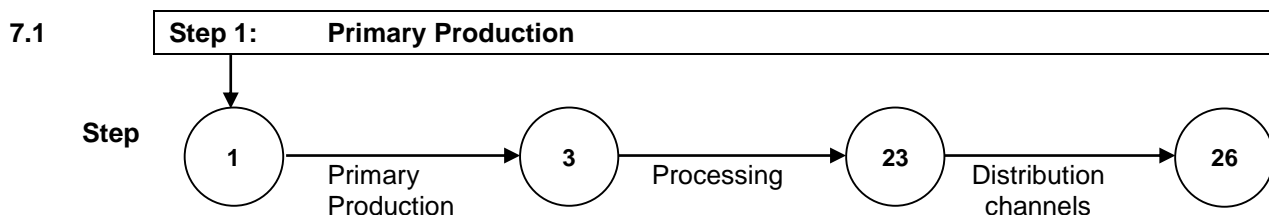
Details for specific hazard-based controls can be found under Step 18, Pre-chill Treatment

²¹ [Code of Hygienic Practice for Meat \(CAC/RCP 58-2005\)](#).

7. CONTROL MEASURES FOR STEP 1 TO 2 (PRIMARY PRODUCTION)

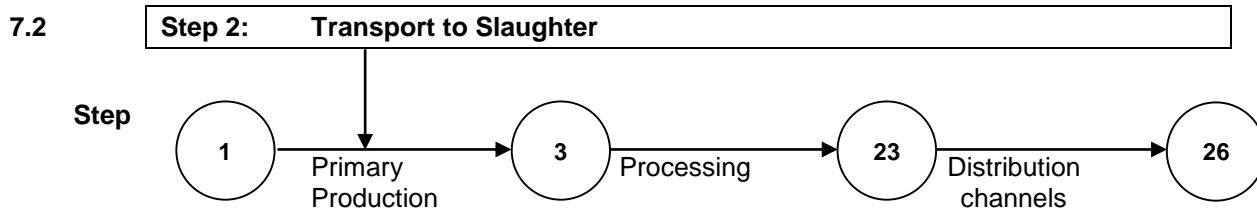
These Guidelines should be used in conjunction with relevant Chapters of the OIE *Terrestrial Animal Health Code*, the [Code of Practice on Good Animal Feeding \(CAC/RCP 54-2004\)](#), and [Code of Hygienic Practice for Meat \(CAC/RCP 58-2005\)](#).

It has been shown in some production systems that control of *Salmonella* in pork can begin on the farm. *Salmonella* prevalence in the herd is a factor for determining the *Salmonella* prevalence and numbers on carcasses. Practical measures to control *Salmonella* during primary production should be implemented.



7.1.1 GHP-based control measures

Refer to relevant Chapters of the OIE *Terrestrial Animal Health Code*.



7.2.1 GHP-based control measures

Refer to relevant Chapters of the OIE *Terrestrial Animal Health Code* and the [Code of Hygienic Practice for Meat \(CAC/RCP 58-2005\)](#).

8. CONTROL MEASURES FOR STEPS 3 TO 22 (PROCESSING)

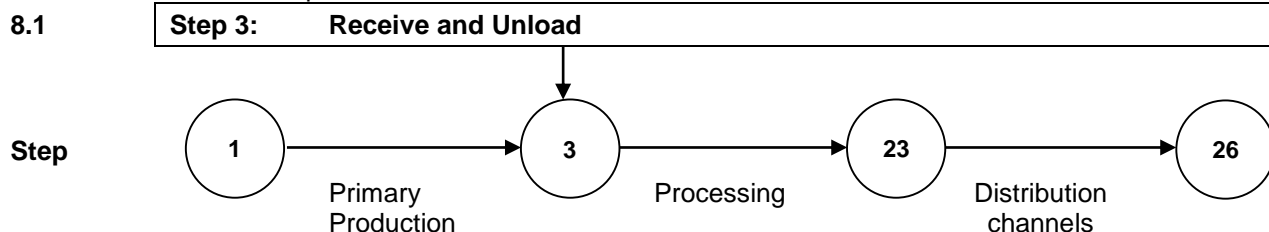
An increased diversity of *S. enterica* serovars has been observed after slaughter compared to that of isolates from pen mates on the farm. The larger diversity suggests that pigs may be exposed to other serovars after leaving the farm i.e. during transport, in lairage and at slaughter. Therefore there should be focus on cross-contamination during these steps.

General control measures including those identified in the [Code of Hygienic Practice for Meat \(CAC/RCP 58-2005\)](#) should be implemented to prevent the contamination or cross-contamination of carcasses throughout the slaughter process. Control measures that may have particular impact on the control of *Salmonella* include:

- Equipment and the environment should be kept clean and disinfected as required.
- Cleaning and disinfection procedures should be employed regularly and performed in a manner to prevent spread of pathogens.
- Water accumulation on the floor should be avoided and good floor drainage design should be ensured.
- Equipment should be maintained and designed to avoid contamination and build-up of organic material.
- Knives should be cleaned and disinfected between carcasses.
- Personnel should be trained both on operations and food safety aspects of slaughtering. The line speed should leave adequate time to perform all process steps in the operations.
- Proper employee hygiene practices should be maintained to prevent the creation of unsanitary conditions (e.g. touching product with soiled hands, tools, or garments). Hygiene should include regular washing of hands to prevent cross-contamination.
- Water used for decontamination or cleaning and disinfection of equipment should be potable²². At steps prior to stunning clean water may be used.
- Personnel health.

²² [General Principles of Food Hygiene \(CAC/RCP 1-1969\)](#).

Also refer to relevant Chapters of the OIE *Terrestrial Animal Health Code*.



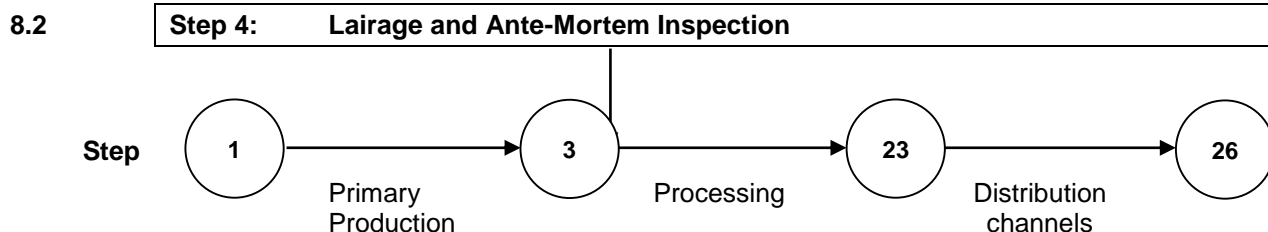
This is the point where the pigs arrive at the establishment and the ante-mortem process may begin. There is an increased potential for contamination with enteric pathogens such as *Salmonella* during this time because of their presence in pig's faeces. Additionally, transportation to the slaughter facility, handling during transport and unloading, and interaction with other pigs may cause stress and increased shedding of pathogens.

8.1.1 GHP-based control measures

Loading docks should be maintained clean and should be disinfected as often as practical, taking into account environmental conditions.

The availability of food chain information prior to slaughter, e.g. in the form of electronic or paper records would allow food business operators, meat inspectors and risk managers to take steps to minimize cross-contamination during slaughter. Where the *Salmonella* status is known, this information should be communicated to the slaughterhouse before arrival/receiving. Based on this information for the herd, the establishment may choose to segregate and process pigs at the end of the production day. Additional measures such as reduction of the slaughter speed as well as other control measures could be considered.

Also refer to relevant Chapters of the OIE *Terrestrial Animal Health Code* and the [Code of Hygienic Practice for Meat \(CAC/RCP 58-2005\)](#).



This is the point where the pigs are held before slaughter. There is an increased potential for contamination with *Salmonella* during this time because of their presence in pig's faeces. Additionally, interaction with other pigs may cause stress and increased shedding of pathogens.

8.2.1 GHP-based control measures

Refer to relevant Chapters of the OIE *Terrestrial Animal Health Code* and the [Code of Hygienic Practice for Meat \(CAC/RCP 58-2005\)](#).

Proper cleaning and disinfection of holding pens should be ensured. The design and maintenance at lairage should also be appropriate to allow effective cleaning process.

Care should be taken to control pest animals (e.g. birds and rodents) in the lairage areas in order to reduce the cross-contamination by these animal vectors.

Applying a water shower in the holding pens may reduce the accumulation of dust and dirt particles that may carry *Salmonella*. Ensure that pigs are dry enough to prevent dripping at the time of stunning.

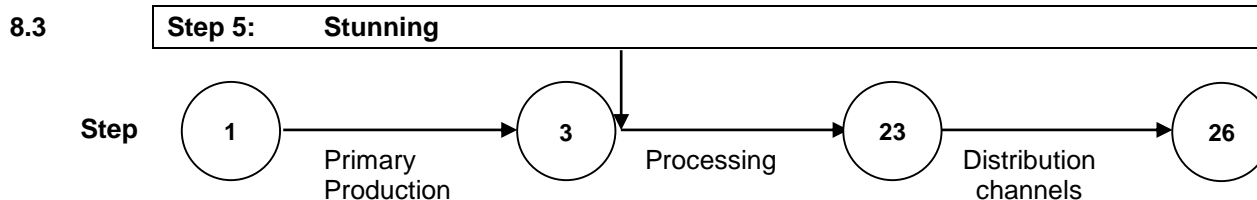
Time spent at lairage and stocking density should be kept to a minimum.

Feed should be withdrawn before slaughter in order to reduce the volume of intestinal contents. This may reduce the risk of intestinal spillage at evisceration.

8.2.2 Ante-mortem Inspection

Ante-mortem inspection should be carried out as soon as practicable after delivery of animals to the lairage. Segregation procedures may be needed for animals designated as potentially infected at the farm level or for animals identified as suspected cases of salmonellosis to minimize contamination.

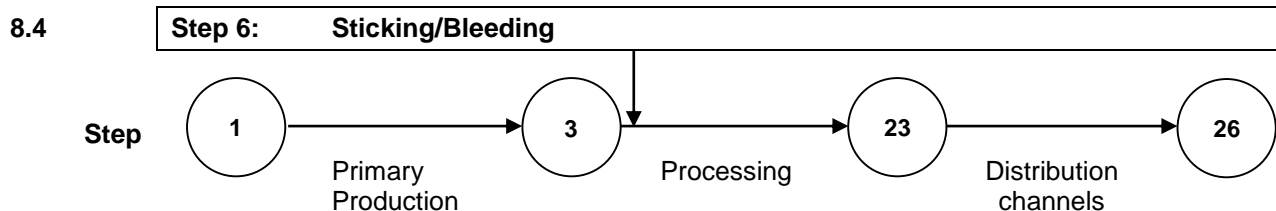
Also refer to relevant Chapters of the OIE *Terrestrial Animal Health Code*.



This is the point where the pig is rendered unconscious. This can result in a shedding reflex and become a cross-contamination point due to animal contact with the ground after stunning.

8.3.1 GHP-based control measures

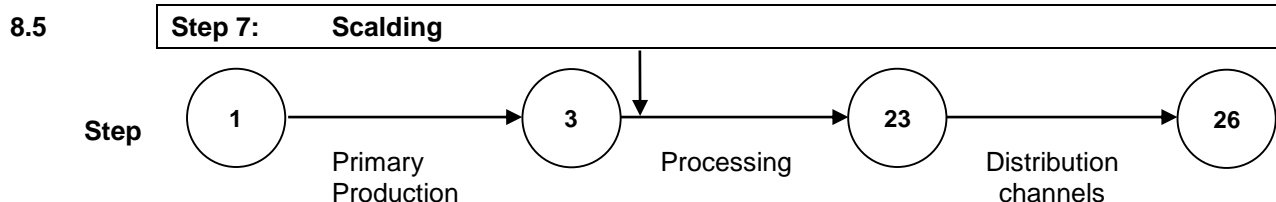
In case of shedding reflex, faeces should be removed in a sanitary manner.



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 made at this step.

8.4.1 GHP-based control measures

Measures should be taken to avoid cross-contamination; cleaning and disinfection of the processing environment should be maintained and carcass contact with the floor while being transferred to the line should be avoided.



This is the point in the process where the carcass is sprayed with or immersed into hot water to facilitate the removal of hair and hooves in the succeeding step. Scalding can efficiently reduce *Salmonella* prevalence; however, at an inappropriate temperature, or in the presence of organic matter in the water, scalding can be a source of *Salmonella* contamination of carcasses. This may be a particular concern with contamination of the pig's pharynx, as subsequent carcass decontamination steps would not address this internal contamination.

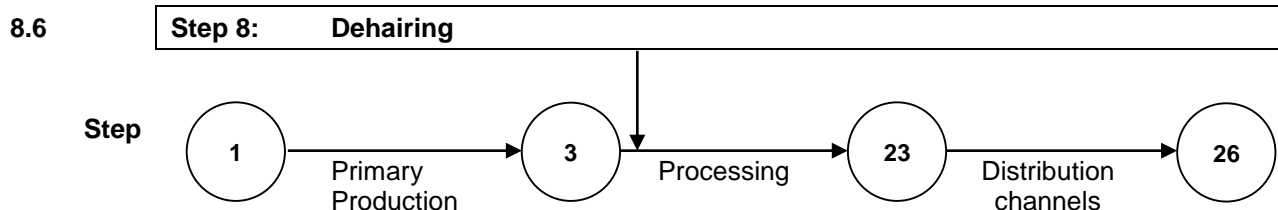
8.5.1 GHP-based control measures

As the cleanliness of the pigs and the microbiological status of the scald water are factors that are significantly associated with the presence of *Salmonella* on the carcasses at the end of the slaughter process, the following measures or equivalent processes should be considered:

- Sanitary conditions should be maintained. Ensure that the scalding tank is easy to clean and in good condition and repair. Accumulations of hair and protein in the scalding tank should be prevented where possible and should be removed before and during operations as needed to maintain sanitary conditions. Condensation should also be controlled as needed. Drain and clean the scalding tank at least once a day. Pay particular attention to seams weld sites and rough, scratched areas in the interior of the tank to ensure adequate cleaning.
- A clean supply of water should be maintained. Recirculation of water may result in greater accumulation of hair and residue and affect the control of temperature fluctuations. Re-use of the scalding tank water in multiple processing batches was associated with a higher *Salmonella* prevalence on carcass swabs. The scalding water should be changed at least once a day to prevent organic load build up. Use counter current water flow (fresh or recirculated scalding water that flows into the scalding tank in an opposite direction from that of the carcasses) to increase heating efficiency and water cleanliness.
- Vertical scalding using steam may improve the bacteriological quality of the meat and prevent bacterial contamination of lungs. A vertical steam scald at 100°C allows for a constant supply of clean steam and prevents the accumulation of organic load as opposed to a water system.

8.5.2 Hazard-based control measures

Scalding efficiently reduces *Salmonella* on carcasses. There is evidence of prevalence reduction from 35% of carcasses to 1.5% (range 8-1%). Scalding water temperature should be at least 61°C for 8 minutes or 70°C for 2-3 minutes or another combination of time and temperature that can achieve an equivalent *Salmonella* reduction²³.



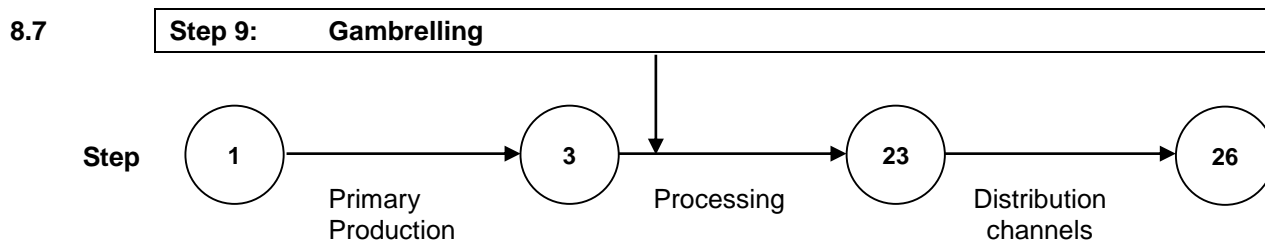
This is the point in the process where the hair is removed from the animal. During dehairing manure is pressed out of the rectum and accumulation of manure and growth of *Salmonella* in the equipment can occur. Among the operations carried out in the unclean area, dehairing and singeing/flaming operations especially affect the number of *Salmonella* on the rind side of the carcass. The combined effect of these two operations can lead to a low prevalence of *Salmonella* after the unclean area. *Salmonella* has been detected in air samples at the locations of dehairing and evisceration operations.

8.6.1 GHP-based control measures

Accumulation of hair in the dehairing equipment should be prevented and removed and sufficient water supply should be ensured as necessary, to maintain sanitary conditions.

At the end of the shift, all organic material and debris from dehairing equipment should be removed. Consider the importance of mechanical action and cleaning. Chemical cleaners and disinfectants should be selected based on several factors including but not limited to the nature of dirt, equipment materials and water hardness.

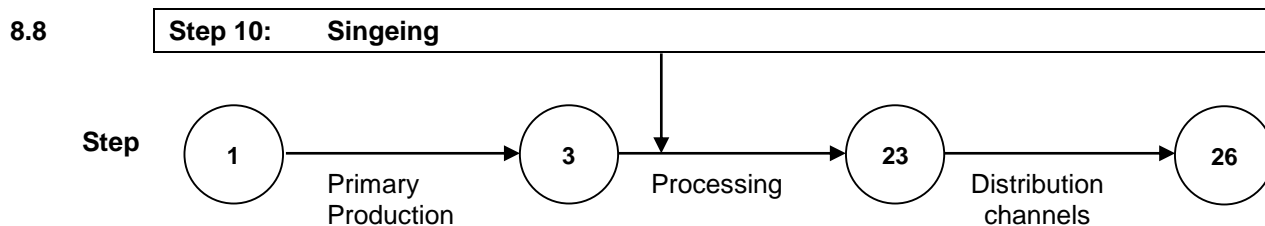
Special care should be taken to prevent recontamination and increases in bacterial load when using a dehairing machine.



Gambrelling is the process of hanging the carcass by the hind legs on hooks.

8.7.1 GHP-based control measures

When gambrel tables are used, carcass contamination should be minimized by cleaning and disinfecting gambrel table when needed to remove faecal materials before processing is resumed.



This is the point in the process where the carcass surface is subjected to direct-fire bursts in order to improve the hair removal and reduce or eliminate the pathogens of skin surface. Singeing has been identified as one of the most important steps for reducing microbial contamination on the surface of pig carcasses, including *Salmonella*.

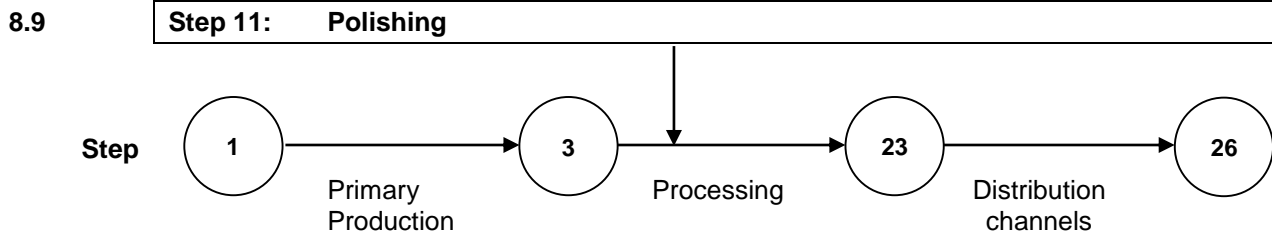
²³ For all numerical values in hazard-based measures, refer to Interventions for the Control of Nontyphoidal *Salmonella* spp. in Beef and Pork. Report of the Joint FAO/WHO Expert Meeting, 2015 (<http://www.fao.org/3/a-i5317e.pdf>).

8.8.1 GHP-based control measures

Singeing is more effective on drier carcasses.

8.8.2 Hazard-based control measures

Singeing can achieve a reduction of *Salmonella* prevalence from 18% pre-treatment to 5% post-treatment (95% confidence interval 3-9) and a 2 log₁₀ CFU/cm² reduction in *Salmonella* concentration. The reduction depends on the intensity of the singeing/flaming and the time used. Increasing time spent in the singeing unit was associated with lower *Salmonella* prevalence in carcass swabs. Singeing temperature should be homogeneous on the carcass as areas such as the base of the ears might not reach the required temperature to inactivate *Salmonella*.



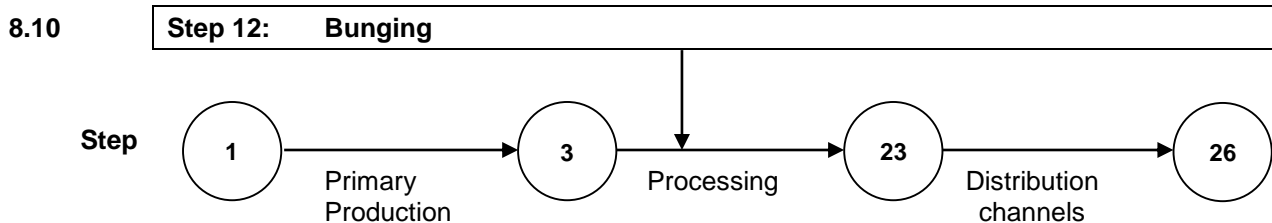
This is the point in the process where the carcass is subjected to the mechanical finishing process of remaining and burned hairs by the previous step. This step aims to eliminate the waste, but polishing is a primary mode of pork carcass recontamination following reductions achieved during singeing. Any surviving bacteria may be mechanically disseminated by stainless steel scrapers or nylon brushes used in polishing.

8.9.1 GHP-based control measures

Polishers should be cleaned thoroughly because they harbour bacteria and allow them to multiply to high numbers. Thorough cleaning and disinfection of the equipment as needed and at the end of the shift will minimize the potential for carcass cross-contamination.

After polishing and before passing the carcasses on to the clean area (bunging) a measure should be in place to prevent visibly contaminated carcasses from being passed on. Steam or hot water vacuum is acceptable to remove faecal contamination. If steam vacuuming is not available, knife trimming can be used to remove faecal contamination and other dressing defects.

If necessary an additional singeing step, after polishing, may be added to reduce contamination introduced by polishing. Consideration should be given as to whether carcasses have been adequately reconditioned in a sanitary manner, if contaminated by faeces voided during the gambrelling step.



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 or an automated bunging system is used to prevent spillage of faecal material.

8.10.1 GHP-based control measures

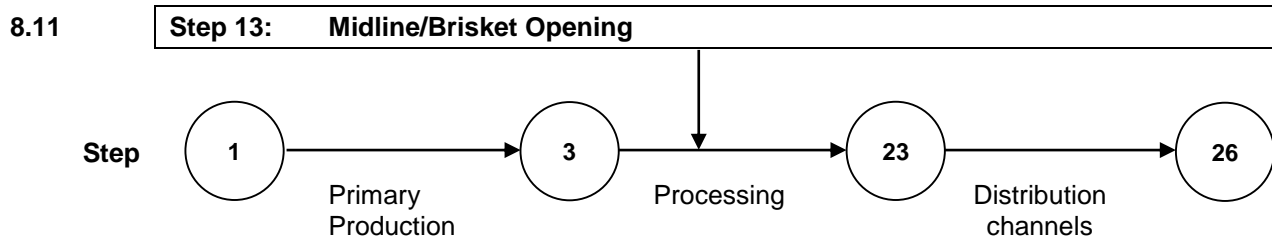
When bunging, tie the bung, cut it free from surrounding tissues with a single incision, and avoid contaminating surrounding tissue. If possible, use an automated bunging system instead of manual bung tying, which will reduce cross-contamination by going around the anus and evacuating the rectum.

During separation, prevent contact of bung with carcass or with viscera. A plastic bag can be used to avoid spilling from rectum. Secure bag with a tie or clip.

Immediately remove any contamination that results from bunging.

Clean and disinfect bung guns, knives, and hooks between each carcass.

Prevent contaminated water from dripping down the back of the carcass.

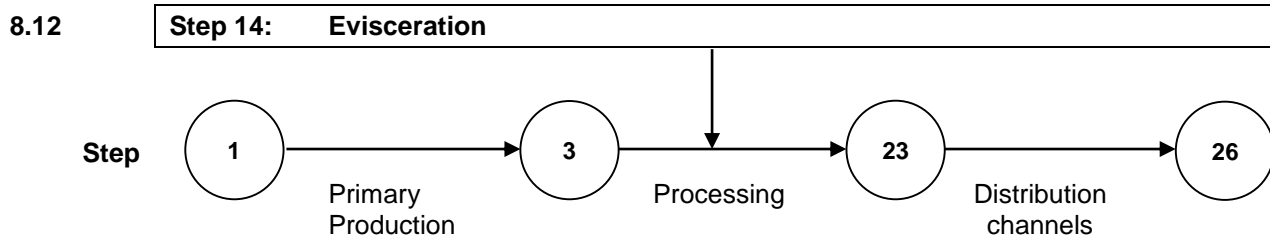


This is the point in the process where the brisket is split (i.e. cut along the centre line).

8.11.1 GHP-based control measures

Measures to prevent the introduction of contamination into the carcass during brisket opening include:

- a) Cleaning and disinfecting the brisket saw and knife between each carcass and ensuring that the gastrointestinal tract is not punctured.
- b) Maintaining proper employee hygiene practices to prevent the creation of unsanitary conditions (e.g. touching the carcass with soiled hands, tools, or garments).
- c) If the gastrointestinal tract has been punctured causing a major contamination the carcass should be identified and additional procedures to avoid cross-contamination should be performed.



This is the point in the process where the removal of the viscera (e.g. the edible offal that includes the heart, intestines, stomach, liver, spleen, and kidneys when presented with viscera) occurs. 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.

8.12.1 GHP-based control measures

Evisceration should be performed carefully to minimize cross-contamination from intestinal contents. Trained and experienced individuals should perform the evisceration; this is particularly important at higher line speeds.

Measures to ensure that employees do not contaminate carcasses during evisceration can include:

- a) Properly using knives to prevent damage (i.e. puncturing) to the gastrointestinal tract.
- b) Maintaining proper employee hygiene practices (e.g. wash hands and arms often enough to prevent contamination of the carcass).
- c) Using footbaths or separate footwear by employees on moving evisceration lines to prevent contaminating other parts of the operation.

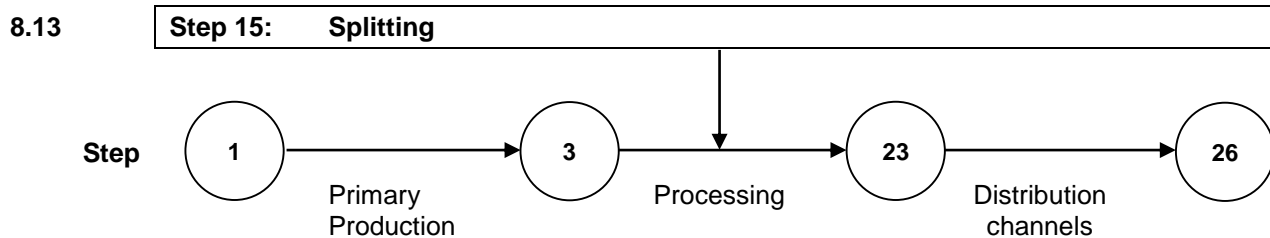
To prevent contamination of the carcass or viscera, the rectum should be tied before evisceration. The pluck should be removed along with the oesophagus and viscera attached (so there is no leakage).

Cutting through tonsils should be avoided because of the risk of spreading *Salmonella* from tonsil tissue.

When removing stomach and intestines, a minimum of 2 cm of oesophagus should be left on the stomach to minimize leakage of stomach contents.

Cutting or rupturing of the gut should be avoided. The critical operations are: cutting around the rectum, removal of the intestinal tract, and removal of the pluck.

Carcasses with visual contamination should be removed from the line and sent for reconditioning (knife trimming or steam vacuuming) before carcass splitting.



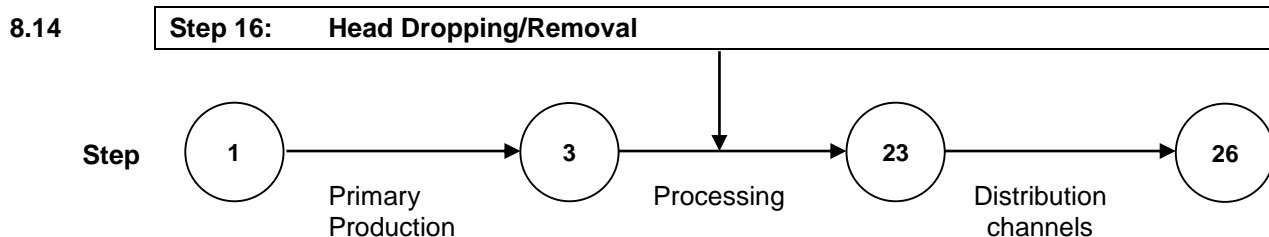
This is the point in the process where carcasses are split vertically into two halves.

8.13.1 GHP-based control measures

Care should be taken to avoid cross-contamination, which may occur when carcass splitting saw blades come in contact with the throat.

Carcass splitting equipment should be cleaned and disinfected during and after each carcass or as appropriate.

When using two blade axe systems, contamination build-up between blades should be controlled by regular cleaning and disinfection with hot water. Cross-contamination should be avoided by allowing adequate distance between carcasses (i.e. avoid carcass-to-carcass contact) and walls and equipment.



This is the point in the slaughter process where the head is totally or partially removed from the carcass. It is important to maintain sanitary conditions because cross-contamination can occur if the head comes into contact with other carcasses or heads, equipment and employees. Between this step and chilling is where decontamination treatments are likely to be most effective.

8.14.1 GHP-based control measures

The ingesta, bile, or other contaminants should be removed by flushing the oral cavity before head dropping and head inspection.

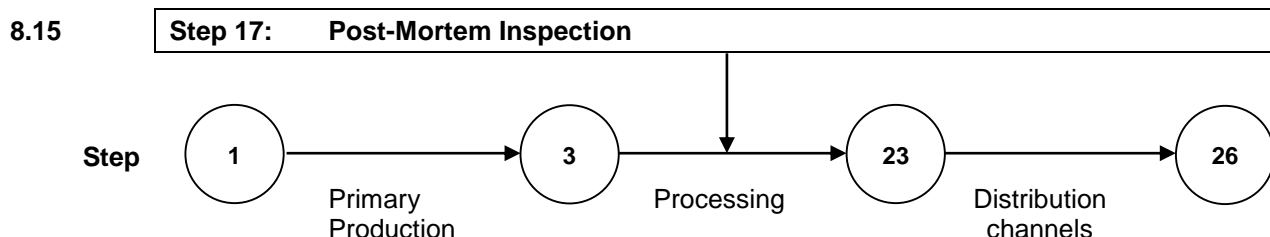
Knives and head dropping equipment should be cleaned and disinfected between carcasses and whenever sectioning of the oesophagus occurs.

Personnel should be aware of potential contamination of the head, neck, and carcass by knives or equipment after incision of the oral-pharyngeal cavity or from exposure to fresh stomach contents when dropping heads and processing of head and cheek meat.

When a contaminated carcass is not adequately cleaned before the final wash, the carcass should be diverted to a holding rail until cleaned or reconditioned.

Measures to minimize contamination of heads, equipment, and employees can include:

- a) Removing heads in a manner that avoids contamination with digestive tract contents.
- b) Limiting the splashing of water when washing heads in order to prevent cross-contamination and to limit airborne contaminants.



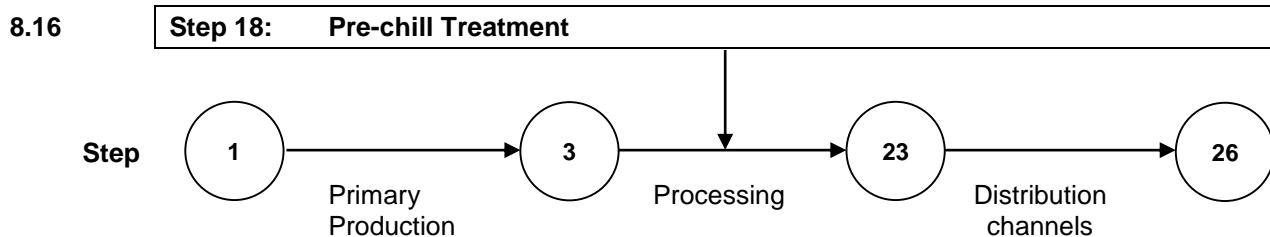
This is the point in the process where inspection of carcasses is carried out.

8.15.1 GHP-based control measures

The need for routine palpations and incisions during post-mortem inspection should be weighed against the potential impact on cross-contamination with *Salmonella* through the application of these techniques.

Line speeds and the amount of light should be appropriate for effective post-mortem inspection of carcasses.

The procedures should be planned to avoid cross-contamination. Touching the carcasses with hands, tools or garments may cause cross-contamination.



At this stage in the process, the carcass may be subjected to a treatment in order to remove *Salmonella* and other contaminants from the surface of the carcass prior to entering the chilling room. The treatment may be also applied at other suitable stages.

8.16.1 GHP-based control measures

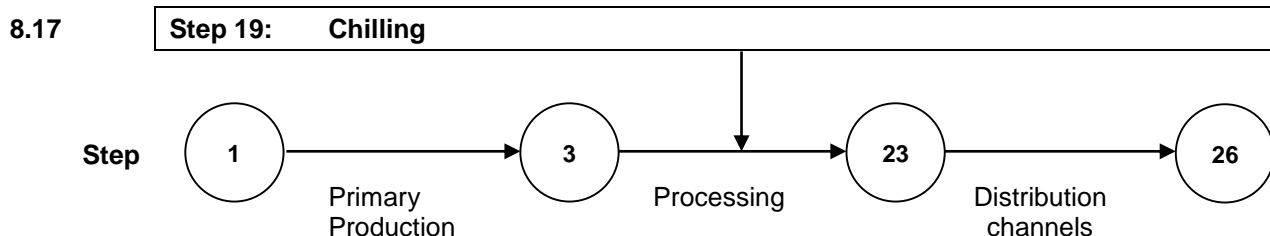
Full carcass steam-vacuum treatment can be a valuable approach for small slaughterhouses as an alternative to whole carcass thermal treatments. The efficacy to reduce *Salmonella* can be highly variable depending on how it is applied and is related to the training of the operator.

8.16.2 Hazard-based control measures

The following decontamination treatments have shown significant reductions of *Salmonella* on the carcass.

Thermal treatments reduce the prevalence and concentration of *Salmonella*. Hot water at 74 to 81°C for 5 to 15 seconds and steam at 82-85 °C for 60 seconds have been shown to reduce the prevalence of *Salmonella* from 13% pre-treatment to 1% post-treatment. Thermal treatments that achieve a carcass surface temperature of at least 70°C would be expected to achieve up to 2 log₁₀ CFU/cm² reduction of the *Salmonella* concentration on the carcass. Time-temperature combinations required to achieve a specific reduction are specific to the establishment.

Organic acid treatments, such as lactic or acetic acid washes can significantly reduce *Salmonella* prevalence on carcasses. Studies have shown that organic acid treatments reduce prevalence of *Salmonella* from 8% pre-treatment to 2% post-treatment. Organic acid treatments should be applied uniformly over the carcass at combinations of concentration, time, duration of contact time, and temperature to achieve the intended reduction. Washing concentrations need to be measured at the site of application. Concentrations required to achieve a specific reduction are specific to the establishment and vary between acids. Contact time of washes may need to be considered, especially if followed by a rinse step. Organic acid treatments would be expected to achieve up to 0.5 to 1 log₁₀ CFU/cm² reduction of the *Salmonella* concentration on the carcass.



This is the point in the process where the carcass is chilled.

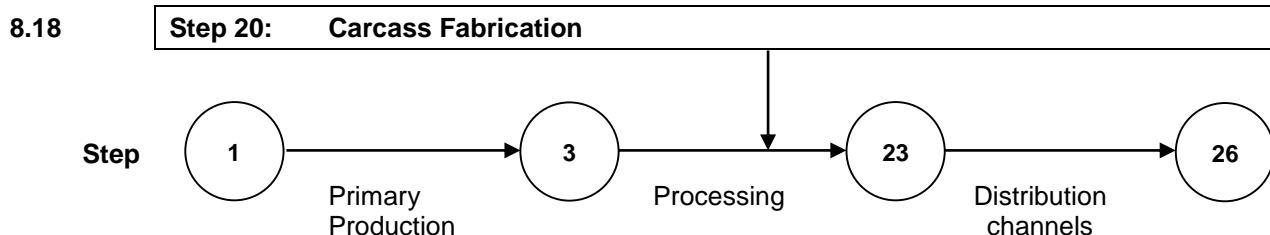
8.17.1 GHP-based control measures

Chilling inhibits the growth of *Salmonella*. The effect of chilling depends on carcass spacing, air-flow, and cooling capacity. Carcasses should be adequately spaced to allow for effective cooling and prevention of cross-contamination.

Sanitary conditions should be maintained in the chilling room.

Effective temperature control should be implemented to achieve and maintain a carcass surface temperature to prevent the growth of *Salmonella*.

Blast chilling involves initial blasting carcasses with air at temperatures below -15°C resulting in a surface that is frozen. Freezing of the surface during blast chilling may yield better reductions in the prevalence of *Salmonella* on carcasses.



These steps include cutting and deboning that can result in wholesale pieces.

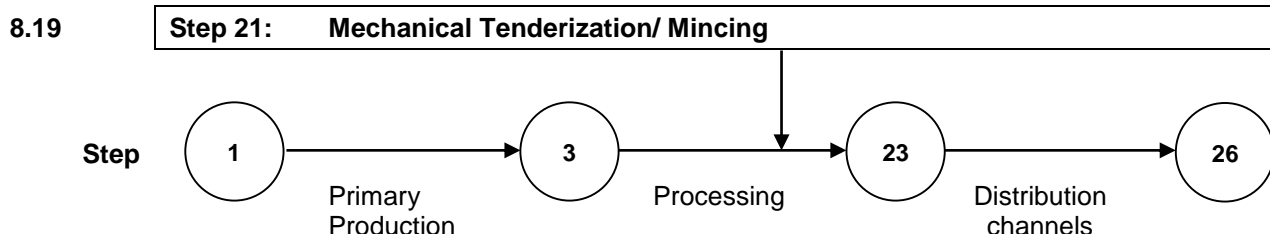
8.18.1 GHP-based control measures

Boning and fabrication rooms should be kept at a temperature that limits the ability for *Salmonella* to grow.

In order to reduce time out of chilling room, and to limit the growth of *Salmonella*, a reasonable flow of products should be ensured.

Knives, saws, slicers, and other food contact surfaces should be cleaned and disinfected as frequently as necessary to prevent the creation of unsanitary conditions.

Airflow should be controlled to prevent cross-contamination from slaughter operations e.g. positive air pressure in carcass fabrication area relative to other areas in the slaughter operations.



This is the point in the process where the meat is subjected to the process of breaking fibres mechanically or manually. This step can be a cross-contamination point if the procedures and handling are not performed in a sanitary manner and by trained and experienced employees.

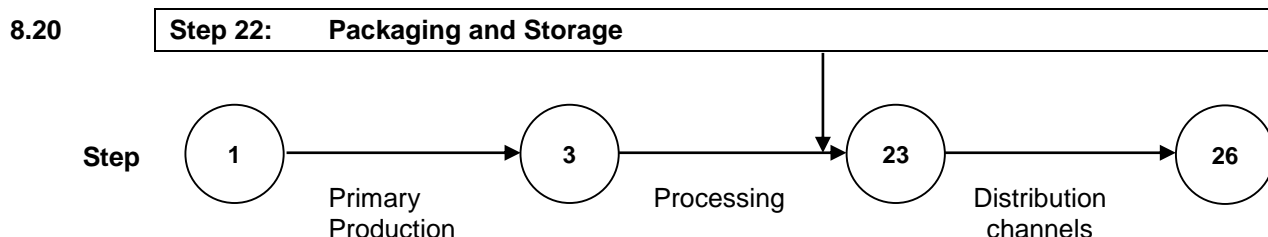
8.19.1 GHP-based control measures

Products should be stored at temperatures to prevent the growth of *Salmonella*.

Equipment used for this operation should be adequately maintained and adjusted.

In order to avoid cross-contamination, equipment and environment should be cleaned on a regular basis and good personal hygiene practices should be followed by employees.

Processes such as mechanical tenderization or mincing, may potentially increase contamination in the meat. There should be increased awareness of the risk of contamination when handling of the meat throughout the rest of the food chain.



8.20.1 GHP-based control measures

Packaging rooms should be kept at a temperature that limits the growth of *Salmonella*.

Use of various technology packaging may limit the growth of *Salmonella*.

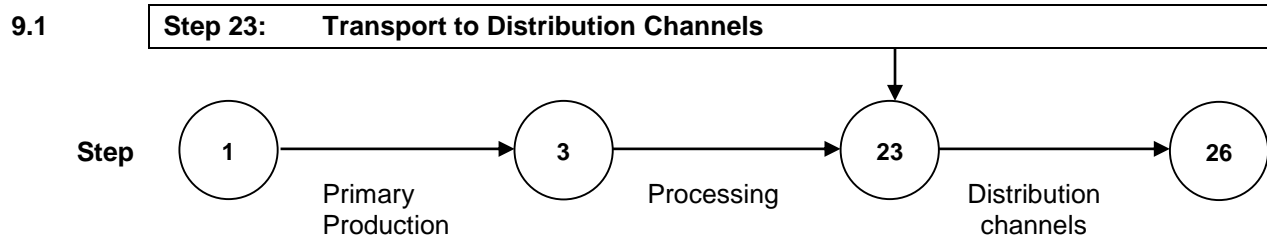
The storage room should be maintained at a temperature that prevents the growth of *Salmonella*.

The temperature of the packaging and storage rooms and meat should be monitored and documented.

8.20.2 Hazard-based control measures

Various doses of ionizing radiation have been shown to be effective at eliminating *Salmonella* in warm, chilled or frozen pork. Application and control of the process should take into consideration the [General Standard for Irradiated Foods \(CODEX STAN 106-1983\)](#) and the [Code of Practice for Radiation Processing of Food \(CAC/RCP 19-1979\)](#). Irradiation of minced pork meat has resulted in D-values of 0.403–0.860 kGy for *S. typhimurium*.

9. CONTROL MEASURES FOR STEPS 23 TO 26 (DISTRIBUTION CHANNELS)

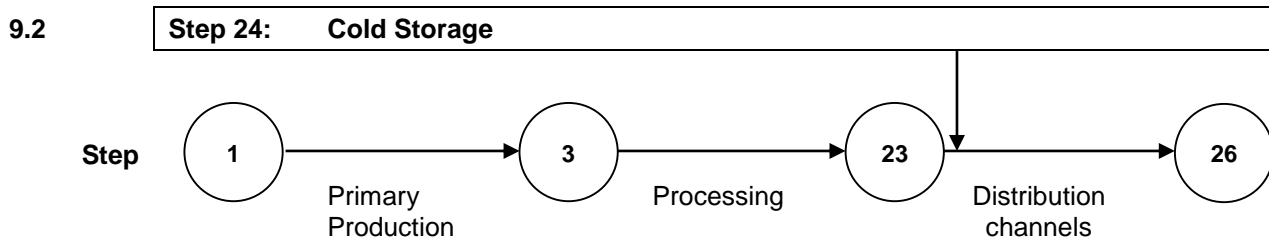


9.1.1 GHP-based control measures

Transportation vehicles should be kept clean and free of pests.

Transportation vehicles should be maintained at a temperature that ensures the temperature of the chilled meat is adequate to prevent the growth of *Salmonella*.

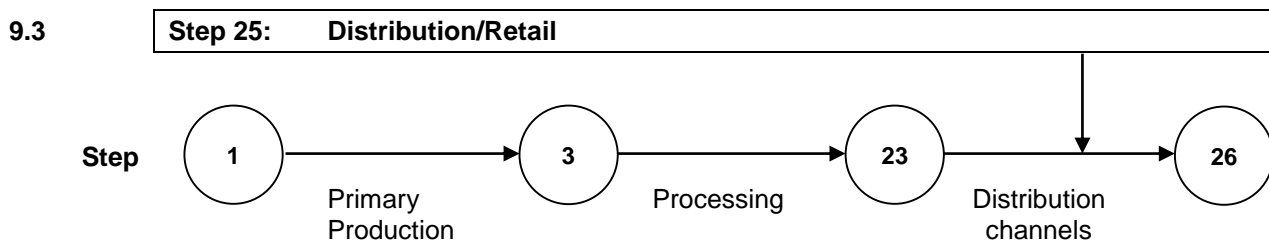
Temperature of vehicle and meat should be monitored and documented. Meat should be chilled before loading onto the vehicle for transport.



9.2.1 GHP-based control measures

Storage room temperature should be maintained at a temperature that prevents the growth of *Salmonella* in the chilled meat

Storage room temperature should be monitored and documented.



9.3.1 GHP-based control measures

9.3.1.1 Retail

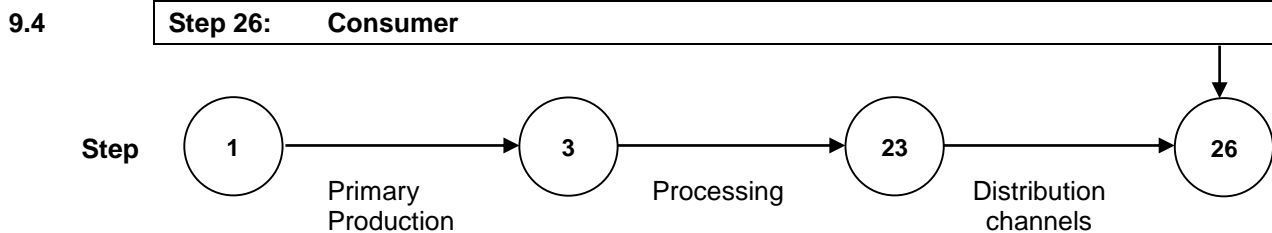
Fresh meat should be held at a temperature that prevents the growth of *Salmonella*.

The temperature of the storage room and display cases should be monitored and documented.

Cross-contamination from or to other food items should be prevented.

Food business operators serving meat for direct consumption to consumers (e.g. caterers, restaurateurs) should take appropriate measures to:

- a) Prevent cross-contamination.
- b) Maintain appropriate storage temperature.
- c) Ensure proper cleaning.
- d) Ensure proper cooking.



9.4.1 GHP-based control measures

Consumers should be informed about the potential risk associated with finished pork product in order to follow instructions and make informed choices on how to avoid the spread and growth of *Salmonella* (e.g. storage, thawing and cooking temperatures, hygiene including hand washing). The WHO Five Keys to Safer Food²⁴ assists in this process.

Cooking of pork can reduce or eliminate *Salmonella*.

Consumers should be appropriately informed of raw treated meat (e.g. mechanically tenderized, minced meat) so they can take appropriate actions to make sure meat is properly cooked.

Special attention should be paid to the education of all persons preparing food, and particularly to those preparing food for the young, old, pregnant and immuno-compromised.

Consumers should wash and disinfect food contact surfaces and utensils after raw pork preparation to significantly reduce the potential for cross-contamination in the kitchen.

The above information to consumers should be provided by the competent authorities, local government, health agencies, manufacturers, retailers or other consumer sources and through multiple channels such as national media, health care professionals, food hygiene trainers, product labels, pamphlets, school curricula and cooking demonstrations.

²⁴ <http://www.who.int/foodsafety/consumer/5keys/en/>