

GUIDELINES FOR THE CONTROL OF *CAMPYLOBACTER* AND *SALMONELLA* IN CHICKEN MEAT

CAC/GL 78-2011

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1. INTRODUCTION

1. Campylobacteriosis and salmonellosis are the two most frequently reported food borne diseases worldwide and chicken meat is considered to be one of the most important food vehicles. The burden of the diseases and the cost of control measures are highly significant in many countries and contamination with zoonotic *Campylobacter* and *Salmonella*¹ has the potential to severely disrupt trade between countries.

2. The Guidelines apply a risk management framework (RMF) approach as advocated in the Codex *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. Following sections on “Implementation” and “Monitoring” complete application of all the components of the RMF.

3. The Guidelines build on general food hygiene provisions already established in the Codex system and develop potential control measures specific for *Campylobacter* and *Salmonella* of public health relevance in chicken meat. In this context, the Guidelines give effect to the Codex Alimentarius Commission (CAC) commitment to developing standards that are based on sound science and risk assessment². Potential control measures for application at single or multiple steps 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 considerably between 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, have a quantitative base in the prevalence and/or concentration of *Campylobacter* or *Salmonella*, and can be validated as to their efficacy in hazard control at the 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 significant human health benefit.³

4. Examples of control measures that are based on quantitative levels of hazard control have been subjected to a rigorous scientific evaluation and review 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 and, where the web-based decision tool is applied, the likely level of public health protection that may result from particular food-chain scenarios and choices of control measures at the national level.

5. 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 differences and commonalities in approach for control measures for *Campylobacter* and *Salmonella*.
- Illustrates relationships between control-measures applied at different steps in the food chain.
- Highlights data gaps in terms of scientific justification / validation for GHP-based control measures.
- Facilitates development of HACCP plans at individual premises and national levels.

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

² Objective 2 “Promoting widest application of scientific principles and risk analysis” of the Codex Strategic Plan 2008-2013 and the first Statement of Principle relating to the Role of Food Safety Risk Assessment “Health and safety aspects of Codex decisions and recommendations should be based on a risk assessment, as appropriate to the circumstances” Codex Procedural Manual,-

³ JEMRA, 2002. Risk Assessments of *Salmonella* in Eggs and Broiler Chickens. FAO/WHO Microbial Risk Assessment Series No. 2. Joint FAO/WHO Expert Committee for Microbial Risk Assessment. JEMRA, 2009. Risk Assessment of *Campylobacter* spp in Broiler Chickens, Technical Report. FAO/WHO Microbial Risk Assessment Series No. 12 Joint FAO/WHO Expert Committee for Microbial Risk Assessment

- Assists in judging the equivalence⁴ of control measures for chicken meat applied in different countries.

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

2. OBJECTIVES

7. The primary objective of these Guidelines is to provide information to governments and industry on the control of *Campylobacter* and *Salmonella* in chicken meat to reduce foodborne disease from this source 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 to control of *Campylobacter* and *Salmonella* in chicken meat according to national risk management decisions.

8. It is not the intention of the Guidelines to set quantitative limits for *Campylobacter* and *Salmonella* in chicken meat in international trade. Rather, the Guidelines follow the example of the overarching Codex *Code of Hygienic Practice for Meat* (CAC/RCP 58-2005) and provide an “enabling” framework which countries can utilise to establish control measures appropriate to their national situation.

3. SCOPE AND USE OF THE GUIDELINES

3.1. Scope

9. These Guidelines apply to control of all *Campylobacter* and *Salmonella* that may contaminate chicken meat (*Gallus gallus*) and cause food borne disease. The primary focus is on chicken meat in the form of broiler carcasses and portions, with the exclusion of offals. These Guidelines can be applied to other classes of chickens, e.g. end-of-lays, as appropriate.

10. The Guidelines apply to all steps in a “primary production-to-consumption” food chain for chicken meat produced in typical “industrial” systems. While the biosecurity provisions in this document have been developed primarily for controlled-environment housing systems they also have applicability to other housing systems.

3.2. Use

11. The Guidelines develop specific guidance for control of *Campylobacter* and *Salmonella* in chicken 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 *Code of Practice – General Principles of Food Hygiene* (CAC/RCP 1 – 1969), the *Code of Hygienic Practice for Meat* (CAC/RCP 58-2005), the *Code of Practice for the Processing and Handling of Quick Frozen Foods* (CAC/RCP 8-1976) and the *Code of Practice on Good Animal Feeding* (CAC/RCP 54-2004).

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

12. The Guidelines systematically present GHP-based control measures and examples of hazard-based control measures. GHP is a pre-requisite to making choices on hazard-based control measures. Examples of hazard-based control measures are limited to those that have been scientifically evaluated as being effective under conditions of commercial use. Where no quantifiable outcome is mentioned for a specific control measure, it should be kept in mind that the effect may be different between *Salmonella* and *Campylobacter*. Countries should note that these hazard-based control measures are indicative only and the references provided should be reviewed to assist application. 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 a meaningful estimate of hazard reduction⁵. 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.

⁴ Codex *Guidelines on the Judgement of Equivalence of Sanitary Measures Associated with Food Inspection and Certification Systems* (CAC/GL 53-2003).

⁵ FAO/WHO, 2009. Technical Meeting on *Salmonella* and *Campylobacter* in chicken meat. 4-8 May 2009, Rome, Italy.

13. Several hazard-based control measures as presented in these Guidelines are based on the use of chemical decontaminants to reduce the prevalence and/or concentration of *Campylobacter* and/or *Salmonella* in broiler carcasses. The use of these control measures, including chemical decontaminants where relevant, in the primary production-to-consumption food chain, is subject to approval by the competent authority, where appropriate. Also these Guidelines do not preclude any other choice of a hazard-based control measure that is not included in the examples.

14. 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.

15. The Guidelines should be useful when judging the equivalence of different food safety measures for chicken meat in different countries

4. DEFINITIONS

Batch	A subset of a flock. A group of chickens sent together to a slaughterhouse at the same time.
Broiler	Birds of the species <i>Gallus gallus</i> selectively bred and reared for their meat rather than eggs.
Chicken	Birds of the species <i>Gallus gallus</i> .
Competitive exclusion⁶	The administration of defined ⁷ or undefined bacterial flora to poultry to prevent gut colonisation by enteropathogens, including <i>Salmonella</i> .
Crate	Container used to transport live chickens.
Epidemiological unit⁶	A group of animals with a defined epidemiological relationship that share approximately the same likelihood of exposure to a pathogen. This may be because they share a common environment (e.g. animals in a pen), or because of common management practices. Usually, this is a herd or a flock. However, an epidemiological unit may also refer to groups such as animals belonging to residents of a village, or animals sharing a communal animal handling facility. The epidemiological relationship may differ from disease to disease, or even strain to strain of the pathogen.
Establishment⁶	The premises in which animals are kept.
Flock⁶	A number of animals of one kind kept together under human control or a congregation of gregarious wild animals. For the purposes of the Terrestrial Code, a flock is usually regarded as an epidemiological unit.
Module	A structure containing crates / cages that facilitates loading and unloading.
On-line Reprocessing	Additional washing step that may be used (instead of trimming or washing off-line) as a control measure for faecal or ingesta contamination.
Partial depopulation	Incomplete harvest of chickens from a growing flock.
Total depopulation	Full harvest of chickens from a growing flock.

⁶ This definition is taken directly from the OIE *Terrestrial Animal Health Code*. www.oie.int

⁷ Probiotics are defined competitive exclusion products

5. PRINCIPLES APPLYING TO CONTROL OF *CAMPYLOBACTER* AND *SALMONELLA* IN CHICKEN MEAT

16. Overarching principles for good hygienic practice for meat 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:

- i. The principles of food safety risk analysis should be incorporated wherever possible and appropriate in the control of *Campylobacter* and *Salmonella* in chicken meat from primary production to consumption
- ii. Wherever possible and practical, Competent Authorities should formulate risk management metrics⁸ so as to objectively express the level of control of *Campylobacter* and *Salmonella* in chicken meat that is required to meet public health goals.

6. RISK PROFILES

17. Risk profiles are an important part of “Preliminary Risk Management Activities” when applying a RMF to a food safety issue. They provide scientific information to risk managers and industry in the design of food safety control systems that are tailor-made to individual food production and processing systems.

18. The contents of these Guidelines are predicated on two extensive risk profiles on *Salmonella* and *Campylobacter* in broiler chicken:

- o Food Safety Risk Profile for *Salmonella* species in broiler (young) chicken, June 2007⁹
- o Food Safety Risk Profile for *Campylobacter* species in broiler (young) chicken, June 2007¹⁰

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

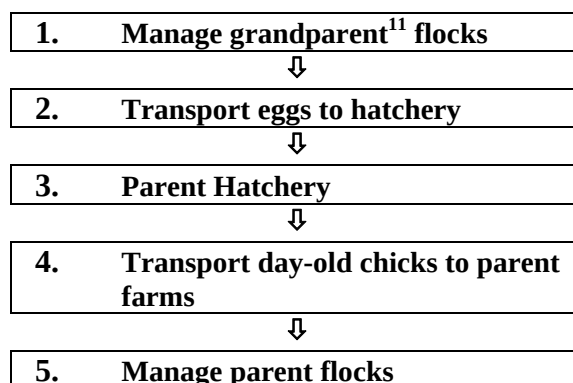
19. These Guidelines incorporate a “primary production-to-consumption” flow diagram approach so as to identify all steps in the food chain where control measures can potentially be applied. It facilitates a systematic approach to the identification and evaluation of all potential control measures. Consideration of all steps in the food chain allows different combinations of control measures to be developed. This is particularly important where differences occur in primary production and processing systems between countries and risk managers need the flexibility to choose risk management options that are appropriate in the national context.

7.1. Generic flow diagram for application of control measures

20. A generic flow diagram is presented in sequence on the following pages.

21. Individual premises will have variations in process flow and should adapt design of HACCP plans accordingly.

Process Flow Diagram 1: Primary production to Consumption

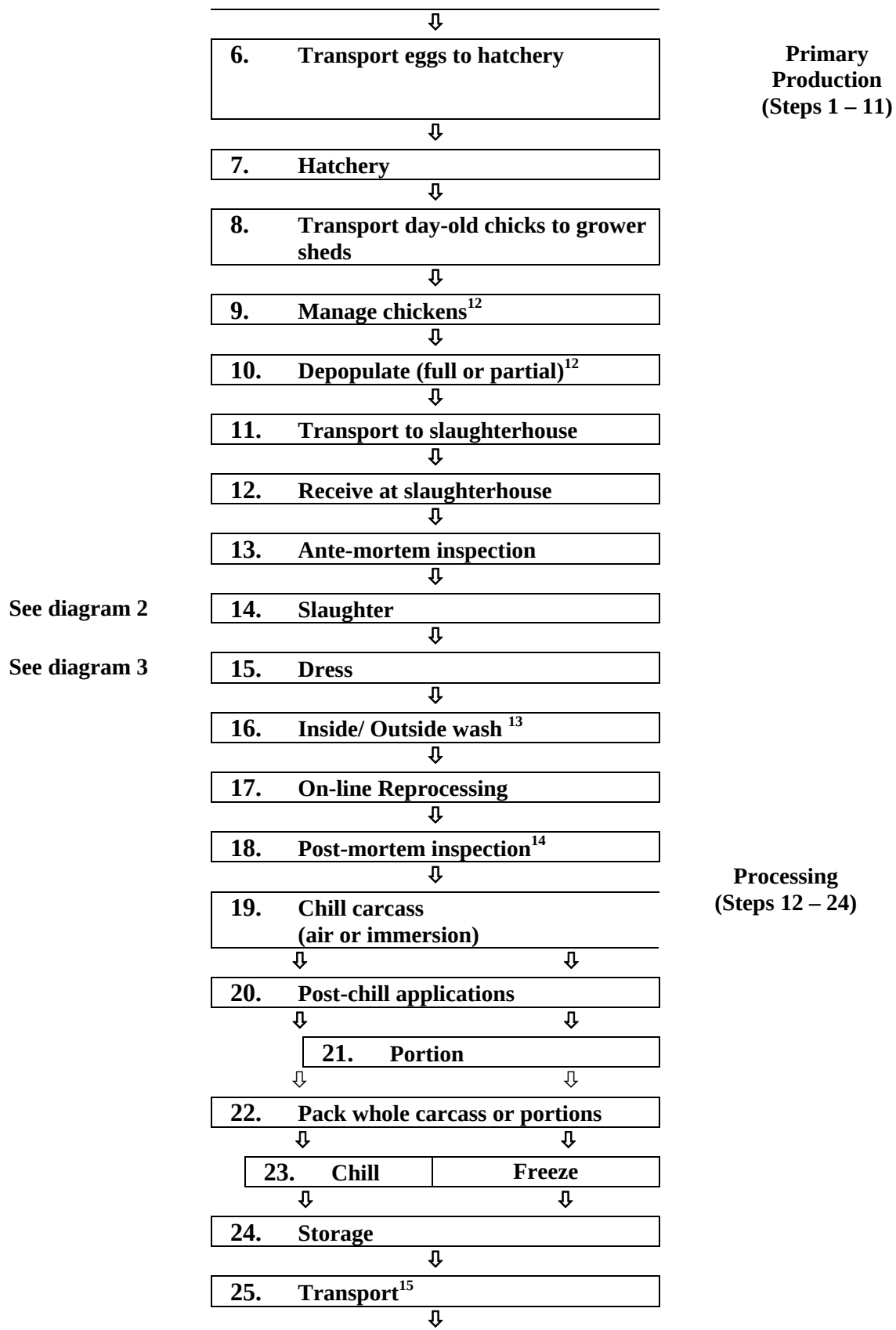


⁸ *Principles and Guidelines for the Conduct of Microbiological Risk Management (MRM)* CAC/GL 63-2007.

⁹ <ftp://ftp.fao.org/codex/ccfh40/fh40rpsl.pdf>

¹⁰ <ftp://ftp.fao.org/codex/ccfh40/fh40rpcb.pdf>

¹¹ Steps 1 – 4 also apply to great grandparents and elite breeding flocks

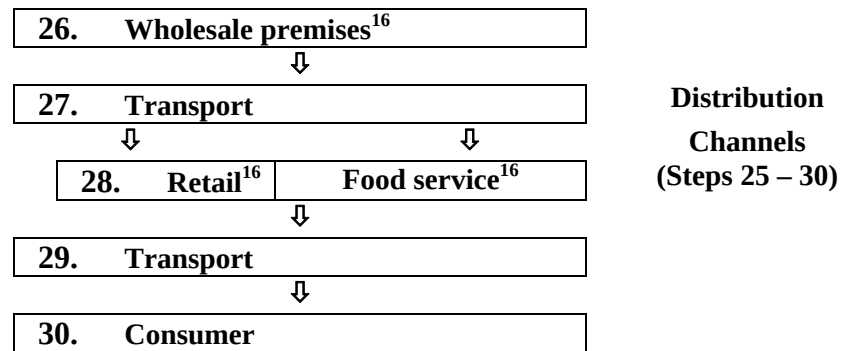


¹² May include ante-mortem inspection

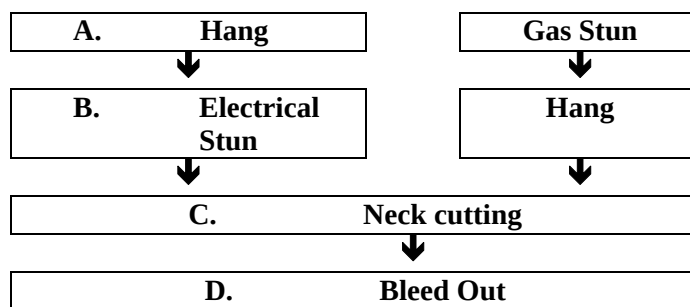
¹³ May occur throughout the process

¹⁴ May occur before the inside / outside wash

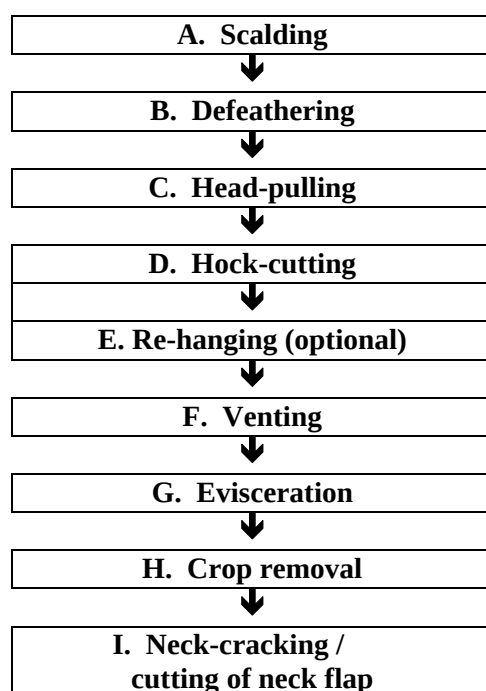
May go direct to retail / food service



Process Flow Diagram 2: Step 14 - Slaughter



¹⁶ Including storage

Process Flow Diagram 3: Step 15 - Dress^{17, 18}**7.2. Availability of control measures at specific process flow steps addressed in these Guidelines**

22. The intent of the following table is to illustrate where specific control measures for *Campylobacter* and/or *Salmonella* have been identified in relation to each of the process flow steps at different sections of the food chain. Control measures are indicated by a tick and their details are provided in these Guidelines or the OIE *Terrestrial Animal Health Code*¹⁹ in the case of GHP. A blank cell means that a specific control measure for *Campylobacter* and/or *Salmonella* has not been identified for the process flow step.

Availability of Specific Control Measures at Steps in the Process Flow

Process Step	GHP-based control measures		Hazard-based Control Measures	
	<i>Campylobacter</i>	<i>Salmonella</i>	<i>Campylobacter</i>	<i>Salmonella</i>
1. Grand Parent Flocks ↓		OIE +✓		
2. Transport to Hatchery ↓		OIE +✓		
3. Parent Hatchery ↓		OIE +✓		
4. Transport to Parent Farms ↓		OIE		
5. Manage Parents ↓		OIE		
6. Transport to Hatchery ↓		OIE +✓		
7. Hatchery ↓		OIE +✓		

¹⁷ These process steps are generic and the order may be varied as appropriate

¹⁸ Washing/rinsing may take place at a number of steps during dressing

¹⁹ Refer to web site: www.oie.int

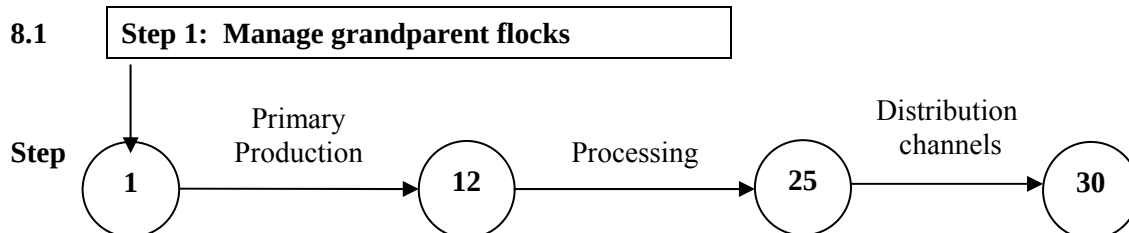
Process Step	GHP-based control measures		Hazard-based Control Measures	
	<i>Campylobacter</i>	<i>Salmonella</i>	<i>Campylobacter</i>	<i>Salmonella</i>
8. DOC to Grower Sheds ↓		OIE		
9. Manage Chickens ↓		OIE +✓	✓	
10. Depopulate ↓		OIE		
11. Transport to Slaughterhouse ↓	✓	OIE		
12. Receive at Slaughterhouse ↓		✓		
13. A-M Inspection ↓				
14. Slaughter ↓				
15. Dress ↓				✓
16. Inside / Outside Wash ↓			✓	✓
17. On-line Reprocessing ↓			✓	✓
18. P-M Inspection ↓				
19. Chill Carcass ↓	✓	✓	✓	✓
20. Post-Chill Applications ↓			✓	✓
21. Portion ↓		✓		
22. Pack ↓		✓	✓	✓
23. Chill or Freeze ↓			✓	
24. Storage ↓		✓		
25. Transport ↓				
26. Wholesale ↓		✓		
27. Transport ↓				
28. Retail or Food Service ↓		✓	✓	✓
29. Transport ↓				
30. Consumer		✓	✓	✓

8. CONTROL MEASURES FOR STEPS 1 TO 11 (PRIMARY PRODUCTION)

23. These Guidelines on primary production are supplementary to, and should be used in conjunction with, the:

- OIE *Terrestrial Animal Health Code*¹⁹ (applies to *Salmonella* only):
 - o Chapter 6.4 “Biosecurity Procedures in Poultry Production”, and
 - o Chapter 6.5 “Prevention, Detection and Control of *Salmonella* in Poultry”.
- *Code of Practice on Good Animal Feeding* (CAC/RCP 54-2004).
- *Code of Hygienic Practice for Meat* (CAC/RCP 58-2005).

Note: specific provisions from the OIE *Terrestrial Animal Health Code* and Animal Feed documents are not provided in these Guidelines.



8.1.1 GHP-based control measures

24. Control of *Campylobacter* and *Salmonella* in grandparent flocks is strengthened by the application of a combination of biosecurity and personnel hygiene measures. The particular combination of control measures adopted at a national level should be determined in consultation with relevant stakeholders.

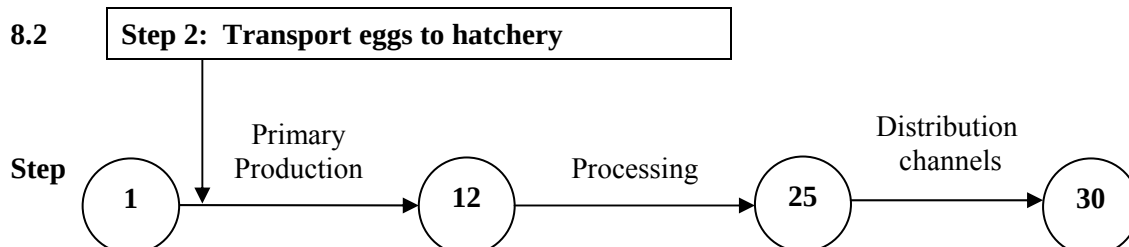
For *Salmonella*

25. The breeder flock should be kept free from *Salmonella* to prevent transmission of infection.

26. Where a flock is found to be *Salmonella*-positive a range of responses, detailed in the OIE *Terrestrial Animal Health Code*¹⁹, Chapter 6.5 “Prevention, Detection and Control of *Salmonella* in Poultry”, should be taken.

27. Feed should be treated, stored and delivered in a manner that minimises the presence of *Salmonella*. Breeder feed should preferably be delivered in dedicated vehicles used only for feed transports.

28. The use of control measures such as live and inactivated vaccines, competitive exclusion and some water and feed additives e.g. organic acids or formaldehyde may require approval by the competent authority, to permit their use.

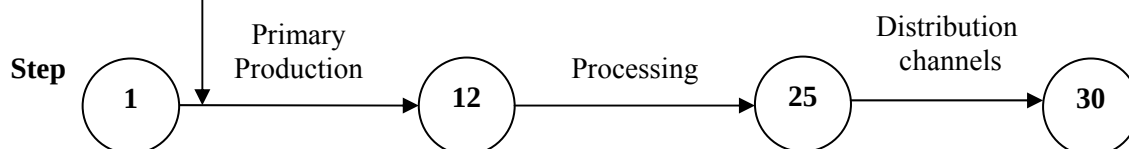


8.2.1 GHP-based control measures

For *Salmonella*

29. Only eggs from *Salmonella*-negative flocks should be sent for hatching. When this is not practical, the eggs from *Salmonella*-positive flocks should be transported separately from other eggs.

8.3 Step 3: Parent hatchery



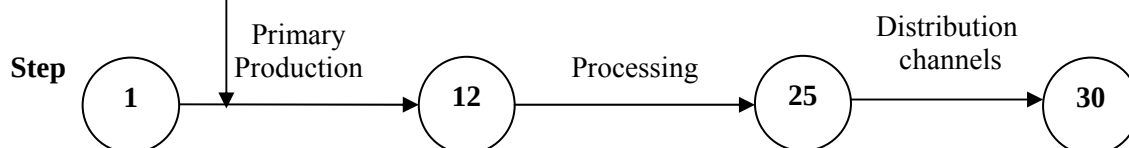
8.3.1 GHP-based control measures

For *Salmonella*

30. If possible, only eggs from *Salmonella*-negative flocks should be hatched.

31. Where the use of eggs from flocks that are known to be contaminated is unavoidable, they should be kept separate and hatched separately from eggs from other flocks. Trace back of contamination to the infected breeding flocks should be performed and control measures should be reviewed.

8.4 Step 4: Transport Day-old Chicks to Parent Farm



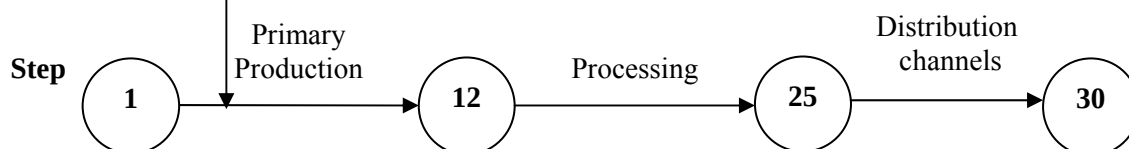
8.4.1 GHP-based control measures

32. Personnel involved in the transportation of day-old chicks to parent flocks should not enter any livestock buildings and should prevent cross contamination of day old chicks during loading and unloading.

8.5 Step 5: Manage parent flocks

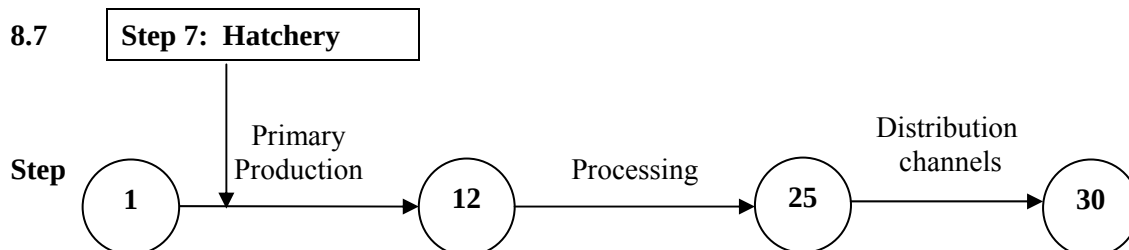
33. The control measures described at Step 1 apply at this Step.

8.6 Step 6: Transport eggs to hatchery



For *Salmonella*

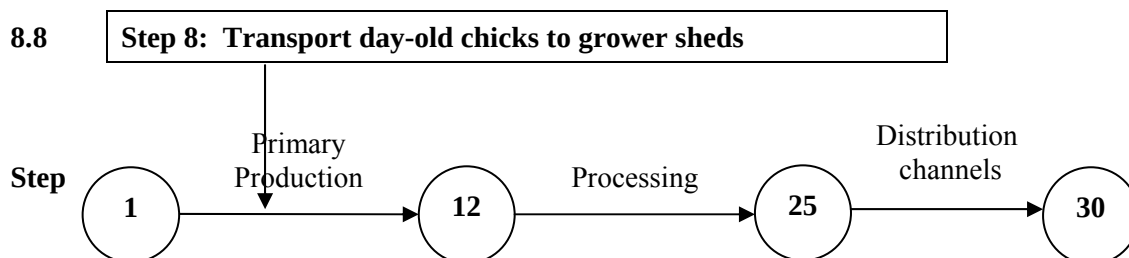
34. Only eggs from *Salmonella*-negative flocks should be sent for hatching. When this is not practical, the eggs from *Salmonella*-positive flocks should be transported separately from other eggs.



8.7.1 GHP-based control measures

For *Salmonella*

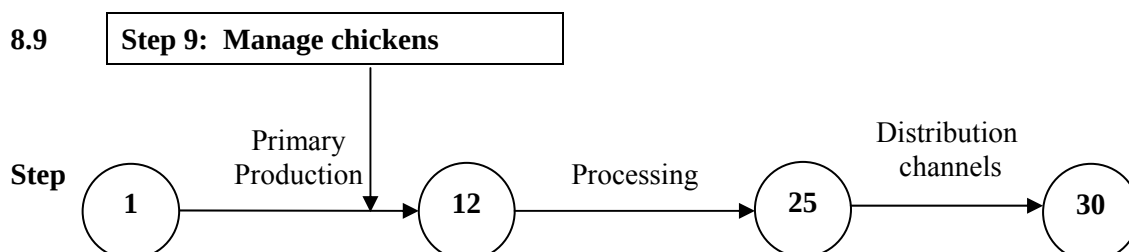
35. Where the use of eggs from flocks that are known to be contaminated is unavoidable, they should be kept separate and hatched separately from eggs from other flocks and the chicks should be kept isolated from other flocks. Trace back of contamination to the infected breeding flocks should be performed and control measures should be reviewed.



8.8.1 GHP-based control measures

36. Personnel involved in the transportation of day-old chicks should not enter any livestock buildings.

37. Personnel should follow appropriate biosecurity procedures to avoid cross contamination of day old chicks during loading and unloading. All live bird transport crates and modules should be cleaned, disinfected and dried to the greatest extent practicable before re-use.



8.9.1 GHP-based control measures

38. Control of *Campylobacter* and *Salmonella* in flocks is strengthened by the application of a combination of biosecurity and personnel hygiene measures. The particular combination of control measures adopted at national level should be determined in consultation with relevant stakeholders. In particular, a pest control programme should be designed according to local conditions.

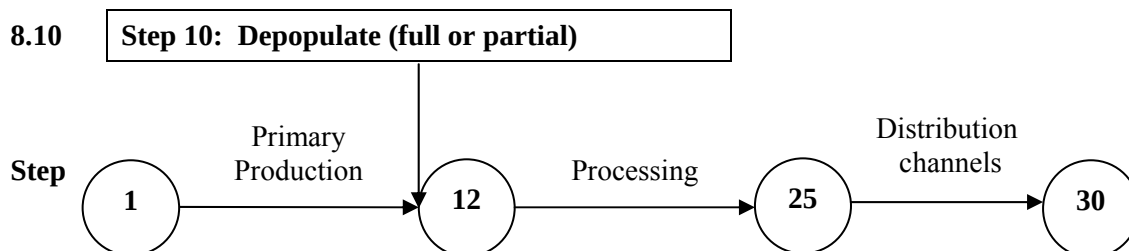
For *Salmonella*

39. The use of specific control measures such as competitive exclusion bacteria, organic acids in pre-slaughter drinking water and organic acids or formaldehyde in feed, may require approval by a competent authority to permit their use.

8.9.2 Hazard-based control measures

For *Campylobacter*

40. The use of fly screens to reduce or eliminate fly infestation in broiler houses has been shown to decrease the percentage of *Campylobacter* spp.-positive flocks from 51.4% to 15.4%.

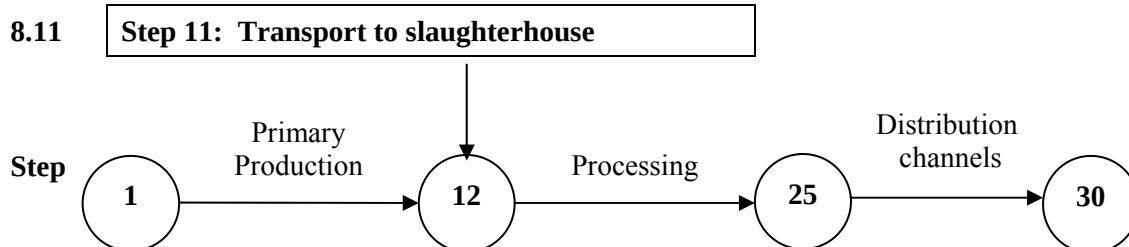


8.10.1 GHP-based control measures

41. Full depopulation of the flock should be carried out where possible. Where this is not practicable and partial depopulation is practised, particular attention should be paid to strict biosecurity and hygiene of catchers and the equipment they use.

42. It is preferable that sheds being partially depopulated are scheduled for catching ahead of those being fully depopulated on the same day.

43. When feed withdrawal is practised, water additives such as lactic acid may be used to lower post-harvest crop contamination.

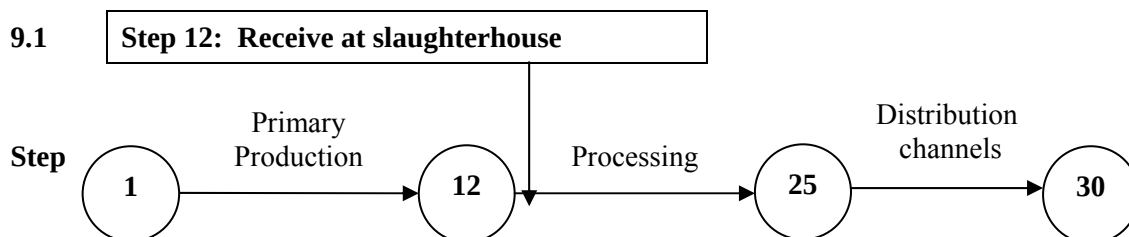


8.11.1 GHP-based control measures

For *Campylobacter* and *Salmonella*

44. All live bird transport crates and modules should be cleaned, disinfected and dried to the greatest extent practicable, before reuse.

9. CONTROL MEASURES FOR STEPS 12 TO 24 (PROCESSING)



9.1.1 GHP-based control measures

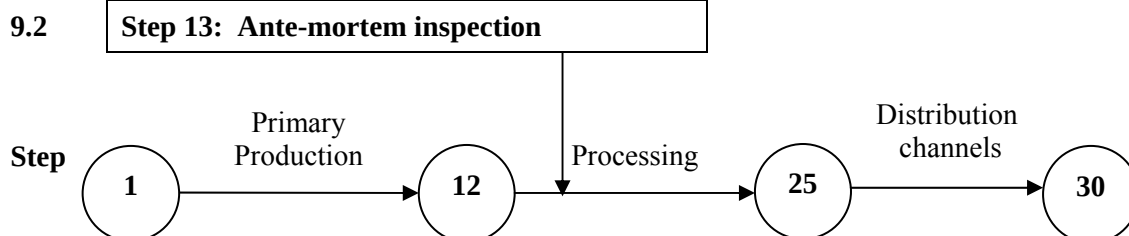
45. Where appropriate to the national situation, information about the flock, in particular about *Salmonella* and/or *Campylobacter* status should be provided in a timely manner to enable logistic slaughter and/or channelling of poultry meat to treatment.

46. Flocks, where practical, should be slaughtered after 8-12 hours feed withdrawal in order to reduce the likelihood of contamination of carcasses by faecal material and ingesta.

47. Stress to chickens should be minimised, e.g. by dim lighting, minimal handling and avoiding delays in processing.

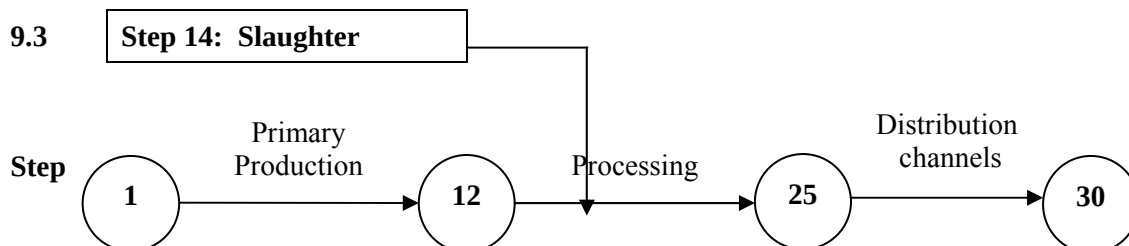
For *Salmonella*

48. If flocks that are positive for *Salmonella* are presented for slaughter this should be done in a manner that minimises cross contamination to other flocks, e.g. by slaughtering them at the end of the day, or all on one day and preferably the last day(s) of the working week or through other effective interventions.

**9.2.1 GHP-based control measures**

49. Moribund, unhealthy or otherwise unsuitable chickens should not be processed.

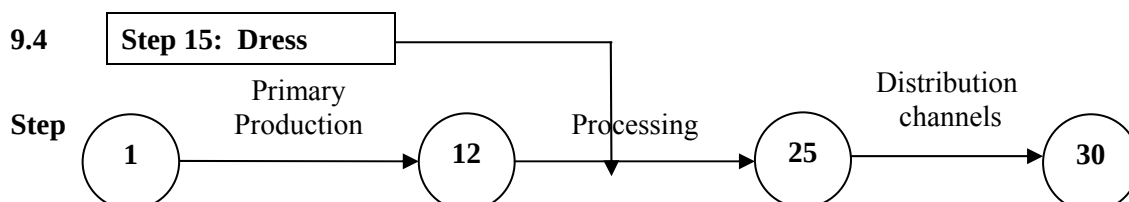
50. Where numbers of chickens that are dead on arrival, moribund, unhealthy or otherwise unsuitable for processing exceed expected levels, the processor should notify the relevant responsible person, e.g. the competent authority, the farmer, veterinarian, catcher or transportation company, so that appropriate preventative and/or corrective action can be taken.

**9.3.1 GHP-based control measures**

51. Positive flocks may be diverted for specific processing and/or treatment according to national food safety policies.

52. Measures should be taken to minimise bird stress at live hanging, e.g. use of blue light, breast comforter, suitable line speed.

53. Bleeding should be substantially completed before scalding in order to prevent inhalation of scald water and to reduce the amount of blood entering the scald.

**9.4.1 GHP-based control measures**

54. So as to minimise contamination²⁰ of carcasses, control measures may include:

- Washing with abundant potable running water
- Trimming
- Disposal or reprocessing of carcasses with extensive faecal contamination

²⁰ Decontamination of carcasses will likely reduce, but not eliminate *Salmonella* and *Campylobacter* bacteria on broiler carcasses and broiler meat

- Use of chemical decontaminants approved by the competent authority
- Use of other physical methods approved by the competent authority.

55. These control measures can be applied alone or in combination at key process steps. Multiple control measures may not always be additive.

56. Where re-hang of carcasses is necessary, it is preferable that this is done mechanically so as to reduce cross-contamination.

57. All chickens which drop on the floor should be condemned, or reprocessed under specific conditions as determined by the competent authority. Any dropped product should trigger corrective actions as appropriate, such as trimming and re-washing.

9.4.1.1 Scalding

58. Contamination during scalding can be minimised by:

- The use of counter-current flow
- High flow rates of water with adequate agitation
- Having an optimum scalding temperature²¹ to minimise levels of *Campylobacter* and *Salmonella*
- Use of approved²² chemicals e.g. pH regulators.

59. Other factors that should be taken into account when designing process control systems that minimise contamination during scalding include:

- Degree of agitation
- Use of multi-staged tanks
- Pre-scald wash systems
- Raising the temperature at processing breaks high enough for a long enough time to kill *Campylobacter* and *Salmonella* in the scalders
- Tanks being emptied and cleaned at end of a processing period
- Tanks being cleaned and disinfected at least daily
- Hygiene measures applied to reused/recycled water.

9.4.1.2 Defeathering

60. Cross contamination at defeathering can be minimised by:

- Ensuring appropriate fasting of chickens prior to slaughter
- Prevention of feather build-up on equipment
- Continuous rinsing of equipment and carcasses
- Regular adjustment and maintenance of equipment
- Particular attention to cleaning moving parts
- Regular inspection and replacement of plucker fingers.

9.4.1.3 Head pulling

61. Head pulling should be carried out in such a manner that leakage from the crop is prevented. Heads should be pulled downwards to reduce contamination due to crop rupture.

9.4.1.4 Evisceration

62. Rupture of the viscera and spread of faeces can be minimised by:

²¹ Taking into consideration, suitability requirements (i.e. not affecting the skin)

²² The competent authority may require processing aids to be approved.

- Limiting size variation in batches so that birds of similar sizes are processed together
- Careful adjustment and regular maintenance of machinery.

9.4.1.5 Crop removal

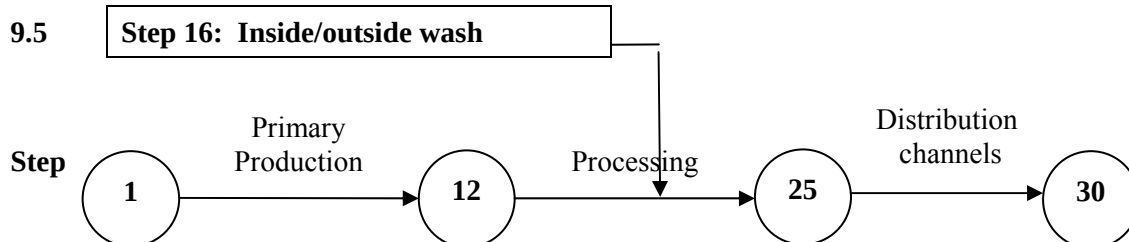
63. Where possible, crops should be extracted in a manner that is likely to limit carcass contamination.

9.4.2 Hazard-based control measures

For *Salmonella*

64. Spray applications of 20-50 ppm chlorinated water following defeathering and carcass evisceration have been shown to reduce the prevalence of *Salmonella*-positive broiler carcasses from 34% to 26% and from 45% to 36% respectively.

65. Immersion in Tri Sodium Phosphate (TSP) has been shown to reduce prevalence of *Salmonella*-positive carcasses from 72% to 4%



9.5.1 GHP-based control measures

66. The inside and outside of all carcasses should be thoroughly washed, using pressure sufficient to remove visible contamination. Appropriate equipment should be used to ensure direct water contact with the carcass. The removal of contaminants may be aided by the use of brushing apparatus installed in line with the inside/outside wash.

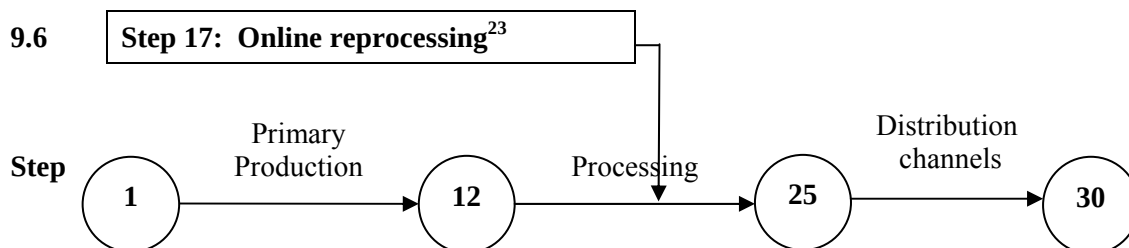
9.5.2 Hazard-based control measures

For *Campylobacter*

67. Carcass washing systems with 1-3 washers using water with 25-35ppm total chlorine have been shown to reduce levels of *Campylobacter* by about 0.5 log₁₀ CFU/ml of whole carcass rinse sample. Post-wash sprays using Acidified Sodium Chlorite (ASC) or TSP may further reduce *Campylobacter* levels by an average of 1.3 log₁₀ CFU/ml or 1.0 log₁₀ CFU/ml of whole carcass rinse sample respectively.

For *Salmonella*

68. Inside/outside washing using a spray application of 20-50 ppm chlorinated water has been shown to reduce the prevalence of *Salmonella*-positive broiler carcasses from 25% to 20%. A second inside/outside washing following upon the first resulted in a reduction of *Salmonella*-positive broiler carcasses from 16% to 12%.



²³ Where approved by the Competent Authority.

9.6.1 Hazard-based control measures

For *Campylobacter* and *Salmonella*

69. An on-line reprocessing spray system incorporating ASC has been shown to reduce *Campylobacter* in the whole carcass rinse sample by about 2.1 log₁₀ CFU/ml and to reduce the prevalence of *Salmonella*-positive carcasses from 37% to 10%.

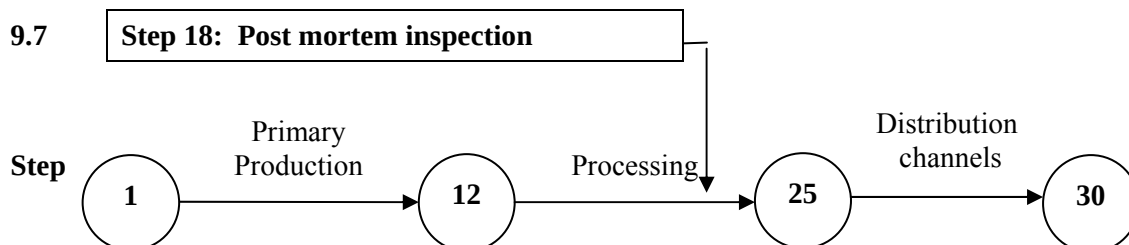
70. Dipping carcasses in 10% TSP reduced *Campylobacter* by 1.7 log₁₀ CFU/g neck skin and the MPN of *Salmonella* was reduced from 1.92 log₁₀ CFU/g neck skin to undetectable levels.

For *Salmonella*

71. The use of ASC (750ppm, pH 2.5, spray application) has in one industrial setting been shown to reduce *Salmonella* prevalence on carcasses from about 50% to levels below detection. In another industrial setting *Salmonella* prevalence was reduced by 18% (700-900ppm, pH 2.5, spray application).

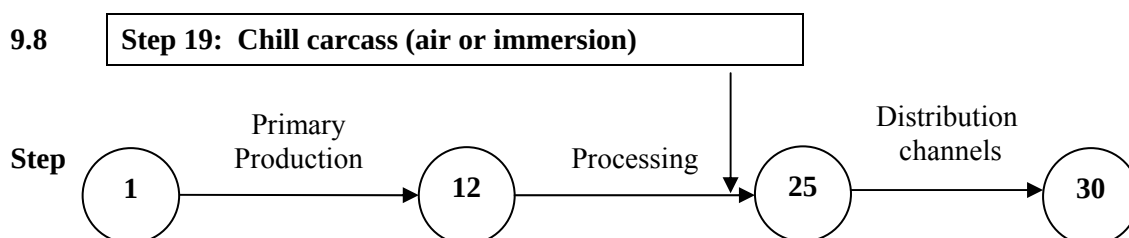
72. A pre-chill ASC spray reduced the *Salmonella* prevalence on carcasses from 17% to 9%. Dipping carcass parts in ASC reduced the *Salmonella* prevalence from 29% to 1%.

73. Spray application of 8-12% TSP immediately before carcass chilling was shown to reduce *Salmonella* prevalence from 10% to 3%.



9.7.1 GHP-based control measures

74. Line speeds and the amount of light should be appropriate for effective post-mortem inspection of carcasses for visible contamination, organoleptic defects and relevant gross pathology.



9.8.1 GHP-based control measures

75. Chicken meat should be chilled, using air or immersion chilling, as quickly as possible to limit the growth of micro-organisms on the carcass. Design and operation of chilling systems should ensure that the target temperature of chilled carcasses is achieved by the time carcasses exit the chiller.

9.8.1.1 Air chilling

76. If water sprays are used during air chilling to prevent desiccation of carcasses, they should be arranged to minimise cross contamination.

9.8.1.2 Immersion Chilling

77. Where considered necessary for control of *Campylobacter* and *Salmonella*, processing aids may be added to the chiller water²⁴. These should be approved by the competent authority and may include, among others:

- Free chlorine (as produced by chlorine gas, sodium-hypochlorite, calcium hypochlorite tablets or electrolytically generated hypochlorous acid)
- Organic acids (e.g. citric, lactic or peracetic acid)
- Other oxidants (e.g. hydrogen peroxide, peroxy acids, chlorine dioxide, acidified sodium chlorite)

78. The use of chlorine in the chill tank may not act as a decontaminating agent by acting directly on the contaminated carcass. However, there would be a washing off effect by the water itself, and the addition of chlorine at a level sufficient to maintain a free residual in the water would then inactivate *Campylobacter* and *Salmonella* washed off, preventing re-attachment and cross-contamination.

79. Water (including recirculated water) should be potable and the chilling system may comprise of one or more tanks. Chilled water can be used or ice may be added to it. Water flow should be counter-current and may be agitated to assist cooling and washing action.

80. Following chilling, any excess water should be allowed to drain away from the carcasses to minimise cross-contamination of carcasses at subsequent steps in the processing chain.

9.8.2 Hazard-based control measures

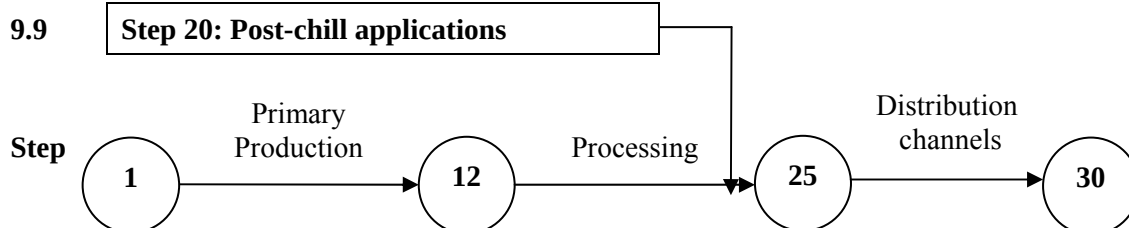
For *Campylobacter*

81. Forced air chilling (blast chilling) may reduce the concentration of *Campylobacter* on chicken carcasses by 0.4 log₁₀ CFU/carcass.

82. Immersion chilling has been shown to reduce concentrations of *Campylobacter* by 1.1-1.3 log₁₀ CFU/ml of carcass rinse.

For *Salmonella*

83. Immersion chilling in water treated with 20ppm or 34 ppm chlorine or 3ppm or 5 ppm chlorine dioxide reduced *Salmonella* prevalence from 14% in controls to 2% (20ppm Cl₂), 5% (34ppm Cl₂), 2% (3ppm ClO₂) and 1% (5 ppm ClO₂) respectively.



9.9.1 Hazard-based control measures

For *Campylobacter*

84. Immersing whole carcasses in 600-800ppm ASC at pH 2.5 to 2.7 for 15 seconds immediately post-chill, has been shown to reduce *Campylobacter* by 0.9-1.2 log₁₀ CFU/ml of whole carcass rinse sample.

For *Salmonella*

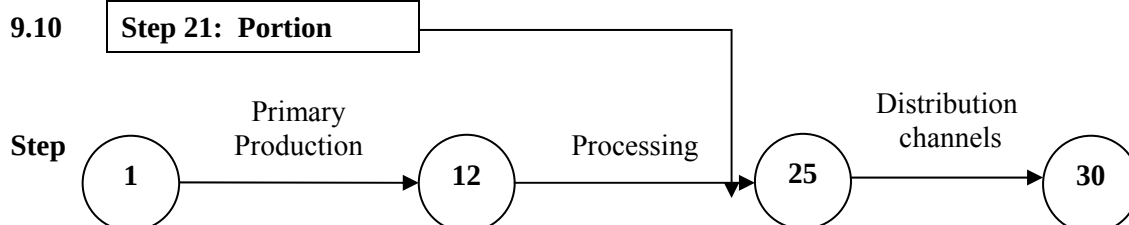
85. The use of ASC (750 ppm, pH ≈ 2.5, immersion dip) post-chill has been shown to reduce prevalence of *Salmonella* positive carcasses from 16% to a level below detection.⁵

²⁴ A variety of processing aids are reviewed in: FAO/WHO: Benefits and Risks of the Use of Chlorine-containing Disinfectants in Food Production and Food Processing. FAO/WHO 2009

86. Spray applications of 20-50 ppm chlorinated water have been shown to reduce the prevalence of *Salmonella*-positive carcasses from 10% to 4%.

87. A chlorine dioxide generating system applied as a dip at 5ppm post-chill resulted in 15-25% reduction in *Salmonella* prevalence.⁵

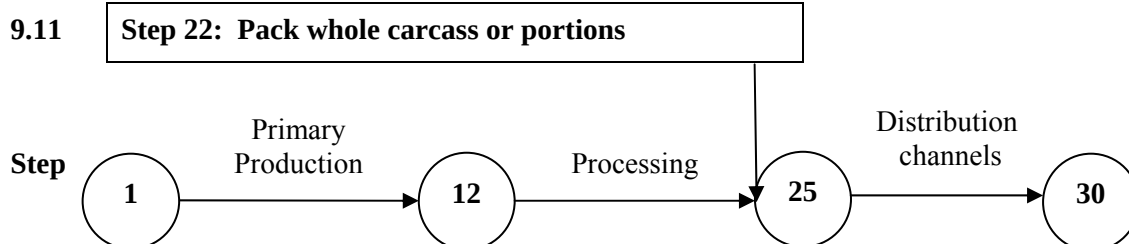
88. Spraying carcasses immediately after spin chilling with 10% TSP resulted in a reduction of *Salmonella* prevalence from 50% to 6%.



9.10.1 GHP-based control measures

For *Salmonella*

89. Chilled carcasses should be held in temperature controlled environments and processed as soon as possible, or with the addition of ice to minimise the growth of *Salmonella*.



9.11.1 GHP-based control measures

90. Care should be taken when packaging to minimise external contamination of the pack, e.g. by use of leakproof packaging or absorbent pads.

91. Pre-packed chicken products intended to be cooked by the consumer should be labelled²⁵ with safe handling, cooking and storage instructions as appropriate to the National situation.

For *Salmonella*

92. Chilled carcasses should be held in temperature controlled environments and processed as soon as possible or with the addition of ice to minimise the growth of *Salmonella*.

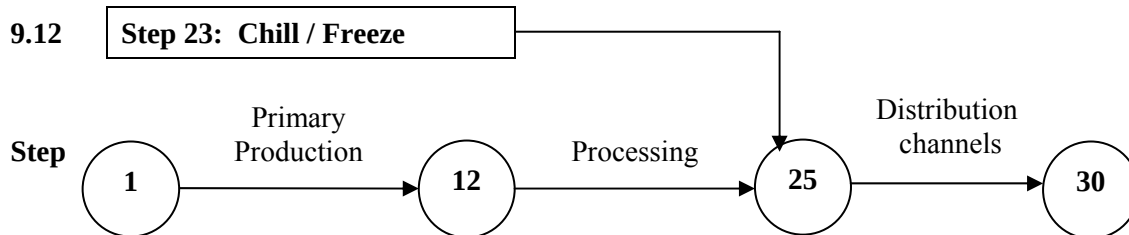
9.11.2 Hazard-based control measures

For *Campylobacter* and *Salmonella*

93. Various doses of Gamma rays or electron beams²⁶ applied to warm, chilled, or frozen carcasses have been shown to be effective at eliminating *Campylobacter* and *Salmonella*. Where irradiation is permitted, levels should be validated and approved by the competent authority.

²⁵ Refer to *General Standard for the Labelling of Pre-packaged Foods* (CODEX STAN 1-1985) and WHO's "Prevention of food-borne disease: Five keys to safer food"

²⁶ Refer to *General Standard for Irradiated Foods* (CODEX STAN 106-1983)

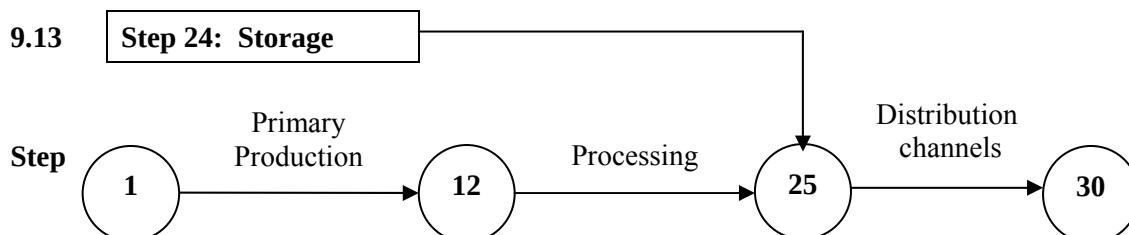


9.12.1 Hazard-based control measures

For *Campylobacter*

94. Freezing of naturally contaminated carcasses followed by 31 days of storage at -20 degrees C has been shown to reduce *Campylobacter* by 0.7 to 2.9 log₁₀ CFU/g.

95. Crust freezing using continuous carbon dioxide belt freezing of skinless breast fillets has been shown to give a reduction of *Campylobacter* of 0.4 log₁₀ CFU/fillet.



9.13.1 GHP-based control measures

For *Salmonella*

96. Products should be stored at temperatures preventing growth of *Salmonella*.²⁷

10. CONTROL MEASURES FOR STEPS 25 TO 30 (DISTRIBUTION CHANNELS)

97. For GHP-based control measures for all aspects of transport, refer to the *Code of Practice – General Principles of Food Hygiene* (CAC/RCP 1-1969) and the *Code of Hygienic Practice for Meat* (CAC/RCP 58-2005).

10.1 Step 25: Transport

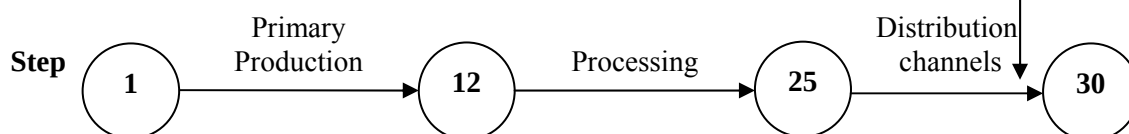
10.2 Step 26: Wholesale Premises

For *Salmonella*

98. Products should be stored at temperatures preventing growth of *Salmonella*.

10.3 Step 27: Transport

10.4 Step 28: Retail / Food service



²⁷ Packaging in modified atmosphere does not prevent growth of *Salmonella* if temperature abuse occurs.

10.4.1 GHP-based control measures

10.4.1.1 Retail

99. Hygiene measures should be in place to prevent cross-contamination between raw chicken meat and other food.
100. Retailers should separate raw and cooked products.
101. Hands should be washed and sanitized before and after handling raw chicken meat. Retailers may also provide customers with the means to sanitise hands after handling raw chicken meat packs.
102. Where product is packed at retail for individual selection by customers, packs should be leak-proof where possible. Extra packaging should be supplied at the display counter to allow customers to separate chicken from other purchases.

10.4.1.2 Food service

103. For GHP-based control measures, also refer to the *Code of Hygienic Practice for Precooked and Cooked Foods in Mass Catering* (CAC/RCP 39-1993).
104. Thawing of frozen chicken should be carried out in a manner that minimises the potential for growth of microorganisms and prevent cross contamination.²⁸ Washing of raw chicken carcasses should not be carried out as it is likely to spread contamination.
105. Food service operators should be fully trained in and aware of the differences between raw and cooked chicken products in relation to food safety and ensure separation at all times.
106. Food service operators should have hygiene measures in place that minimise cross-contamination between raw chicken and hands, contact surfaces and utensils, and should prevent contamination of other foods.

For Salmonella

107. Products should be stored at temperatures preventing growth of *Salmonella*.

10.4.2 Hazard-based control measures

For Campylobacter and Salmonella

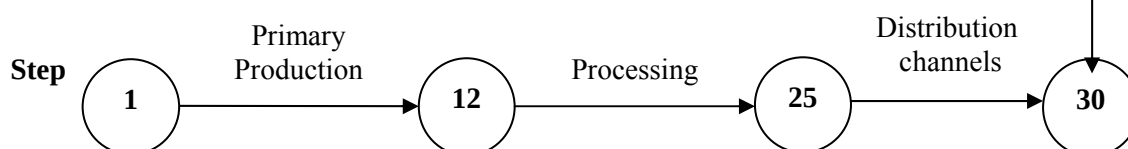
108. Chicken meat should be cooked according to a process that is capable of achieving at least a 7 log reduction in both *Campylobacter* and *Salmonella*.²⁹

10.5

Step 29: Transport

10.6

Step 30: Consumer



10.6.1 GHP-based control measures

109. Consumer education should focus on handling, hand washing, cooking, storage, thawing, prevention of cross contamination, and prevention of temperature abuse. The WHO Five keys to safer food³⁰ assists in this process.

²⁸ Refer to the *Code of Practice for the Processing and Handling of Quick Frozen Foods* (CAC/RCP 8-1976)

²⁹ Cooking chicken meat thoroughly will eliminate *Campylobacter* and *Salmonella*. It has been shown that cooking chicken meat to 165°F (74°C) minimum internal temperature, with no hold time, will give at least a 7 log₁₀ reduction in both *Campylobacter* and *Salmonella*.

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

111. The above information to consumers should be provided through multiple channels such as national media, health care professionals, food hygiene trainers, product labels, pamphlets, school curriculae and cooking demonstrations.

112. Washing of raw chicken in the kitchen should be discouraged so as to minimise the possibility of contamination of other foods and surfaces that come in contact with food and humans. Where deemed necessary washing of raw chicken carcasses and/or chicken meat, should be carried out in a manner which minimises the possibility of contamination of other foods and surfaces that come in contact with other foods and humans

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

For *Salmonella*

114. Products should be stored at temperatures preventing growth of *Salmonella*.

10.6.2 Hazard-based control measures

For *Salmonella* and *Campylobacter*

115. Chicken meat should be cooked according to a process that is capable of achieving at least a 7 log reduction in both *Campylobacter* and *Salmonella*³¹

11. RISK-BASED CONTROL MEASURES

116. 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 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).

117. While these guidelines provide generic guidance on development of GHP-based and hazard-based control measures for *Campylobacter* and *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.

11.1. Development of risk-based control measures

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

119. Risk modelling tools used to explore risk management options and contribute to risk management decisions should be fit for purpose.

120. The risk manager needs to understand the capability and limitations of risk modelling tools they have selected³².

121. When developing risk-based control measures, competent authorities may use the quantitative examples of the likely level of control of a hazard at certain steps in the generic food chain in this document, as a peer-reviewed scientific resource⁵.

122. Competent authorities formulating risk management metrics⁸ as regulatory control measures should apply a methodology that is scientifically robust and transparent.

³⁰ <http://www.who.int/foodsafety/consumer/5keys/en/>

³¹ Cooking chicken meat thoroughly will eliminate *Campylobacter* and *Salmonella*. It has been shown that cooking chicken meat to 165°F (74°C) minimum internal temperature, with no hold time, will give at least a 7 log₁₀ reduction in both *Campylobacter* and *Salmonella*.

³² *Principles and Guidelines for the Conduct of Microbiological Risk Assessment* (CAC/GL 30-1999)

11.2. Availability of a web-based decision tool

123. FAO/WHO through JEMRA has developed a web-based decision support tool³³ for exploring the potential for development of risk-based control measures for *Campylobacter* and *Salmonella* in the raw chicken meat food chain at the national level.³⁴

124. This web-based tool can be used to estimate relative risk reduction and/or ranking consequential to:

- implementation of a specific control measure at a particular step in the food chain (from primary production through to consumption)
- implementation of a particular combination of control measures at different steps in the food chain
- modelling of different food chain scenarios to that presented in this document

125. Industry may also make use of the decision support tool when designing premises-specific food safety programmes that may differ in availability of specific control measures.

126. The user of the decision support tool at the national level should:

- Take responsibility for the appropriateness of the scientific data that is introduced
- Be aware of the uncertainty that inevitably accompanies risk modelling and in conjunction with the risk manager, use the web-based tool to *explore* risk management options and *inform* risk management decisions, rather than provide a prescriptive base
- Not use the tool to impose specific scientific assumptions

12. IMPLEMENTATION OF CONTROL MEASURES

127. Implementation⁸ involves giving effect to the selected control measure(s), development of implementation plan, communication on the decision on control measure(s), ensuring regulatory framework and infrastructure for implementation, and evaluation process to assess whether the control measure(s) have been properly implemented. Validation of control measures should be carried out prior to their implementation.

12.1 Validation of control measures

128. Refer to the *Guidelines for the Validation of Food Safety Control Measures* (CAC/GL 69 -2008).

Note: GHP-based control measures are not subject to validation.

12.2 Prior to Validation

129. Prior to validation of the hazard-based control measures for *Campylobacter* and/or *Salmonella*, the following tasks should be completed:

- Identification of the specific measure or measures to be validated. This would include consideration of any measures approved 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.

12.3 Validation

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

131. Where validation is undertaken for a measure based on hazard control for *Campylobacter* and/or *Salmonella*, evidence will need to be obtained to show that the measure is capable of controlling *Campylobacter* and/or *Salmonella* to a specified target or outcome. This may be achieved by use of a single

³³ Initiated after FAO/WHO Technical Meeting on *Salmonella* and *Campylobacter* in chicken meat. Rome 4-8 May 2009. Tried November 2009. Reviewed April 2010.

³⁴ www.mramodels.org

measure or a combination of measures. The *Guidelines for the Validation of Food Safety Control Measures* (CAC/GL 69 -2008) provides detailed advice on the validation process (section VI).

12.4 Implementation

132. Refer to section 9.2 of the *Code of Hygienic Practice for Meat* (CAC/RCP 58-2005)..

12.4.1 Industry

133. Industry has the primary responsibility for implementing, documenting, applying and supervising process control systems to ensure the safety and suitability of chicken meat, and these should incorporate GHP and validated measures for control of *Campylobacter* and/or *Salmonella* (HACCP) as appropriate to national government requirements and industry's specific circumstances.

134. 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 *Campylobacter* and/or *Salmonella*, industry verification activities, and corrective and preventive actions.

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

12.4.2 Regulatory systems

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

137. The competent authority may choose to 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.

12.5 Verification of control measures

138. 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).

12.5.1 Industry

139. Industry verification should demonstrate that all control measures for *Campylobacter* and/or *Salmonella* have been implemented as intended. Verification should include observation of processing activities, documentary checks, and sampling for *Campylobacter* and/or *Salmonella* testing as appropriate.

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

12.5.2 Regulatory systems

141. 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 *Campylobacter* and/or *Salmonella*.

13. MONITORING AND REVIEW

142. Monitoring and review of food safety control systems is an essential component of application of a risk management framework (RMF) ⁸. It contributes to verification of process control and demonstrating progress towards achievement of public health goals.

143. Information on the level of control of *Campylobacter* and *Salmonella* at appropriate points in the food chain can be used to 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 prioritise 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.

13.1 Monitoring

144. Monitoring should be carried out at appropriate steps³⁵ in the food chain using randomized or targeted sampling as appropriate. Examples of the utility of monitoring systems for *Campylobacter* and/or *Salmonella* in broiler chickens may include:

- Sampling (e.g. environmental, blood, faecal) of breeders and hatcheries for determination of general *Salmonella* status.
- Faecal sampling of chickens prior to delivery to slaughter to determine flock status and permit logistic scheduling and/or channelling of positive chickens for specific processing steps e.g. to heat treatment or freezing.
- Caecal or cloacal sampling for *Campylobacter* at delivery to determine slaughter flock status for epidemiological investigations.
- Whole bird rinse, neck skin or other sampling at the end of primary processing (normally after immersion or air chilling) to verify compliance with hazard-based regulatory or company performance goals.
- Sampling of retail product to determine contamination trends post-processing.
- National or regional surveys for establishing baseline levels of contamination and assisting in formulation of regulatory performance goals within the food chain.

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

146. The type of data collected in monitoring systems should be appropriate for the outcomes sought³⁶.

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

148. Wherever possible, monitoring information from the food chain 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 and campylobacteriosis in humans.
- Epidemiological investigations including outbreaks and sporadic cases.

13.2 Review

149. Monitoring data on *Campylobacter* and *Salmonella* and associated risks should be reviewed on a periodic basis to provide information on the effectiveness of risk management decisions and actions. Results from *Campylobacter* and *Salmonella* spp. should be shared with competent authorities so that the information could be integrated in trend analysis.

150. Periodic review of monitoring data at relevant process steps should be used to inform future decisions on selection of specific control measures, and provide a basis for their validation.

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

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

³⁵ Recommendations on surveillance in poultry flocks for *Salmonella* are provided in the OIE *Terrestrial Animal Health Code*, Chapter 6.5 “Prevention, Detection and Control of *Salmonella* in Poultry”

³⁶ Enumeration and sub-typing of microorganisms generally provides more information for risk management purposes than presence or absence testing.

13.2.1 Public health goals

153. Countries should consider the results of monitoring and review when setting public health goals³⁷ for food-borne campylobacteriosis and salmonellosis and when evaluating progress. Monitoring of the food chain in combination with source attribution and human health surveillance data are important components.

³⁷ International organisations such as WHO provide guidance for establishing and implementing public health monitoring programmes. WHO Global Foodborne Infections Network (GFN) <http://www.who.int/salmsurv/en/>