Chapter 6

HACCP IN PRIMARY PROCESSING

The Science of Poultry and Meat Processing

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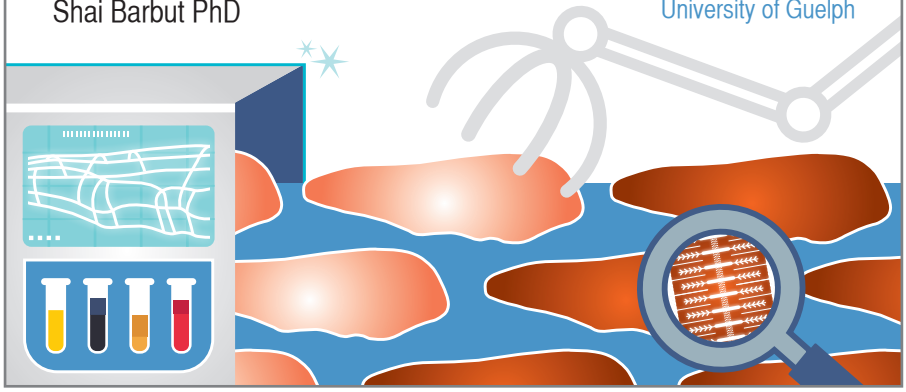

Chapters

* Topics focussing on poultry. Rest of the chapters are related to both red meat and poultry.

Preface

The aim of The Science of Poultry and Meat Processing book is to provide students and industry personnel with a comprehensive view of the modernized primary poultry meat industry and further processing of both red meat and poultry. An emphasis is placed on basic concepts as well as recent advancements such as automation (e.g. increasing poultry line speed from 3,000 to 13,000 birds per hour over the last 40 years) and food safety (e.g. HACCP in primary and the further processing areas). The book also includes chapters explaining basic muscle biology, protein gelation, heat and mass transfer, microbiology, as well as meat colour and texture to help the reader understand the underlying scientific concepts of meat processing. The Science of Poultry and Meat Processing book is based on over two decades of university teaching experiences, and is designed to be used as a course textbook by students, as well as a resource for professionals working in the food industry. The book is available online, at no cost, to any interested learner. Using this format has also allowed me to include many colour pictures, illustrations and graphs to help the reader.

The book is dedicated to my past and current students who have inspired me to learn more and conduct challenging research projects. I see this as an opportunity to give back to the field that I have received so much from as a student and as a faculty member. Looking back, I have learned a great deal from my MSc and PhD advisor, Dr. A. Maurer, who was the student of Dr. R. Baker - the father of poultry processing in North America. I would also like to thank Dr. H. Swatland with whom I worked for almost 20 years, for the many challenging scientific discussions.

Writing The Science of Poultry and Meat Processing book was a long process, which also included having all chapters peer reviewed. I appreciate the help of my colleagues, but I still take responsibility for any inaccuracy in the book. If you have comments or **suggestions,** I would appreciate hearing from you (sbarbut@uoguelph.ca), as I am planning to revise and update a few chapters on a yearly basis.

I would like to thank the many people who have helped me during the writing process. To Deb Drake who entered all of the material for the book, to Mary Anne Smith who assisted in editing, and to ArtWorks Media for the design and desktop publishing of the book. I greatly appreciate the help of my colleagues who reviewed chapters and provided useful discussions. They include Mark B., Ori B., Sarge B., Gregoy B., Joseph C., Mike D., Hans G., Theo H., Melvin H., Myra H., Walter K., Roland K., Anneke L., Massimo M., Johan M., Erik P., Robert R., Uwe T., Rachel T., Jos V., Keith W., and Richard Z. I would also like to thank my family for their love and support during the entire process.

About the Author

Shai Barbut is a professor in the Department of Food Science at the University of Guelph in Ontario, Canada. He received his MSc and PhD at the University of Wisconsin in meat science and food science. He specializes in primary and further processing of poultry and red meat. His research focuses on factors affecting the quality of meat, as well as protein gelation with an emphasis on structure / function relationships, rheological properties and food safety aspects. He has published over two hundred peer reviewed research papers and is the author of the Poultry Products Processing – An Industry Guide textbook. He is a fellow of the Institute of Food Technologists and has received awards from the Meat Science Association, Poultry Science Association, and the Canadian Institute of Food Science and Technology. He is involved in a number of government committees as well as academic and industrial research projects.

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HACCP IN PRIMARY PROCESSING

6.1 Introduction

The Hazard Analysis Critical Control Point (HACCP) program was developed in the early 1970s at the Pillsbury Food Company while developing food for the National Aeronautic and Space Administration Program and the US Army Research Laboratory (Mortimore and Wallace, 1995). HACCP represents a scientific preventive approach to controlling and reducing hazards associated with food production. Overall, it was developed to replace the Random Finished Product Quality Control program, which could not guarantee the level of safety required for the space program. Today, implementing a HACCP program has other added benefits such as problem identification and quality monitoring at an early stage of production, which saves time and money. At the beginning, the HACCP concept was only applied to few products (e.g., low acid canned foods), but today it is used around the world for a large variety of foods and across international trade. Currently, most large food companies, supermarkets, and fast food chains use HACCP in one form or another and quite a few require that their suppliers become HACCP approved. This kind of an integrated approach has resulted in better cooperation within the industry to assure high quality and safe food products. It is important to mention organizations such as the Global Food Safety Initiative (GFSI, 2014). This is a global industry driven initiative aiming at harmonizing and providing guidance on food safety management system controls of the food supply chain. Numerous countries have mandated the use of HACCP in sections or whole food processing plants, while others have only recommended its use to create a more effective food inspection system. For a processing plant, becoming HACCP approved requires a strong commitment from management (e.g., resources, time) and the concept embraced by all employees (Yiannas, 2009). Implementing a HACCP program usually starts with putting together a team of people from different areas of the plant (e.g., engineering, production, and maintenance) who review the entire production line(s).

Overall, an effective HACCP system is one that leads to the production of safe food (free of microbiological, chemical, and physical hazards) via a systematic

approach that monitors each processing step from receiving raw materials to packaging and storing the final product. This is done through identifying the hazard and interventions to minimize risks. The following chapter will introduce the reader to the seven HACCP principles that have been internationally accepted and described in the Codex Alimentarius Commission Codex (1993) and the National Advisory Committee on Microbiological Criteria for Foods (Mortimore and Wallace, 1995). This chapter also describes a generic model related to operating a primary poultry/meat processing plant that readers can use as a template in setting up their own operation or compare to an existing program. In later chapters two other HACCP models will be introduced for ready to eat meats (Chapter 12) and breaded products (Chapter 14). The models not only illustrate the use of a HACCP plan, but also provide the reader additional information about processes described elsewhere in the book (e.g., live animal/bird handling which is discussed in Chapter 4; preservation discussed in Chapter 11; preparation of poultry products discussed in Chapter 13; microbiology discussed in Chapter 15.

Many food companies around the world have already implemented or are in the process of implementing HACCP and/or ISO 9000 programs. These companies experience tangible benefits such as legislation compliance, consistent product quality, increased product safety, and easy acceptance of performance by third party auditing. Today some of the plants aim to simultaneously implement both HACCP and ISO 9000 because the two systems are complimentary (Barbut and Pronk, 2014; Sandrou and Arvanitoyannis, 1999). It should be mentioned that there are several books specifically devoted to the technical aspects of HACCP, including books that deal with employee commitment and motivation.

6.2 The Seven HACCP Principles

1. Conduct a hazard analysis. Prepare a list of processing steps where significant hazards could occur and describe the preventive measures. There are three types of hazards:

a. Biological (B) – hazards primarily concerned with pathogenic bacteria (e.g., S*almonella enteritidis, Staphylococcus aureus, Campylobacter jejuni, Clostridium perfringens, Clostridium botulinum, Listeria monocytogenes,* and *Escherichia coli* O157:H7), viruses (e.g., the bird flu H5N1), and parasites (e.g., *Trichinella spiralis* in pork).
b. Chemical (C) – toxic substances or compounds that may be unsafe for consumption (e.g., cleaners, sanitizers, pesticides, insecticides, rodenticides, paint, lubricants, mycotoxins, antibiotics). An example

that received a lot of publicity in the poultry industry was the Belgian dioxin incident that occurred in January 1999 when a mixture of polychlorinated biphenyls (PCBs) contaminated with dioxins was accidentally added to a stock of recycled fat used in the production of animal feeds. It impacted more than 2500 farms and resulted in a major food crisis that rapidly extended to the whole country and resulted in the implementation of a large PCB/dioxin food monitoring program. The Belgian dioxin incident was due to a single source of PCB oil that was introduced into the food chain. The total amount of PCBs added to recycled fats was estimated at 50 kg, which corresponds to about 100 liters of PCB oil. The highest concentrations of PCBs and dioxins were found in poultry, particularly in the reproduction animals (hens), which showed classical manifestations of chick edema disease. Pigs were also affected but to a lesser extent and no sign of intoxication was observed.

c. Physical (P) – foreign objects that may injure the consumer (e.g., stones, wood, feathers, metal, glass, bolts, screws, plastic, knife blades, needles, hair).

2. Identify the critical control points (CCPs) in the process by using a decision tree (described in Section 6.4). A CCP is defined as a point, step, or procedure in a food production system at which control can be applied to prevent, eliminate, or reduce a hazard to an acceptable level. Examples of potential CCPs:

a. Heat/radiation process to destroy a specific pathogen.
b. Reaching and maintaining a certain pH level which prevents pathogen growth.

3. Establish critical limits for preventive measures associated with each identified CCP. A critical limit is defined as a criterion that must be met for each preventive measure associated with a CCP (e.g., raw meat to be cooked to a temperature of 72°C; see also Chapter 12). Each CCP will have one or more preventive measures that must be properly controlled to assure prevention, elimination, or reduction of the hazard(s) to acceptable levels.

4. Establish CCP monitoring requirements. Establish procedures to monitor the results of each step in the process. This involves a scheduled testing or observations of each identified CCP and its limits. The results must be documented and kept on record for a pre-determined period of time (e.g., five years). For monitoring a parameter such as temperature, a chart recorder may be used to demonstrate that a certain cooking temperature has been achieved and maintained for a specified period of time.

5. Establish corrective action(s) to be taken when monitoring indicates that there is a deviation from an established critical limit (out of limit). The action(s) should bring back the process under control, and eliminate the hazard potentially created by deviation from the plan. If the hazard cannot be remediated then the product should be removed. Overall, the action(s) must show that the hazard was brought under control.

6. Establish effective record keeping procedures that document the HACCP system. This is a crucial step in running the program. The entire HACCP plan must be kept on file and be made available, at any time, to an official government inspector. Examples of forms used for recording and documenting are provided later on in the chapter. While some inspection agencies require the use of standardized forms, others let the plant develop its own, which must first be approved before use.

7. Establish procedures for verification. This ensures that the HACCP system is functioning correctly and effectively, and that it is delivering products as promised. Verification consists of procedures and tests to show that the system is in compliance with the prescribed plant. An example of a verification step might be a scheduled or random insertion of metal into a marked package to show that the system is capable of identifying it when metal has been identified as a potential hazard. The verification process should also confirm that all hazards have been identified and dealt with when the HACCP plan was developed. Some of the verification measures may include compliance with a set of standard criteria (e.g., microbiological test referencing) provided by government or industry bodies. Verification procedures should include activities such as reviews of the HACCP plan, checking CCP records/deviations, random sample collections, and written record verifications. The reports should also include the name(s) of the individual(s) responsible for each step in the HACCP plan.

6.3 Generic HACCP Models

Several generic models have been developed by government agencies and industry bodies worldwide to provide working blueprints for various meat processing operations (e.g., primary processing of poultry/beef/pork, ready to eat meat products) and other foods (e.g., yogurt, frozen vegetables). A generic model provides processors with a useful template that can be adapted as needed. As indicated before, some countries have mandated the use of HACCP. For example, the United States Department of Agriculture (USDA) ruled in July 1996 that

HACCP be implemented as a system of process control in all USDA inspected meat and poultry plants (and these supplying US markets). To help the industry, government bodies such as the USA Food Safety and Inspection Service (FSIS), and the Canadian Food Inspection Agency, have published generic models. However, it should be noted that there are several procedures that should be in place prior to the implementation of a HACCP plan. They include procedures such as Good Manufacturing Practices (GMPs), the Standard Operating Procedures (SOPs), and the Sanitation Standard Operating Procedures (SSOPs). Good Manufacturing Practices are minimum sanitary and processing requirements applicable to all companies processing food; sections related to different sectors of the food industry are available on the Internet. Standard Operating Procedures are step-by-step directions for executing major plant procedures that specifically describe the method for conducting and controlling each procedure. SOPs are designed to ensure minimum standards are met and should be evaluated regularly (i.e., daily, weekly, or monthly, depending on the step) to confirm proper and consistent application. They should also be modified as necessary to ensure proper control. Once GMPs and SOPs are in place, the HACCP generic models can be used as a starting point for the development of a process specific plan that reflects the plant environment. The generic models are not intended to be used "as is", but rather should be developed to address the hazards relevant to a specific product manufacturing (e.g., account for different machinery, plant lay out, unique intervention methods, local regulations, etc.). See also discussion in Chapter 15 about current requirements for sanitary equipment design.

6.4 Poultry Slaughter - A HACCP Generic Model

The generic model provided here is the revised Canadian Food Inspection Agency (CFIA) model for chilled, ready to cook, whole chicken (CFIA, 2011). The previous CFIA model, from 1998, was revised with the intention to reduce the number of CCPs from 9 to 5 and to focus more on the prerequisite programs. The previous CFIA model is quite similar to the USDA (1999) HACCP model. Note: the USDA model is still being revised as some other related documents are being finalized (FSIS, 2014).

In the introduction of the revised CFIA model there are a few important notes:

> "This generic model has been developed based on incoming materials and a sequence of processing steps that are common to a chicken slaughter establishment operating on a HACCP

based inspection system (including on-line reprocessing and reconditioning with downstream cavity defect detection). Considering the many variations in the set-up of chicken slaughter establishments and numerous types of products produced, it would be difficult to include all possible scenarios. Operators, therefore, need to adapt this generic model to their plant specific environment when developing their HACCP plans; i.e., as they are also responsible for food safety in their plant.

Additional hazards may also have to be considered when this model is used for either other poultry species or other classes of poultry; for instance, in the cases of mature poultry such as spent laying hens or spent breeder hens (any species of poultry), contamination and cross-contamination by eggs or egg proteins during the evisceration and chilling process must be considered as a significant chemical hazard that should be controlled and/or mitigated otherwise it could reach unacceptable levels. The ultimate control available for that allergen is the avoidance through the labeling of all products and by-products made of mature poultry to inform further users and/or consumers in order to prevent allergic reactions" (CFIA, 2011).

The flow diagram included in the CFIA model (Fig. 6.4.1) starts with receiving the live bird (i.e., can be used for chickens, turkeys, ducks, etc.), the packaging materials, and the various chemicals (e.g., antimicrobial agents, salt) that will be used in the process. Figure 6.4.1 lists all of the steps and provides a general overview of the process (see also Fig. 5.1.3 in Chapter 5) with an emphasis on potential hazards and points at which they can be controlled (CCPs).

In addition to the flow diagram, plant management is also required to submit an Employee Traffic Pattern Diagram. This schematic provides a basis for evaluating potential areas of cross contamination and must include:

a. The flow of raw products, ingredients and finished products.
b. The flow of packaging materials.
c. The employee traffic pattern throughout the establishment including change rooms, washrooms and lunchrooms.
d. The flow of waste, inedible products, and other non-food products that could cause cross contamination.
e. The hand/boot washing and sanitizing installations/stations.

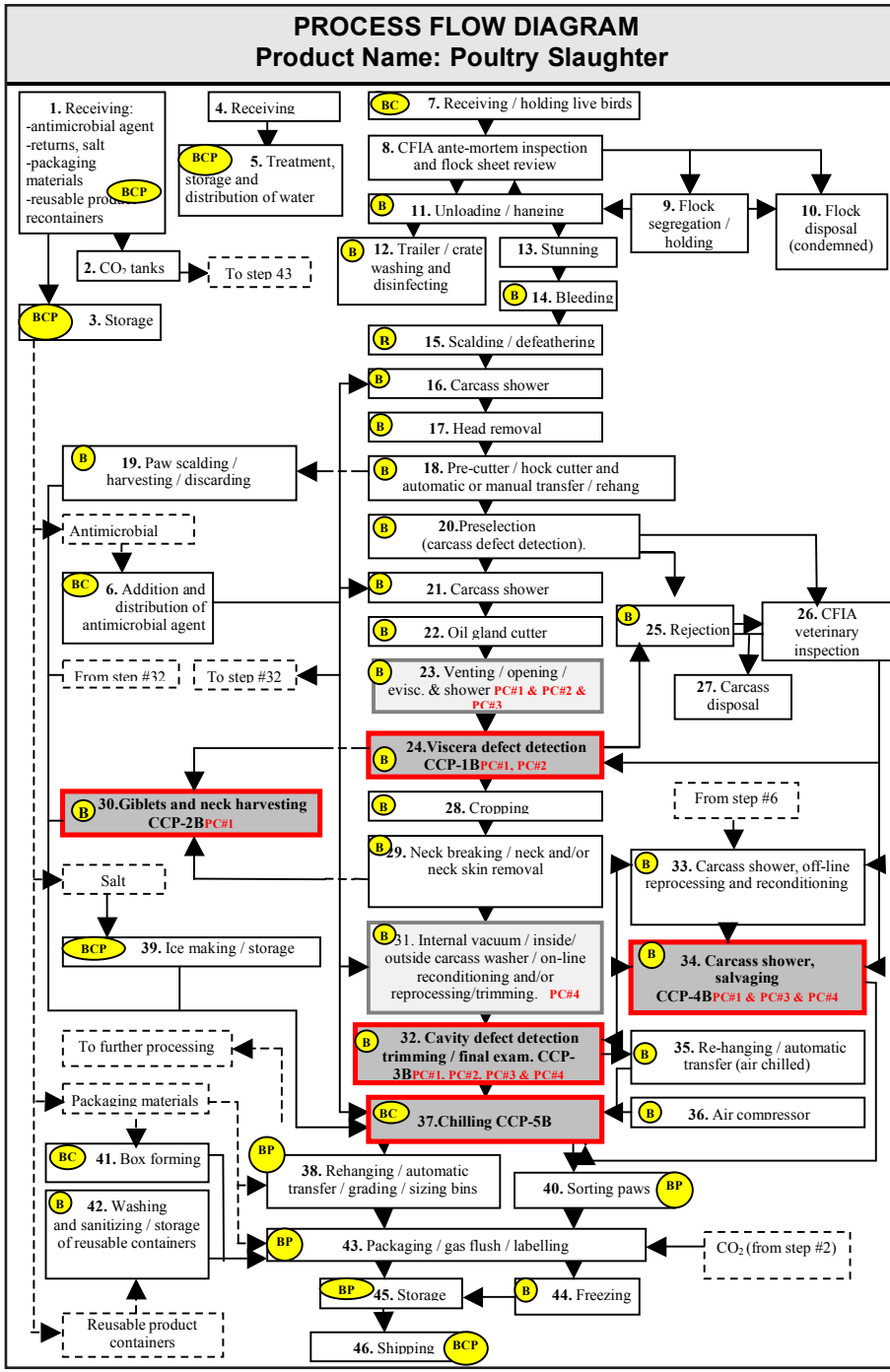

Figure 6.4.1 Process flow diagram for poultry primary processing, including suggested critical control points (CCPs) marked as shaded areas. From CFIA (2011).

The official HACCP document starts with a product description (Table 6.4.1) that includes detailed information regarding the products intended use, shelf life, holding temperature, etc. As indicated above, this is a generic model and each plant should revise it to fit its needs/intended uses (e.g., can have different hazards in a plant that uses water chilling vs. air chilling). Fitting / adjusting the model is a very important step in developing a HACCP plan, as later on it will become an official document that the plant uses when dealing with the government.

Table 6.4.2 and Figure 6.4.1 show that there are three main streams in receiving: live animals/meat, non-meat components (e.g., water/ice, gases for modified atmosphere packaging, salt), and packaging materials (e.g., Styrofoam trays, absorbent pads, plastic film wraps, and cardboard boxes). All non-meat components and packaging materials will be in contact with food and therefore should meet certain agreed specifications (outlined in the prerequisite program or Letter of Guarantee from the supplier).

Table 6.4.3 lists examples of potential hazards from the incoming raw materials. The goal is to systematically identify and prioritize all hazards in order to control the risks and devise procedures to eliminate/minimize the hazards. A HACCP plan should be supported by scientific evidence. Overall, there are various scientific studies that point to procedures that can help reduce bacterial load in ready to cook poultry meat:

a. Timely feed withdrawal that results in empty crops; i.e., to reduce gut spills.
b. High quality water in chilling tanks.
c. Spray washing carcasses with sufficient water volume and pressure can remove about 0.5-1.0 log CFU of bacterial load (i.e., up to 90%). See more discussion and actual references in Chapter 15.
d. Forced air cooling with ozone.
e. Reprocessing or decontamination of carcasses with visible fecal/other contamination (see step 33 in Fig. 6.4.1).
f. Cooling of meat to < 40C to minimize bacterial growth.
g. Using counter flow scalders and water chillers (see also Chapters 5 and 15).
h. Using antimicrobial agents (where permitted) such as chlorine, hot water, or lactic acid during washing and/or water chilling of carcasses (see Chapter 15 for in depth discussion).
i. Constant cleaning of transfer belts and automatic evisceration equipment (e.g., using sprays for rinsing in a so called cleaning in place operation) to reduce cross contamination.

Table 6.4.1 Example of product description form which is part of the official HACCP document. From CFIA (2011).

PRODUCT DESCRIPTION – FORM #1 **Process/Product Type Name: Poultry Slaughter**	
1. Product name(s)	- Raw whole chicken - Raw chicken portions (bone-in and deboned) - Chicken giblets (heart, liver, gizzard) - Chicken paws
2. Important product characteristics (a_w, pH, preservatives, etc)	Non applicable
3. Intended use	Carcasses, portions, giblets and paws: - Ready to cook - For further processing.
4. Packaging	Consumer-size (Modified Atmosphere Packaging) - Styrofoam tray (food contact) - Absorbent pads (food contact) - Plastic film wrap (food contact) - Cardboard boxes (non-food contact) Bulk packs - Plastic/metal breast tags (food contact) - Waxed cardboard boxes (food contact) - Plastic liners / bags (food contact) - Combos (metal cages / plastic / cardboard) (non-food contact) - Plastic containers (food contact) - Stainless steel vats (food contact) - Plastic/metal clips (non-food contact)
5. Shelf life	Consumer-size (Modified Atmosphere Packaging) - Carcasses & portions – "Y" days at ≤ 4°C Bulk packs - Fresh carcasses & portions – "Y" days at ≤ 4°C - Fresh giblets and paws – "Y" days at ≤ 4°C - Frozen carcasses – "Y" days at ≤ -18°C
6. Where it will be sold	Consumer-size - Retail – General population Bulk packs - Federally registered establishments for further processing - Institutions - Restaurants
7. Labelling instructions	Keep refrigerated Keep frozen Best before date Safe handling instructions (recommended)
8. Special distribution control	Fresh product: maintained at ≤ 4°C Frozen product: maintained in a frozen state

Table 6.4.2 Example of the product ingredients and incoming materials used to make and distribute fresh poultry meat. From CFIA (2011).

LIST OF PRODUCT INGREDIENTS AND INCOMING MATERIAL – FORM #2 Product Name: Poultry Slaughter					
Live Animals	**code**	**Non Meat Products**	**code**	**Packaging Materials**	**code**
Chickens	BC	water	BCP	**Food contact**	
		ice	BCP	styrofoam tray	BCP
		CO_2 (Modified Atmosphere Packaging – MAP)	C	absorbent pads	BCP
		salt	C	plastic liners / bags / film wrap	BCP
		air (compressed)	BC	plastic / metal breast tags	BCP
				waxed cardboard boxes	BCP
				stainless steel vats	BP
Meat Products				plastic containers	BCP
Returned products	BCP			**Non-food contact**	
				cardboard boxes	P
				combos (metal cages / plastic / cardboard)	P
				plastic / metal clips	
				pallets	P
Antimicrobial Agents	**code**	**Others**	**code**		
antimicrobial agents e.g.: • Chlorine (Cl_2) • Acidified Sodium Chlorite • Trisodium Phosphate (TSP) • Lactic Acid • Chlorine dioxide					
Explanation of codes: B : Biological; C : Chemical; P : Physical					

The generic model also includes provisions for optional processing schemes, such as using manual re-hanging versus automatic transfer (see step 35 in Fig. 6.4.1). Another example is for plants equipped with different technologies for evisceration (e.g., total separation of viscera from carcass or keeping the viscera attached to the carcass during inspection). Such procedures should be clearly identified in the HACCP document in order to get the appropriate government approval.

Table 6.4.3 Examples of hazard identification using a decision-tree for critical point (CCP) determination and other control measures [Prerequisite Program (PP), Process Control (PC)] for a poultry slaughter operation. Adapted from CFIA (2011).

List each ingredient / process where hazard has been identified	Identify hazard (B,C,P) + describe. Determine if fully controlled by PP. YES-indicate (last column). Move to next hazard. NO- Move to Q1.	Q1. Could control measure(s) be used? NO-indicate how hazard controlled (last column). Move to next hazard. YES-describe measure. Move to Q2.	Q2. Is it likely contamination occurs in excess of acceptable level? NO-identify reason(s). Move to next hazard. YES-identify acceptable level wherever possible. Move to Q3.	Q3. Is this process specifically designed to prevent/ eliminate occurrence? YES-CCP (last column). NO- Move to Q4.	Q4. Will a subsequent step eliminate/reduce hazard? NO-CCP (last column). Move to next hazard. YES-identify next control step. Move to Q5.	Q5. Does step provide partial control? YES-PC (last column). Move to next hazard. NO- Move to next hazard.	Controlled at: #CCP #PC PP - before/after process.
Live chicken	**Biological** – Presence of pathogenic bacteria on feathers, skin, intestinal tract. **NO**	**NO**					**Farm level:** Husbandry practices and On-Farm Safety Program. **Further Processing:** Use thermal process that leads to a 7 log reduction in pathogens. **Consumer level:** Ultimate control through proper handling and cooking of meat.
	Biological – Pathogenic contamination during evisceration due to inadequate feed withdrawal. **YES**						PP: 1, 3, 4, 5, 6 *
	Chemical –Unacceptable levels of drug (antibiotics, coccidiostats) in live chicken. **YES**	**NO**					PP: 1, 3, 4, 5, 6
	Chemical – Unacceptable heavy metal/pesticide levels in live chicken. **NO**						**Farm level:** Prevent exposure to chemical products and On-Farm Food Safety Program.

List each ingredient / process where hazard has been identified	Identify hazard (B,C,P) + describe. Determine if fully controlled by PP. YES-indicate (last column). Move to next hazard. NO- Move to Q1.	Q1. Could control measure(s) be used? NO-indicate how hazard controlled (last column). Move to next hazard. YES-describe measure. Move to Q2.	Q2. Is it likely contamination occurs in excess of acceptable level? NO-identify reason(s). Move to next hazard. YES-identify acceptable level wherever possible. Move to Q3.	Q3. Is this process specifically designed to prevent/ eliminate occurrence? YES-CCP (last column). NO- Move to Q4.	Q4. Will a subsequent step eliminate/reduce hazard? NO-CCP (last column). Move to next hazard. YES-identify next control step. Move to Q5.	Q5. Does step provide partial control? YES-PC (last column). Move to next hazard. NO- Move to next hazard.	Controlled at: #CCP #PC PP - before/after process.
Water	**Biological** – Not meeting the drinking water criteria established by Government **YES**						PP: 2*
	Biological – Presence of pathogenic bacteria (e.g., *Salmonella spp., Campylobacter jejuni, Staphylococcus aureus, Shigella spp., Streptococcus sp, Yersinia spp., Escherichia coli, Listeria monocytogenes*). **YES**						PP: 2
Salt	**Chemical** – Non-food grade or contaminated at source. **YES**						PP: 1, 3, 4, 5, 6
3. Storage	**Biological** – Contamination due to improper handling / practices **YES**						PP: 1, 3, 4, 5, 6, 8

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	Biological – Pathogen contamination due to pests **YES**						PP: 1, 3, 4, 5, 6, 9, 10
	Chemical – Contamination of incoming / packaging materials during storage (e.g. cleaners, sanitizers, lubricants). **YES**						PP: 1, 3, 4, 5, 6
5. Treatment, distribution, storage - water	**Biological** – Contamination due to "dead ends" or back siphoning. **YES**						PP: 2
	Chemical – Excess chlorine **YES**						PP: 2
7. Receiving / holding live birds	**Biological** – Contamination during evisceration due to inadequate feed withdrawal. **YES**						PP: 1, 3, 4, 5, 6
	Chemical – Accepting bird with residues (e.g. antibacterial, pesticides) **YES**						PP: 1, 3, 4, 5, 6

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11. Unloading / hanging	**Biological** – Pathogens in septicemic birds which were dead on arrival that are hung instead of being discarded. **YES**						PP: 1, 3, 4, 5, 6
12. Trailer / crate washing and disinfecting	**Biological** – Contamination of subsequent flocks / live birds due to poorly cleaned crates. **YES**						PP: 1, 3, 4, 5, 6, 9 ,10
14. Bleeding	**Biological** – Contamination of bleeding incision due to build-up of organic debris on equipment and / or faulty cleaning of the hands and knife of the back-up employee. **YES**						PP: 2, 7, 8, 9 ,10
15. Scalding / defeathering	**Biological** – Spread of pathogens through scald water due to inadequate temperature and/or inadequate water replacement/supply. **YES**						PP: 2, 7, 8

List each ingredient / process where hazard has been identified	Identify hazard (B,C,P) + describe. Determine if fully controlled by PP. YES-indicate (last column). Move to next hazard. NO- Move to Q1.	Q1. Could control measure(s) be used? NO-indicate how hazard controlled (last column). Move to next hazard. YES-describe measure. Move to Q2.	Q2. Is it likely contamination occurs in excess of acceptable level? NO-identify reason(s). Move to next hazard. YES-identify acceptable level wherever possible. Move to Q3.	Q3. Is this process specifically designed to prevent/ eliminate occurrence? YES-CCP (last column). NO- Move to Q4.	Q4. Will a subsequent step eliminate/reduce hazard? NO-CCP (last column). Move to next hazard. YES-identify next control step. Move to Q5.	Q5. Does step provide partial control? YES-PC (last column). Move to next hazard. NO- Move to next hazard.	Controlled at: #CCP #PC PP - before/after process.
	Biological – Contamination of muscle resulting from breakage of the skin barrier due to: 1. improper scald water temperature:**YES** 2. improper adjustment of feather pickers: **YES** 3. kill line stoppage and overscalding product: **YES**						1. PP: 2, 8 2. PP: 7, 8 3. PP: 2, 7, 8
16. Carcass shower	**Biological** – Failure to reduce pathogen levels due to inadequate application of a water film preventing bacterial attachment and removal of visible contamination on carcasses (e.g., insufficient water volume/pressure, spray nozzles at improper location). **YES**						PP: 2, 7, 8
	Biological – Pathogen survival due to insufficient antimicrobial agent. **YES**						PP: 7

List each ingredient / process where hazard has been identified	Identify hazard (B,C,P) + describe. Determine if fully controlled by PP. YES-indicate (last column). Move to next hazard. NO- Move to Q1.	Q1. Could control measure(s) be used? NO-indicate how hazard controlled (last column). Move to next hazard. YES-describe measure. Move to Q2.	Q2. Is it likely contamination occurs in excess of acceptable level? NO-identify reason(s). Move to next hazard. YES-identify acceptable level wherever possible. Move to Q3.	Q3. Is this process specifically designed to prevent/ eliminate occurrence? YES-CCP (last column). NO- Move to Q4.	Q4. Will a subsequent step eliminate/reduce hazard? NO-CCP (last column). Move to next hazard. YES-identify next control step. Move to Q5.	Q5. Does step provide partial control? YES-PC (last column). Move to next hazard. NO- Move to next hazard.	Controlled at: #CCP #PC PP - before/after process.
18. Pre-cutter / hock cutter and automatic/ manual transfer / rehang	**Biological** – Contamination due to build-up of organic debris. **YES**						PP: 1, 3, 4, 5, 6, 7, 8, 9, 10 *
	Biological – Cross-contamination due to cloacal leakage. Subsequent: 1. carcass-to-carcass contact: **YES** 2. chute-, table- or belt-to-carcass contact: **YES**						1. PP: 1, 2, 3, 4, 5, 6, 8, 9, 10 2. PP: 1, 4, 5, 6, 8, 9, 10
19. Paw scalding / harvesting / discarding	**Biological** – Inadequate removal of faecal contamination due to inadequate temperature of scald water. **YES**						PP: 2, 7, 8
	Biological – Pathogen growth due to delay in processing. **YES**						PP: 1, 3, 4, 5, 6

List each ingredient / process where hazard has been identified	Identify hazard (B,C,P) + describe. Determine if fully controlled by PP. YES-indicate (last column). Move to next hazard. NO- Move to Q1.	Q1. Could control measure(s) be used? NO-indicate how hazard controlled (last column). Move to next hazard. YES-describe measure. Move to Q2.	Q2. Is it likely contamination occurs in excess of acceptable level? NO-identify reason(s). Move to next hazard. YES-identify acceptable level wherever possible. Move to Q3.	Q3. Is this process specifically designed to prevent/ eliminate occurrence? YES-CCP (last column). NO- Move to Q4.	Q4. Will a subsequent step eliminate/reduce hazard? NO-CCP (last column). Move to next hazard. YES-identify next control step. Move to Q5.	Q5. Does step provide partial control? YES-PC (last column). Move to next hazard. NO- Move to next hazard.	Controlled at: #CCP #PC PP - before/after process.
	Biological – Failure to discard paws from condemned / rejected carcasses. **YES**						PP: 7, 8
21. Carcass shower	**Biological** – Inadequate application of a water film preventing bacterial attachment and the removal of visible contamination e.g., insufficient volume / pressure, spray nozzles improper location. **YES**						PP: 2, 7, 8
23. Venting / opening / evisceration and shower	**Biological** – Contamination from gut content due to evisceration accidents (inadequate feed withdrawal, equipment operation / adjustment, back-up failure). **NO**	**YES** - Monitoring application of : 1. Evisceration standards 2. Presentation standards 3. Defect detection standards	**YES**	**NO**	**YES** Step # 24 CCP#1B Step # 30 CCP#2B Step # 32 CCP#3B Step # 34 CCP#4B	**YES**	PC: #1 PC: #2 PC: #3

List each ingredient / process where hazard has been identified	Identify hazard (B,C,P) + describe. Determine if fully controlled by PP. YES-indicate (last column). Move to next hazard. NO- Move to Q1.	Q1. Could control measure(s) be used? NO-indicate how hazard controlled (last column). Move to next hazard. YES-describe measure. Move to Q2.	Q2. Is it likely contamination occurs in excess of acceptable level? NO-identify reason(s). Move to next hazard. YES-identify acceptable level wherever possible. Move to Q3.	Q3. Is this process specifically designed to prevent/ eliminate occurrence? YES-CCP (last column). NO- Move to Q4.	Q4. Will a subsequent step eliminate/reduce hazard? NO-CCP (last column). Move to next hazard. YES-identify next control step. Move to Q5.	Q5. Does step provide partial control? YES-PC (last column). Move to next hazard. NO- Move to next hazard.	Controlled at: #CCP #PC PP - before/after process.
24. Viscera Defect Detection	**Biological** – Pathogens on viscera due to failure to detect visible fecal contamination as a result of: 1. viscera inadequate presentation. **YES** 2. lack of synchronization between carcass and viscera. **YES** 3. inadequate lighting. **YES**						1. PP: 7, 8 2. PP: 7, 8 3. PP: 2
	Biological – Pathogens in / on viscera due to failure to remove visible fecal contamination. **NO**	**YES** Monitoring application of Defect Detection Standards for viscera	**YES**	**YES**			**CCP-1B**
32. Cavity Defect Detection and examination	**Biological** – Presence ofpathogens due to failure to detect and/or remove internal / external ingesta . **NO**	**YES** - Monitoring application of Carcass Dressing Standards (CDS)	**YES**	**YES**			**CCP-3B**

List each ingredient / process where hazard has been identified	Identify hazard (B,C,P) + describe. Determine if fully controlled by PP. YES-indicate (last column). Move to next hazard. NO- Move to Q1.	Q1. Could control measure(s) be used? NO-indicate how hazard controlled (last column). Move to next hazard. YES-describe measure. Move to Q2.	Q2. Is it likely contamination occurs in excess of acceptable level? NO-identify reason(s). Move to next hazard. YES-identify acceptable level wherever possible. Move to Q3.	Q3. Is this process specifically designed to prevent/ eliminate occurrence? YES-CCP (last column). NO- Move to Q4.	Q4. Will a subsequent step eliminate/reduce hazard? NO-CCP (last column). Move to next hazard. YES-identify next control step. Move to Q5.	Q5. Does step provide partial control? YES-PC (last column). Move to next hazard. NO- Move to next hazard.	Controlled at: #CCP #PC PP - before/after process.
33. Carcass shower, off-line reprocessing and reconditioning	**Biological** – Failure to reduce pathogen level due to inadequate application of water film to prevent bacterial attachment (e.g. water- wrong direction of spray nozzle, insufficient volume / pressure). **YES**						PP: 2, 7, 8 *
All Steps	**Chemical** – Contamination by non-food chemicals (e.g., mineral oil, hydraulic fluid, cleaners, sanitizers, dust, refrigerant). **YES**						PP: 1, 2, 3, 4, 5, 6, 7, 9, 10
All Steps (to be considered from # 16 and higher)	Physical – Contamination with metal / plastic fragments from equipment wear (e.g., conveyors). **YES**						PP: 2, 7
*The prerequisite programs (PP) related to this model include: 1. Transportation; 2. Premises; 3. Purchasing; 4. Receiving; 5. Shipping; 6. Storage; 7. Equipment; 8. Personnel; 9. Sanitation; 10. Pest Control							

Table 6.4.3 lists examples of potential biological (B), chemical (C) and physical (P) hazards that might be a problem in each of the steps during processing (note: the full CFIA 2011 document contains more examples, and there are also Hazard Databases found on the Internet). It is the responsibility of the HACCP team to identify all potential problems so that proper measures can be taken to minimize hazards specific to their plant. The first example describes hazards associated with raw materials entering the plant (e.g., live chicken, water, salt) and ways that these hazards can be addressed. This is done by using a decision tree (see Table 6.4.3, questions 1-5) to determine how to categorize and deal with each hazard.

This table is part of the package that is submitted to the government during certification. It provides the inspector a way to review the thought process of the team and helps to direct the plant's personnel through constructive comments. It is also a very important document for the plant's management, especially during times of employee and equipment turnover (i.e., the document serves as a guide and a reference for ongoing improvements). It should be pointed out again that today many of the hazards are (should be) controlled by GMP's.

Table 6.4.4 focuses on the critical control points (CCPs) determined by the aforementioned decision tree process. The first CCP listed is "Viscera Defect Detection" and is identified as CCP 1B. It provides a detailed description of the hazard and its critical limits as well as specific monitoring, deviation, and verification procedures. These procedures should be well thought out by the HACCP team, as they will later become official binding procedures (i.e., can also be reviewed in the course of an audit).

As can be seen in Table 6.4.3, some of the identified hazards may be controlled through a prerequisite program and/or various process controls while others are controlled via critical control points (CCPs). The prerequisite programs related to this model are listed at the bottom of Table 6.4.3. A detailed document for each can be obtained from the CFIA website. A process control (PC) is a control used at a point or step that will contribute to the effectiveness of the related CCP(s) or postmortem inspection activities. According to the Canadian model, poultry related PCs must be utilized by poultry slaughter establishments as described in Chapter 19 of the Canadian Food Inspection Agency Manual of Procedures (MOP). Any deviation of a CCP will require an evaluation of the supporting PC(s) as part of the deviation procedures associated with that CCP.

The following is a list of CCPs and their supporting PCs in the Poultry Generic Model (CFIA, 2011) described in Tables 6.4.3 and 6.4.4:

- CCP-1B. Step 24 Viscera Defect Detection:
  - PC #1 (Evisceration Standards)
  - PC #2 (Presentation Standards)

- CCP-2B. Step 30 Giblet and Neck Harvesting:
  - PC #1 (Evisceration Standards)

- CCP-3B. Step 32 Final Examination:
  - PC #1 (Evisceration Standards)
  - PC #2 (Presentation Standards)
  - PC #3 (Defect Detection Standards, carcass group)
  - PC #4 (Carcass Dressing Standards)

- CCP-4B. Step 34 Salvaging:
  - PC #1 (Evisceration Standards)
  - PC #3 (Defect Detection Standards, carcass group)
  - PC #4 (Carcass Dressing Standards)

- CCP-5B. Step 37 Chilling:
  - PC #1 (Evisceration Standards)
  - PC #3 (Defect Detection Standards, carcass group)
  - PC #4 (Carcass Dressing Standards)

In Canada, operators are required to have a written program for each PC. The material must meet the requirements found in Chapter 19 of the Manual of Procedures (CFIA, 2010).

Table 6.4.4 Detailed description of the individual critical control points (CCPs) listed in the HACCP generic model (Figure 6.4.1).

CRITICAL CONTROL POINTS Product Name: Poultry Slaughter							
Process Steps	**CCP/ Hazard number**	**Hazard Description**	**Critical Limits**	**Monitoring Procedures**	**Deviation Procedures**	**Verification Procedures**	**HACCP Records**
24. Viscera Defect Detection	CCP-1B	Presence of pathogens in or on viscera due to failure to detect visible fecal and/or ingesta contamination and/or failure to detect visceral pathological conditions and/ or improper removal (e.g. Septicaemia/ Toxaemia or Hepatitis).	As per MOP (Manual of Procedures 19.6.2.4) viscera defect group as per DDS program.	Randomly, once per hour, "CCP-1B monitor" will visually monitor "X" number of randomly selected viscera on the line after the viscera helper, for fecal, ingesta and\ or pathological defects as per DDS program. Records observations and date\time and signs on "CCP-1B Form". Note: see Company Random Selection Procedures.	If lot is rejected, "CCP-1B monitor" will contact maintenance to find and correct the cause of deviation. "CCP-1B monitor" will contact Supervisor to conduct a food safety assessment and either add additional employees or slow down the line. "CCP-1B monitor" will conduct a retest. If the re-test also fails, product since last successful test will be held and the DDS decision tree will be followed as per MOP 19.6.2.5.2.10. If the lot is rejected for Septicaemia/ Toxaemia, immediate carcass and viscera post chill verification is required as per DDS decision tree MOP 19.6.2.5.2.10. The following information is documented on deviation CCP-1B Form: 1. A description of the deviation and its cause 2. Action(s) taken to control affected product 3. Corrective action(s) taken to restore control of the CCP 4. Measures taken to prevent reoccurrence of the deviation The following information is documented on the "Defect Detection Standards Defects Log Post Chill Product Verification" record. Verification of effectiveness of corrective and preventative actions taken (re-tests) Both forms must include initials, date and exact time an entry is made Any deviation will require an evaluation at the supporting PC#1 and PC#2.	The "CCP-1B verifier" observes the "CCP- 1B monitor" once every "Y" (validated frequency) to ensure he/she is performing his/her task as per written program. The "CCP-1B verifier" also examines "X" day(s) worth of "CCP-1B Forms" and "Defect Log" once per "Y" days to ensure monitoring is performed as specified by written procedures and forms are completed and appropriate corrective and preventative measures were taken as required. Also to ensure Pre-shipment review is completed as per MOP 11, USA, Annex Q, Q.1.1b. If deficiencies are noted during verification procedures, a root cause analysis and food safety assessment will be performed. Corrective actions/ preventative measures may include retraining of "CCP -1B monitor" and/ or employees and/or re-evaluation of monitoring/deviation procedures. Verification observations, verifier's signature and date\time are recorded on "CCP-1B Verification Form".	"CCP-1B Form" "CCP 1B Verification Form" "Defect Detection Standards Defects Log Post Chill Product Verification" record.

CRITICAL CONTROL POINTS Product Name: Poultry Slaughter							
Process Steps	**CCP/ Hazard number**	**Hazard Description**	**Critical Limits**	**Monitoring Procedures**	**Deviation Procedures**	**Verification Procedures**	**HACCP Records**
30. Giblets and neck harvesting	CCP-2B	Pathogen contamination on giblets due to presence of fecal and ingesta as a result of failure to discard contaminated giblets.	Edible giblets free of visible fecal/ingesta contamination as defined in the CDS program (MOP 19.6.2.7).	Once per "Y" hour(s), "CCP-2B monitor" will select "X" number of hearts, livers and gizzards and evaluate for the presence of fecal and ingesta. Records observations and date\time and signs on "CCP-2B Form".	If fecal/ingesta is observed on edible giblets or if ingesta/ crop portion are observed on necks, "CCP-2B monitor" will hold all product (as per Company Hold Procedures) since last successful test and product will be re-worked or discarded. Supervisor will be contacted to conduct a food safety assessment and evaluate the giblet or neck harvesting procedure and identify any deficiencies and implement corrective actions. The following information is documented on deviation CCP-2B Form: 1. A description of the deviation and its cause 2. Action(s) taken to control affected product 3. Corrective action(s) taken to restore control of the CCP 4. Verification of effectiveness of corrective measures 5. Measures taken to prevent reoccurrence of the deviation 6. Verification of effectiveness of preventative measures CCP-2B Form must include initials, date and exact time an entry is made Any deviation will require an evaluation at the supporting PC#1.	The "CCP-2B verifier" observes the "CCP- 2B monitor" once every "Y" days to ensure he/she is performing his/her task as per written program. The "CCP-2B verifier" also examines "X" day(s) worth of "CCP-2B Forms" once per "Y" days to ensure monitoring is performed as specified by written procedures and forms are completed and appropriate corrective and preventative measures were taken as required. Also to ensure Pre-shipment review is completed as per MOP 11, USA, Annex Q, Q.1.1b. If deficiencies are noted during verification procedures, a root cause analysis and food safety assessment will be performed. Corrective actions/ preventative measures may include retraining of "CCP -2B monitor" and/ or employees and/or re-evaluation of monitoring/deviation procedures. Verification observations, verifier's signature and date\time are recorded on "CCP-2B Verification Form".	"CCP-2B Form". "CCP-2B Verification Form".
		Pathogen contamination of necks due to presence of ingesta or with the remaining portion of crops.	Free of visible ingesta contamination or crop portions as defined in the CDS program (MOP 19.6.2.7).	Once per "Y" hour(s), "CCP-2B monitor" will select "X" number of necks and evaluate for the presence of ingesta and crop portions. Records observations and date\time and signs on "CCP-2B Form".			

CRITICAL CONTROL POINTS Product Name: Poultry Slaughter							
Process Steps	**CCP/ Hazard number**	**Hazard Description**	**Critical Limits**	**Monitoring Procedures**	**Deviation Procedures**	**Verification Procedures**	**HACCP Records**
32. Cavity Defect Detection and trimming / final examination	CCP-3B	Presence of pathogens due to failure to detect and/or remove internal or external ingesta and/or fecal material contamination and/or portions of Gastro Intestinal Tract (GIT) from carcasses.	As per CDS defect groups FS1 (Food Safety), FS2, FS3 accept/ reject numbers (MOP 19.6.2.7)	Randomly, once per hour, "CCP-3B monitor" will visually monitor "X" number of randomly selected carcasses prior to chilling for fecal, ingesta and\or GIT defects as per CDS program. Records observations and date\time and signs on "CCP-3B Form". Note: see Company Random Selection Procedures.	If lot is rejected for ingesta or GIT, "CCP-3B monitor" will contact maintenance to find and correct the cause of deviation."CCP-3B monitor" will contact supervisor to conduct a food safety assessment and evaluate the upstream process and determine the root cause. If the lot is rejected for fecal, immediate product post chill verification is required as per CDS decision tree (MOP 19.6.2.7.6.7). When process evaluation leads to a rejection of an FS group, the "CCP-3B monitor" will conduct a retest. If the re-test also fails for ingesta and/or GIT, product since last successful test will be held as per CDS decision tree (MOP 19.6.2.7.6.7). The following information is documented on deviation CCP-3B Form: 1. A description of the deviation and its cause 2. Action(s) taken to control affected product 3. Corrective action(s) taken to restore control of the CCP 4. Measures taken to prevent reoccurrence of the deviation The following information is documented on the "Carcass Dressing Standard Defect Log Post Chill Verification" record. Verification of effectiveness of corrective and preventative actions taken (re-tests) Both forms must include initials, date and exact time an entry is made Any deviation will require an evaluation at the supporting PC#1, PC#2, PC#3 and PC#4.	The "CCP-3B verifier" observes the "CCP- 3B monitor" once every "Y" (validated frequency) to ensure he/she is performing his/her task as per written program. The "CCP-3B verifier" also examines "X" day(s) worth of "CCP-3B Forms" and "Defect Log" once per "Y" days to ensure monitoring is performed as specified by written procedures and forms are completed and appropriate corrective actions and preventative measures were taken as required. Also to ensure Pre-shipment review is completed as per MOP 11, USA, Annex Q, Q.1.1b. If deficiencies are noted during verification procedures, a root cause analysis and food safety assessment will be performed. Corrective actions/ preventative measures may include retraining of "CCP -3B monitor" and/ or employees and/or re-evaluation of monitoring/deviation procedures. Verification observations, verifier's signature and date\time are recorded on "CCP-3B Verification Form".	"CCP-3B Form" "CCP-3B Verification Form" "Carcass Dressing Standard Defect Log Post Chill Verification" record.

CRITICAL CONTROL POINTS Product Name: Poultry Slaughter							
Process Steps	**CCP/ Hazard number**	**Hazard Description**	**Critical Limits**	**Monitoring Procedures**	**Deviation Procedures**	**Verification Procedures**	**HACCP Records**
34. Carcass shower, salvaging	CCP-4B	Salvaging: Presence of pathogens on portions due to failure to effectively remove visible contamination (e.g. inadequate performance of employees and/or too many defective carcasses)	Free of visible fecal and ingesta contamination as defined in the CDS program (MOP 19.6.2.7).	Once per "Y" hour(s), "CCP-4B monitor" will select "X" number of portions and evaluate for the presence of fecal and ingesta. Records observations and date\time and signs on CCP-4B Form.	If fecal/ingesta are observed, "CCP-4B monitor" will hold all product (as per Company Hold Procedures) since last successful test and product will be re-worked or discarded. Supervisor will be contacted to conduct a food safety assessment and evaluate the portion harvesting procedure and identify any deficiencies and implement corrective actions. The following information is documented on deviation CCP-4B Form: 1. A description of the deviation and its cause 2. Action(s) taken to control affected product 3. Corrective action(s) taken to restore control of the CCP 4. Verification of effectiveness of corrective measures 5. Measures taken to prevent reoccurrence of the deviation 6. Verification of effectiveness of preventative measures CCP-4B Form must include initials, date and exact time an entry is made Any deviation will require an evaluation at the supporting PC#1, PC#3 and PC#4.	The "CCP-4B verifier" observes the "CCP- 4B monitor" once every "Y" days to ensure he/she is performing his/her task as per written program. The "CCP-4B verifier" also examines "X" day(s) worth of "CCP-4B Forms" once per "Y" days to ensure monitoring is performed as specified by written procedures and forms are completed and appropriate corrective and preventative measures were taken as required. Also to ensure Pre-shipment review is completed as per MOP 11, USA, Annex Q, Q.1.1b. If deficiencies are noted during verification procedures, a root cause analysis and food safety assessment will be performed. Corrective actions/ preventative measures may include retraining of "CCP-4B monitor" and/ or employees and/or re-evaluation of monitoring/deviation procedures. Verification observations, verifier's signature and date/time are recorded on "CCP-4B Verification Form".	"CCP-4B Form" "CCP-4B Verification Form"

CRITICAL CONTROL POINTS Product Name: Poultry Slaughter							
Process Steps	**CCP/ Hazard number**	**Hazard Description**	**Critical Limits**	**Monitoring Procedures**	**Deviation Procedures**	**Verification Procedures**	**HACCP Records**
37. Chilling	CCP-5B	Pathogen growth due to inadequate chilling resulting from time / temperature abuse.	As per "dressed poultry carcasses and parts" of the MOP (19.8.2.4.1 & 19.8.4.1). Portions/ necks/ giblets - chilled to 4°C or lower within 2 hours after evisceration (salvaged turkey breasts, breast fillets, legs, drumsticks and thighs shall be chilled to 4°C or lower within 4 hours after evisceration) as per MOP 19.8.2.4.2. Dressed poultry carcasses can be shipped to another registered establishment provided the product surface temperature has reached 7°C or lower before being shipped.	Every "Y" hour(s) for "X" number of carcasses, CCP-5B Monitor inserts a calibrated digital thermometer in the deepest part of the breast and records product temperature at the time/location specified within the validated chilling procedure. Every "Y" hour(s) for "X" number of portions/necks/ giblets, CCP-5B Monitor inserts a calibrated digital thermometer into each and records product temperature (s) at the time/location specified within the validated chilling procedure. It is highly recommended that the monitoring frequencies established by the operator must allow for the opportunity to effectively further cool the product prior to exceeding the regulatory time frame. CCP-5B Monitor records observations and date\time and signs on "CCP-5B Form".	If product temperature in carcasses and portions is not being brought down according to the prescribed temperature according to the operator's chilling protocol, the Supervisor is contacted and appropriate measures must be readily initiated to bring down the product temperature within the timeframe specified in the MH-MOP.Whenever a deviation is noticed in the chilling of carcasses or parts, the product could be either cooked or if kept fresh, the shelf life / best before date must be re-evaluated. If the violations result in the spoilage of the product, then the product must be disposed of to prevent its entry in the human food chain. In the case of portions/ necks/ giblets, a deviation is noticed, then the product must be disposed of to prevent its entry in the human food chain. Dressed poultry carcasses to be shipped to another registered establishment must reached product surface temperature of 7°C or lower before being shipped, otherwise the product must stay in the approved continuous chilling process until appropriate temperature is reached. The following information is documented on deviation CCP-5B Form: 1. A description of the deviation and its cause 2. Action(s) taken to control affected product 3. Corrective action(s) taken to restore control of the CCP 4. Verification of effectiveness of corrective measures 5. Measures taken to prevent reoccurrence of the deviation 6. Verification of effectiveness of preventative measures CCP-5B Form must include initials, date and exact time an entry is made	The "CCP-5B verifier" observes the "CCP- 5B monitor" once every "Y" days to ensure he/she is performing his/her task as per written program. The "CCP-5B verifier" also examines "X" day(s) worth of "CCP-5B Forms" once per "Y" days to ensure monitoring is performed as specified by written procedures and forms are completed and appropriate corrective and preventative measures were taken as required. Also to ensure Pre-shipment review is completed as per MOP 11, USA, Annex Q, Q.1.1b. If deficiencies are noted during verification procedures, a root cause analysis and food safety assessment will be performed. Corrective actions/ preventative measures may include retraining of "CCP -5B monitor" and/ or employees and/or re-evaluation of monitoring/deviation procedures. Verification observations, verifier's signature and date\time are recorded on "CCP-5B Verification Form".	"CCP-5B Form" "CCP-5B Verification Form"

6.5 Continuous Improvements by Implementing HACCP

Continuous improvements are an integral part of the HACCP program as new findings and growing experiences can help address new challenges and ultimately result in a safer product. In the USA, the Food Safety and Inspection Service (FSIS) got a mandate to verify that industry prerequisite (PR)/HACCP systems are effectively controlling the risks associated with human disease-causing bacteria in raw meat and poultry. The USA government set product specific performance standards for *Salmonella* that must be met by slaughter establishments and establishments producing raw ground meat and poultry products (Eblen et al., 2006). The performance standards are based on the prevalence of *Salmonella*, as determined by the FSIS's nationwide microbial baseline studies, and are expressed in terms of the maximum number of *Salmonella* positive samples that are allowed in a given sample set. From January 1998 through December 2000, federal inspectors collected 98,204 individual samples and 1,502 complete/batch sample sets for *Salmonella* analysis from large, small, and very small establishments that produced at least one of seven raw meat and poultry products: broilers, market hogs, cows and bulls, steers and heifers, ground beef, ground chicken, and ground turkey. *Salmonella* prevalence in most of the product categories was lower post-implementation of PR/HACCP programs than in pre-PR/HACCP baseline study surveys conducted by the FSIS. Results of testing from 1998 to 2000, at establishments of all sizes combined showed that >80% of the sample sets met the *Salmonella* prevalence performance standards (e.g., ≤20.0% prevalence for broilers, 8.7% for market hogs, 2.7% for cows and bulls). The decrease in *Salmonella* prevalence partly reflected industry improvements such as improved process control, incorporation of antimicrobial interventions, and increased microbial monitoring, all in conjunction with PR/HACCP implementation. A follow up study in 2003 revealed that 81% of establishments never had a failed test. In establishments that did experience a sample set failure, the failed sets were generally collected early in the establishment testing history. Small establishments were more likely to have experienced a set failure than were large or very small establishments (Eblen et al., 2006). The FSIS response to failed *Salmonella* sample sets, in-depth verification reviews and related establishment-initiated corrective actions, has likely contributed to declines in the number of establishments that failed the set procedure. The authors mentioned that focusing on food safety measures in small establishments should further reduce the number of sample sets that fail to meet the *Salmonella* performance standards. In Europe, the summary report by the European Food Safety Authority (EFSA, 2010) also discussed positive trends in microbial reduction and further ways to improve the situation.

Overall, interventions should be validated to determine their efficacy before they are introduced. A few examples are provided, below. However, this is by no

means a comprehensive list of all possible intervention procedures. Stopforth et al. (2007) looked at changes in aerobic plate counts (APC), total coliform counts (TCC), *E. coli* counts (ECC), and *Salmonella* incidences on poultry carcasses and parts as well as in poultry processing wastewater. They examined samples before and after individual interventions and after exposure to multiple sequential interventions at various stages of the slaughter process in three different plants. Interventions included post-evisceration wash, inside/outside bird washes, chlorine dioxide wash (note: chlorine is currently allowed in North America but not in Europe), chlorine dioxide wash plus chlorine chiller, chiller exit spray, post-chiller wash, and a tri-sodium phosphate wash at two of the plants. The majority of individual interventions effectively and significantly ($p < 0.05$) reduced microbial populations on or in carcasses, carcass parts, and processing water. Reductions in microbial counts in all three plants ranged from 0 to 1.2 log CFU/ml of sample rinse. Multiple sequential interventions resulted in significant reductions ($P < 0.05$) in APC, TCC, ECC, and *Salmonella* incidence of 2.4, 2.8, and 2.9 log CFU/ml and 79%, respectively, at the first plant; 1.8, 1.7, and 1.6 log CFU/ml and 91%, respectively, at second plant; and 0.8, 1.1, and 0.9 log CFU/ml and 40%, respectively, at the third plant. These results validated the in-plant poultry processing interventions and provided a source of information to help the industry in its selection of antimicrobial strategies with focus on some specific pathogens such as *Salmonella*. Gill et al. (2006) looked at different groups of bacteria after various interventions applied during broiler processing at a HACCP approved plant. The mean log numbers of aerobes, coliforms, *E. coli* and presumptive *Staphylococci* and *Listeria* on carcasses after scalding at 58°C and plucking were about 4.4, 2.5, 2.2 and 1.4 log cfu/cm^2, respectively. The number of bacteria on eviscerated carcasses was similar. After a series of operations to remove the crop, lungs, kidneys, and neck, the number of aerobes was decreased by about 1 log unit from the eviscerated carcass count, but the other numbers were unchanged. After water chilling, the coliform and *E. coli* counts were decreased by about 1 log unit and the counts for presumptive *Staphylococci* plus *Listeria* were decreased by about 0.5 log units from the dressed carcasses, but the number of aerobes was unchanged. Further discussion regarding these and other intervention methods can be found in Chapter 15.

Another emerging issue is the avian influenza virus (AIV) and, more specifically, the highly pathogenic strain known as H5N1. The possible human health threat that it poses has raised concerns over the food safety implications of this virus infecting poultry (note: this is currently not directly dealt with the processing plant's HACCP program, but can be found in various on-farm HACCP procedures. Overall, the meat processor should be aware of these procedures as part of the farm to fork concept). The European Food Safety Agency and the US

Department of Agriculture's Animal and Plant Health Inspection Service, have identified legal and illegal importations of infected poultry commodities (Beato et al., 2009). The authors indicate that AIV may be recovered from a variety of poultry products. However, its presence is influenced by the characteristics of the viral strain, particularly its ability to cause systemic infection (pathogenicity). As a consequence, the host also influences the likelihood of the virus being present. Overall, data are still incomplete and further studies should be carried out in a more extensive and coordinated manner in order to establish proper risk assessments on the spread of infection to a given area and/or host by poultry products. Although only a limited number of studies have been published, it is reassuring that heat and pressure treatments have been shown to inactivate, to acceptable levels, any viable viruses in selected commodities (Beato et al., 2009).

Equipment and machinery also play an important role in maintaining the cleanliness of the operation and, if correctly designed, can reduce cross contamination problems (i.e., equipment is covered under the prerequisite programs). An example is the evisceration line, where the first machine is used to make an opening to the abdominal cavity. In a highly functional machine, this is done at high speeds (e.g., 13,500 broilers per hr) with little to no damage to the carcass, which prevents gut spills from damaged intestines later on (i.e., bacterial count of gut content is about 10^8 to 10^9 per gram). The length of the cut should be adjusted to correspond to the size of the birds processed. It is very important that adjustments can be done quickly and easily during production as there is little time between flocks. Although equipment design is related to the prerequisite program (i.e., not HACCP), it is mentioned here because hygiene focused design helps keep the machine clean during operation. Even simple features such as sloped surfaces can help prevent water or debris accumulation on equipment. Avoiding blind spots also enables the machine to stay clean during operation and a water spray can be used to remove any material that falls on equipment at certain locations (see also Chapter 15 about Principles of Sanitary Equipment Design).

Consumer education and provision of adequate instructions are also important points in the overall picture. For example, the need for very clear cooking instructions was demonstrated in 2007 when frozen chicken and turkey pot pies were recalled after being undercooked by some customers in the USA (Anonymous, 2007). This led to 152 cases of *Salmonella* poisoning and 20 hospitalizations in 31 states. The company responded by: a) asking customers to return suspected products, b) reminding customers that these products were not ready-to-eat and must be thoroughly cooked, and c) most importantly, revising the cooking instructions on the label (including for microwave ovens and mentioning heating to an internal temperature of 71°C).

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