Food Safety
AUTHORITY OF IRELAND

Food Safety Management System (FSMS) Guide for Low-Throughput Cattle, Sheep, Goat and Pig Slaughterhouses

Section E: Hazard Analysis and Critical Control Point

Covering Prerequisite Programmes (PRPs) and Procedures Based on HACCP Principles

Food Safety Management System (FSMS) Guide for Low-Throughput Cattle, Sheep, Goat and Pig Slaughterhouses

Published by:
Food Safety Authority of Ireland
The Exchange, George's Dock
IFSC, Dublin 1
D01 P2V6

Tel: +353 1 817 1300
Email: info@fsai.ie
www.fsai.ie

Revision 1
2022

ISBN 978-1-910348-26-0

Section E: Hazard analysis and critical control point

Hazard analysis and critical control point

Hazard analysis and critical control point (HACCP) is a process control system that is designed to ensure that the food that is produced is safe. Prerequisite programmes (PRPs) are good hygienic practices, the basic conditions and activities necessary to maintain a hygienic environment. HACCP-based procedures (a legal requirement under Article 5 of Regulation (EC) No. 852/2004) are a useful tool to identify and control hazards that may occur in the production of food.

Product description

Low-throughput cattle, sheep, goat and pig slaughterhouses produce carcases and edible offal which, at dispatch, are chilled to 7 °C or less for carcases and 3 °C or less for edible offal. This meat and offal is intended to be cooked before consumption.

Note: Red meat primary processing plants produce raw meat that is not considered to be sterile and which may be contaminated with harmful organisms. However, hygiene legislation requires the processor/food business operator (FBO) to keep the level of contamination as low as possible. This is in order to reduce the risk to the final consumer.

Critical control point definition

The definition of a critical control point (CCP) is: a step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level.[1]

It is generally accepted that there is no step during the slaughter process that would prevent, eliminate or reduce the likely occurrence of a biological hazard to an acceptable level in raw meat.

In this Food Safety Management System (FSMS), the stakeholder expert working group (the HACCP team) used a semi-quantitative risk evaluation method to carry out the hazard analysis using a risk matrix to guide the evaluation. See Annex I of this Section for a description of this risk evaluation.

The conclusion of this hazard analysis and the subsequent CCP determination was that there is no CCP in the slaughter process.

This has been recognised in a European Food Safety Authority (EFSA) opinion: “For example, in the butcher shop there is no practical intervention that would consistently achieve a specific reduction in bacterial pathogens on products to be sold as raw. However, PRP activities such as correct chilling, prevention of cross-contamination by separation of

[1] Recommended international code of practice – general principles of food hygiene – *CAC/RCP 1-1969, Rev.4-2003*.

raw from cooked and effective cleaning and disinfection, etc. will minimise the risk associated with these hazards.[2]

Control point definition

A control point (CP) is a point or step in the production process identified by the hazard analysis as essential in order to control the likelihood of the introduction, survival and/or proliferation of food safety hazards. A number of steps in the slaughter process were identified as being important for food safety, and these have been categorised as CPs, also known as operational prerequisite programmes (oPRPs).

The checklists and PRPs in this Guide may form the basis of the FSMS. If this Guide is followed by the FBO, it will help satisfy legislative requirements. However, the FBO must be aware that due to the layout of, and operations carried out at, individual establishments, a generic guide such as this document may not identify and control all hazards. Therefore, the FBO should check to ensure that all activities in the business are covered in the Guide. If not, then the FBO should develop its own procedures based on HACCP principles for additional activities.

Note: Before applying the HACCP principles in any food business, there must be a robust Pre-Requisite Programme (PRP) in place, for example good hygiene practices (GHPs) to ensure food safety. Once the PRPs are in place, a HACCP-based procedure can be applied.

HACCP flexibility

Regulation (EC) No. 852/2004 (Recital 15) states that "HACCP requirements should provide enough flexibility to be applicable in all situations, including in small businesses. In particular, it is necessary to recognise that, in certain food businesses, it is not possible to identify critical control points and that, in some cases, good hygienic practices can replace monitoring of critical control points. Similarly, the requirement of establishing 'critical limits', does not imply that it is necessary to fix a numerical limit in every case. In addition, the requirement of retaining documents needs to be flexible in order to avoid undue burdens for very small businesses."

This HACCP document

Commission Notice 2016/C 278/01[3] specifically mentions slaughterhouses as an example of a food business where generic guides to HACCP principles may be appropriate: "In those sectors where there is a lot of commonality between businesses or the manufacturing process is linear and short, and where the hazard prevalence is well known, generic HACCP guides may be appropriate, e.g., for slaughterhouses, dairy establishments."

[2] Hazard analysis approaches for certain small retail establishments in view of the application of their food safety management systems, *EFSA Journal* 2017;15(3):4697.

[3] Commission Notice on the implementation of food safety management systems covering prerequisite programs (PRPs) and procedures based on the HACCP principles, including the facilitation/flexibility of the implementation in certain food businesses (2016/C 278/01).

This Section of the FSMS Guide deals with HACCP. It provides a comprehensive description of the HACCP principles, and the procedures involved in preparing a HACCP plan. However, due to the limited resources and low staff numbers in a small, low-throughput slaughterhouse, it may not be possible or practical for such an establishment to prepare its own FSMS based on the HACCP principles. Therefore, an expert working group has carried out the hazard analysis in this FSMS.

This generic FSMS for low-throughput cattle, sheep, goat and pig slaughterhouses has been produced in order to facilitate compliance with the legislative requirement to produce a FSMS based on HACCP principles.

The rest of this Section describes the preparation of a HACCP plan for a low-throughput cattle, sheep, goat or pig slaughterhouse. The common biological, physical and chemical hazards which can occur at slaughter are described, followed by a process flow diagram for the slaughter process. The results of the hazard analysis are tabulated in the hazard analysis tables. The final part (contained in Annex I to this Section) is a more detailed description of the process of hazard analysis; this describes the method used by the stakeholder expert working group to carry out the hazard analysis in this FSMS.

Biological hazards

Biological hazards are harmful microorganisms which include bacteria, viruses, parasites and prions. Red meat primary processing plants produce raw meat that is not considered to be sterile and which may be contaminated with harmful organisms.

Bacteria

Bacteria are the most common cause of food poisoning. Unlike food spoilage bacteria, food poisoning bacteria do not affect the taste, smell or look of food. There are many food poisoning bacteria, but some key pathogens include *Salmonella* spp. (beef and pork), Shiga toxin-producing *Escherichia coli* (STEC) (beef, lamb, goat), *Listeria monocytogenes* (reported in beef, pork and lamb carcases but more commonly in ready-to-eat products), and *Yersinia enterocolitica* (pork). *Campylobacter* spp. are the most common cause of bacterial food poisoning in the European Union (EU), but they do not grow outside of the host and never at temperatures below 30 °C.[4]

The principle sources of carcase contamination occur as a result of direct contact with faeces or contact with surfaces which themselves have been in contact with faeces, e.g. hides.

See the following websites for further information on bacterial hazards:

- https://www.fsai.ie/salmonellaspecies.html
- http://www.hpsc.ie/a-z/gastroenteric/vtec/factsheet/
- https://www.cdc.gov/foodsafety/diseases/clostridium-perfringens.html
- http://www.hpsc.ie/a-z/gastroenteric/yersiniosis/factsheet/
- https://www.fsai.ie/staphylococcusaureus.html
- http://www.hpsc.ie/a-z/gastroenteric/listeriosis/
- https://www.fsai.ie/publications_prevention_VTEC/
- https://www.fsai.ie/listeriamonocytogenes.html
- http://www.hpsc.ie/a-z/gastroenteric/campylobacter/factsheet/
- https://www.fsai.ie/campylobacterspecies.html
- http://www.hpsc.ie/a-z/gastroenteric/vtec/factsheet/
- http://www.hpsc.ie/a-z/vaccinepreventable/tuberculosistb/tbfactsheets/
- http://www.hpsc.ie/a-z/zoonotic/brucellosis/factsheet/
- http://www.fsai.ie/uploadedfiles/zoonotic_tb.pdf
- http://www.hpsc.ie/a-z/zoonotic/leptospirosis/factsheet/
- http://www.hpsc.ie/a-z/gastroenteric/norovirus/factsheets/informationforemployers/

[4] EFSA Panel on Biological Hazards (2014) Scientific Opinion on the public health risks related to the maintenance of the cold chain during storage and transport of meat. Part 1 (meat of domestic ungulates). *EFSA Journal*, **12**(3): 3601.

Viruses

Zoonotic viruses occur in meat, e.g. hepatitis E can cause food poisoning from eating undercooked pork.

See the following website for further information on hepatitis E.

- https://www.fsai.ie/faq/hepatitis_E.html

Parasites

Zoonotic parasites occur in Ireland but are a less common hazard in meat than bacterial pathogens. Some examples of zoonotic parasites include *Trichinella*, *Sarcocystis*, *Echinococcus* and *Toxoplasma*.

See the following websites for further information on zoonotic parasites:

- https://www.cdc.gov/dpdx/trichinellosis/index.html
- https://www.cdc.gov/dpdx/sarcocystosis/index.html
- https://www.cdc.gov/parasites/taeniasis/index.html
- https://ecdc.europa.eu/en/echinococcosis/facts
- https://www.cdc.gov/parasites/toxoplasmosis/biology.html

Prions

A prion is an abnormal form of a protein, and prions cause transmissible spongiform encephalopathies (TSEs). TSEs are a group of diseases that affect the brain and nervous system in both humans and animals. These diseases cause brain tissue degeneration, e.g. bovine spongiform encephalopathy (BSE) in cattle, scrapie in sheep and goats, and variant Creutzfeldt-Jakob disease (vCJD) in humans.

With the exception of the infectious agent causing BSE, which can be transmitted to humans through consumption of contaminated meat causing vCJD, there is no scientific evidence that other TSE diseases can be transmitted to humans.[5]

Specified risk material (SRM) is those parts of cattle, sheep and goats that are most likely to pose a risk of infection if the animal from which it comes was infected with a TSE. It is essential, therefore, that it is removed from both the human and animal food chains and destroyed.

See the following website for further information on prions.

- https://www.cdc.gov/prions/index.html

[5] Transmissible spongiform encephalopathies (TSEs), EFSA European Food Safety Authority website. https://www.efsa.europa.eu/en/topics/topic/transmissible-spongiform-encephalopathies-tses

Chemical hazards

Sources of chemical hazards include environmental and feed contaminants, veterinary drug residues, pesticide residues, cleaning chemical residues, allergens, additives, and migration from food contact materials. The routes by which chemical hazards may enter an animal's body include feed, ingested soil or drinking water, inhalation, direct skin contact, or other routes such as veterinary drug administration. Such hazards may end up in the meat if the animal is exposed to them in sufficient quantities.

Feed contaminants and veterinary drug residues

Feedstuffs fed to livestock may contain chemical contaminants, either naturally (e.g. plant toxins), intentionally (e.g. feed additives) or unintentionally (e.g. mycotoxins, dioxins, or heavy metals such as mercury, lead, cadmium, tin and arsenic).

Veterinary medicines are substances used to treat and prevent disease in animals, thus having the potential to enter the food chain through their occurrence as residues in food. A further category of substances of potential concern is growth-promoting agents and non-approved veterinary medicines prohibited for use in food-producing animals. It is critical that residues of veterinary medicines, contaminants, and prohibited substances are either not present in animal products destined for the human food chain or are present at such a level that adverse effects on the health of consumers will not occur. At animal intake, the farmer/producer signs food chain information (FCI) declaration document to declare that the prescribed withdrawal periods have been observed for all medications administered.

Pesticides, environmental chemicals/contaminants, and cleaning agents

Animals may also be exposed to a range of chemicals such as pesticides and environmental contaminants (e.g. organohalogens, persistent organic pollutants such as dichlorodiphenyltrichloroethane (DDT), chemical elements) occurring in air, soil, water or feed. See Pest control (PRP 11) in Section A.

In the slaughterhouse environment, surface and environmental cleaning chemicals (e.g. detergents, sanitisers) must not contaminate the meat or offal. All chemicals (including cleaning chemicals) must be used according to user guidelines in order to prevent meat or offal contamination. Oil and lubricants used during processing must be of food grade. See Cleaning and sanitation (PRP 5) in Section A.

Allergens, additives and migration from food contact materials

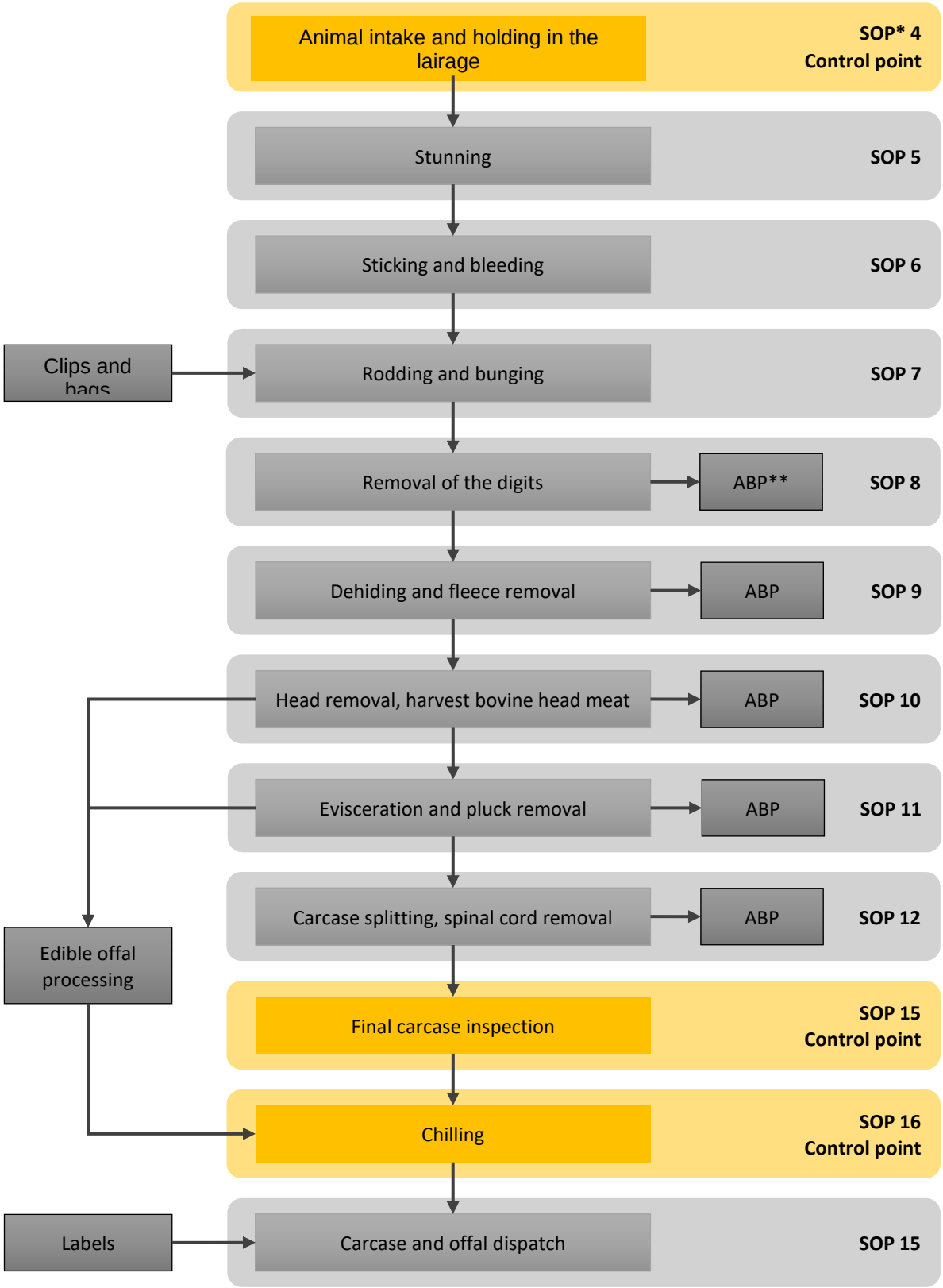
As meat leaving the slaughterhouse is in carcase form, there is little chance of contamination with allergens, additives or migration from food contact materials. All food contact surfaces and food contact materials used must be food grade.

Physical hazards

Physical hazards include objects such as metal (e.g. a piece of a knife blade, rail dust from slaughterhouse rails, a hypodermic needle in a live animal), glass and plastic (e.g. from the slaughter/cutting environment) which appear as foreign objects in the meat or offal. Physical hazards also include those intrinsically present in the food (e.g. bones, or parts thereof, in meat products).

If a robust PRP is in place, the likelihood of a physical hazard due to an object from the premises/equipment occurring in the meat leaving the slaughterhouse is extremely low. The ante-mortem (AM) veterinary inspection, visual inspection checks during slaughter, and final inspection further reduce this possibility. The possibility of a foreign body from the live animal, e.g. a broken needle, being found in the final meat cut and injuring the consumer is highly unlikely.

Figure E1: Process flow diagram – cattle, sheep and goats



* SOP = standard operating procedure
** ABP = animal by-product

Hazard analysis: cattle, sheep and goat slaughter

Legislation

Regulation (EC) No. 852/2004, Article 5.1

Food business operators shall put in place, implement and maintain a permanent procedure based on HACCP principles.

Note: This hazard analysis has determined that there are no CCPs in this process. All hazards are controlled by the PRPs. A number of steps are CPs. CPs are steps which are important for ensuring food safety and compliance with food law.

Stage/process step	B: Biological hazard C: Chemical hazard P: Physical hazard	Control measures/monitoring	Corrective actions	Comments
1. Animal intake (SOP 4)	**B:** Livestock may carry pathogens in their gut or on their hide/fleece. Livestock may be presented from a herd that is restricted for herd health or public health reasons, according to accompanying documentation.	Follow SOP 4. Visual inspection for hide/fleece cleanliness at intake. Follow clean livestock policy: A: Satisfactory B: Acceptable C: Unacceptable. FCI declaration document must be presented and evaluated before animal intake and AM inspection.	Clip hair/wool or wait until dry and then clip. Reject animals for slaughter if unsatisfactory. If animal is already presented at slaughterhouse, the animal must be killed separately and declared unfit for human consumption, and precautions must be taken to safeguard animal and public health where appropriate. Animals without complete FCI declaration documents must not be presented for slaughter. However, where the veterinary inspector (VI) permits, the animal may be	**This is a CP.** Carcase dressing procedures are designed to minimise carcase contamination. Visible contamination is trimmed at the final carcase inspection step.

Stage/process step	B: Biological hazard C: Chemical hazard P: Physical hazard	Control measures/monitoring	Corrective actions	Comments
			slaughtered and the carcase detained pending delivery of FCI within 24 hours. The carcase will be condemned if the FCI is not presented within this timeframe.	
	C: Livestock must be free of any substance which may render their meat unfit for human consumption, e.g. veterinary medicinal products.	Follow SOP 4. The FCI declaration document must be signed by the keeper/person in charge before slaughter.	Carcase will be detained pending delivery of the FCI within 24 hours; otherwise, the carcase will be condemned.	The FCI declaration document is signed by the animal's owner, who provides assurances regarding the use of veterinary medicines and the presence of any other substance which may render the meat unfit for human consumption. There is a low likelihood of chemical residues being present. The results of the National Residue Control Plan report a very low level of residues in cattle, sheep and pigs at slaughter. In the event of consumers ingesting product with such residues, the most likely adverse health effect, if any, would be reversible or minor damage. Therefore, the severity is deemed moderate.
	P: Needles or foreign bodies.	The extremely low risk of a needle or foreign body being present in meat is further reduced by subsequent inspections		The likelihood of a needle or foreign body being present in the animal is low. Surface injury or damage should be evident at AM or PM meat inspection.

Stage/process step	B: Biological hazard C: Chemical hazard P: Physical hazard	Control measures/monitoring	Corrective actions	Comments
		at slaughter, cutting and packing.		If a consumer ingests a foreign body (e.g. a broken needle), the most likely adverse health effect, if any, would be reversible or minor illness/injury, therefore the severity is deemed moderate.
2. Animal intake and holding in the lairage (SOP 4)	**B**: Dirty lairage facilities may cause contamination of livestock hide/fleece. Cross-contamination from one animal to another	Follow SOP 1 (Cleaning and Sanitation), SOP 4 and fill in the Daily Slaughter Record. Regular visual inspection	Clean lairage more often/thoroughly. Revise SOP 1 and SOP 4. Staff training.	By following SOP 4 on animal intake and SOP 1 on keeping the lairage clean, the lairage will be maintained satisfactorily.
	C: None identified.			
	P: None identified.			
3. Stunning (SOP 5)	**B:** Introduction of pathogens or BSE prion particles into the bloodstream from the captive bolt.	Follow SOP 5 and fill in the Daily Slaughter Record. Regular visual inspection of captive bolt equipment. Proper sanitation and hygiene of the captive bolt.	Revise SOP 5. More frequent/thorough cleaning of the stun gun.	The incidence of BSE positives in slaughtered animals is very low. Good hygiene practices (GHPs) will ensure that the captive bolt is free of pathogens. The likelihood of occurrence is considered to be low. Only trained personnel who have a certificate of competence may stun animals. The severity is deemed significant, as vCJD is an incurable disorder.

Stage/process step	B: Biological hazard C: Chemical hazard P: Physical hazard	Control measures/monitoring	Corrective actions	Comments
	C: None identified.			
	P: None identified.			
4. Sticking and Bleeding (SOP 6)	**B:** Contamination with pathogens from the skin/knife into the bloodstream due to poor sticking technique.	Follow SOP 6. Regular visual inspection of sticking and bleeding. Only trained staff who have a certificate of competence may stun, then hygienically and effectively bleed the animal.	Revise SOP 6. Retrain staff.	Any organisms introduced into the bloodstream will be few in number and are unlikely to survive in the deep tissues.[6] There is a medium likelihood of carcase contamination at this step. Subsequent trimming at final inspection can remove surface contamination. The final product of this process is raw meat intended to be cooked before consumption.
	C: None identified.			
	P: Broken knife blade lodging in the carcase.	Maintenance of knives. Regular visual inspection of the knife while in use.	Replace broken knife. Find and remove the piece of broken knife from the carcase.	There is a very low likelihood of a knife blade breaking while cutting into the carcase and lodging in the carcase. The severity of biting into a piece of meat containing a broken knife blade is moderate.

[6] Mackey BM and Derrick CM (1979) Contamination of the deep tissues of carcases by bacteria present on the slaughter instruments or in the gut. *Journal of Applied Bacteriology*, **46**(2): 355–366.

Stage/process step	B: Biological hazard C: Chemical hazard P: Physical hazard	Control measures/monitoring	Corrective actions	Comments
5. Rodding and bunging (SOP 7)	**B:** Biological contamination with pathogens from poor rodding technique and/or applying the clip may cause leakage of gut contents.	Follow SOP 7 and SOP 11 (including the evisceration accident protocol (burst belly procedure)). Regular visual inspection of operations.	Revise SOP 7 and SOP 11 as appropriate. Retrain staff.	Subsequent trimming at final inspection will remove visible contamination. A breakdown in hygiene at this step can happen but is not frequent if SOP 7 and SOP 11 are followed.
	C: None identified**.**			
	P: None identified.			
6. Removal of the front digits (SOP 8a) and hind digits (SOP 8b)	**B:** Biological contamination of the carcase with pathogens from poor technique	Follow SOP 8a and SOP 8b (includes the two-knife technique). Regular visual inspection of operations.	Revise SOP 8a and SOP 8b as appropriate. Retrain staff.	A breakdown in hygiene at this step can happen but is not frequent if SOP 8a and 8b is followed. Subsequent trimming at final inspection will remove visible contamination.
	C: None identified.			
	P: None identified.			
7. Dehiding and fleece removal (SOP 9)	**B:** Biological contamination of the carcase with pathogens from poor technique or dirty equipment.	Follow SOP 9 (includes the two-knife technique) Regular visual inspection of operations.	Revise SOP 9. Retrain staff.	Contamination of the carcase from the hide can happen but is not frequent when SOP 9 is followed. Visible contamination will be trimmed at the final carcase inspection step.
	P: None identified.			

Stage/process step	B: Biological hazard C: Chemical hazard P: Physical hazard	Control measures/monitoring	Corrective actions	Comments
	C: None identified.			
8. Head removal, harvest bovine head meat (SOP 10)	**B:** Poor technique may cause contamination with pathogens or prion.	Follow SOP 10 (includes the two-knife technique). Regular visual inspection of operations.	Revise SOP 10. Retrain staff.	Visible contamination of the carcase can happen but is not frequent when SOP 10 is followed. Visible contamination will be trimmed at the final carcase inspection step. The incidence of BSE positives in slaughtered animals is very low.
	C: None identified.			
	P: Broken knife blade lodging in the carcase.	Maintenance of knives. Regular visual inspection of knife while in use.	Replace the broken knife. Find and remove the piece of broken knife from the carcase.	There is a very low likelihood of a knife blade breaking while cutting into the carcase and lodging in the carcase. The severity of biting into a piece of meat containing a broken knife blade is moderate. However, it is unlikely to be life-threatening.
9. Dressing/opening the abdomen (SOP 11)	**B:** Poor technique may cause contamination with pathogens.	Follow SOP 11 (includes the two-knife technique). Regular visual inspection.	Revise the SOP. Retrain staff.	Contamination of the carcase can happen but is not frequent when SOP 11 is followed. Visible contamination will be subsequently trimmed at the final carcase inspection step.

Stage/process step	B: Biological hazard C: Chemical hazard P: Physical hazard	Control measures/monitoring	Corrective actions	Comments
	C: Oil/grease from overhead railings due to inadequate cleaning/maintenance or excess greasing.	Regular maintenance and visual inspection of operations. Follow maintenance (PRP 4) in Section A.	Follow manufacturer's instructions for greasing railings. Use food-grade oil/grease. Trim and reinspect the carcase.	Food-grade oil is aesthetically unsatisfactory but is not a food safety risk.
	P: (a) Rail dust/metal filings due to inadequate maintenance of overhead rails. (b) Glass/plastic from the processing environment due to breakage or damage. **(c)** Broken knife blade lodging in carcase.	(a) Regular visual inspection and maintenance. (b)Regular visual inspection and maintenance. (c)Maintenance of knives. Regular visual inspection of knife while in use.	(a) Trim and reinspect the carcase. (b) Trim and reinspect the carcase. Assess the environment before recommencing operations. (c) Replace the broken knife. Find and remove the piece of broken knife from carcase.	The likelihood of these physical hazards ending up in the meat is low if the maintenance PRP 4 is in place and is being followed. The severity of ingesting these hazards is negligible, as the most likely effect would be reversible or minor illness.
10. Evisceration, pluck removal (SOP 11)	**B:** Poor technique may cause contamination from the gastrointestinal tract.	Follow SOP 11. Regular visual inspection of operations.	Retrain staff. Corrective action as per the evisceration accident protocol (burst belly procedure).	Faecal contamination of the carcase can happen but is not frequent when SOP 11 is followed. Visible contamination will be trimmed at the final carcase inspection step.
	C: Oil/grease from overhead railings due to inadequate cleaning/maintenance or excess greasing.	Regular visual inspection of operations. Regular maintenance.	Follow manufacturer's instructions for greasing railings. Use food-grade oil/grease.	Food-grade oil is aesthetically unsatisfactory but is not a food safety risk.

Stage/process step	B: Biological hazard C: Chemical hazard P: Physical hazard	Control measures/monitoring	Corrective actions	Comments
			Trim and reinspect the carcase.	
	P: (a) Rail dust/metal filings due to inadequate maintenance of overhead rails. (b) Glass/plastic from the processing environment. (c) Broken knife blade lodging in carcase.	(a) Regular visual inspection and maintenance. (b) Regular visual inspection and maintenance. (c) Maintenance of knives. Regular visual inspection of knife while in use.	(a) Trim and reinspect the carcase. (b) Trim and reinspect the carcase. (c) Assess the environment before recommencing operations. Replace the broken knife. Find and remove the piece of broken knife from the carcase.	The likelihood of these hazards ending up in the meat is low if the maintenance PRP 4 is in place and is being followed. The severity of ingesting any of these hazards is negligible as the most likely effect would be reversible or minor illness.
11. Carcase Splitting (SOP 12)	**B:** (a) Biological contamination with pathogens from poor technique or dirty equipment. (b) Tunnelling (i.e. a section of the spinal canal which is not opened so as to expose the spinal cord) resulting in difficulty removing the spinal cord, which may contain BSE prion particles. (c) Bone dust from the vertebral column of bovines over 30 months of age.	(a) Follow GHPs and SOP 12. (b) Regular visual inspection. (c)The bone saw collecting tray must be marked 'SRM', and/or the waste water outlet must have drain traps or screens with apertures with a filter pore or a mesh size of no more than 6 mm, downstream of carcase splitting. This	(a) Retrain staff. Revise the SOP. (b) If inaccurate sawing results in tunnelling, the carcase must be clearly identified and such tunnels must be cut again so as to allow the trapped spinal cord to be removed. (c) Fix or replace defective equipment.	(b) The incidence of BSE positives in slaughtered animals is now very low. Tunnelling will be detected and rectified at final carcase inspection.

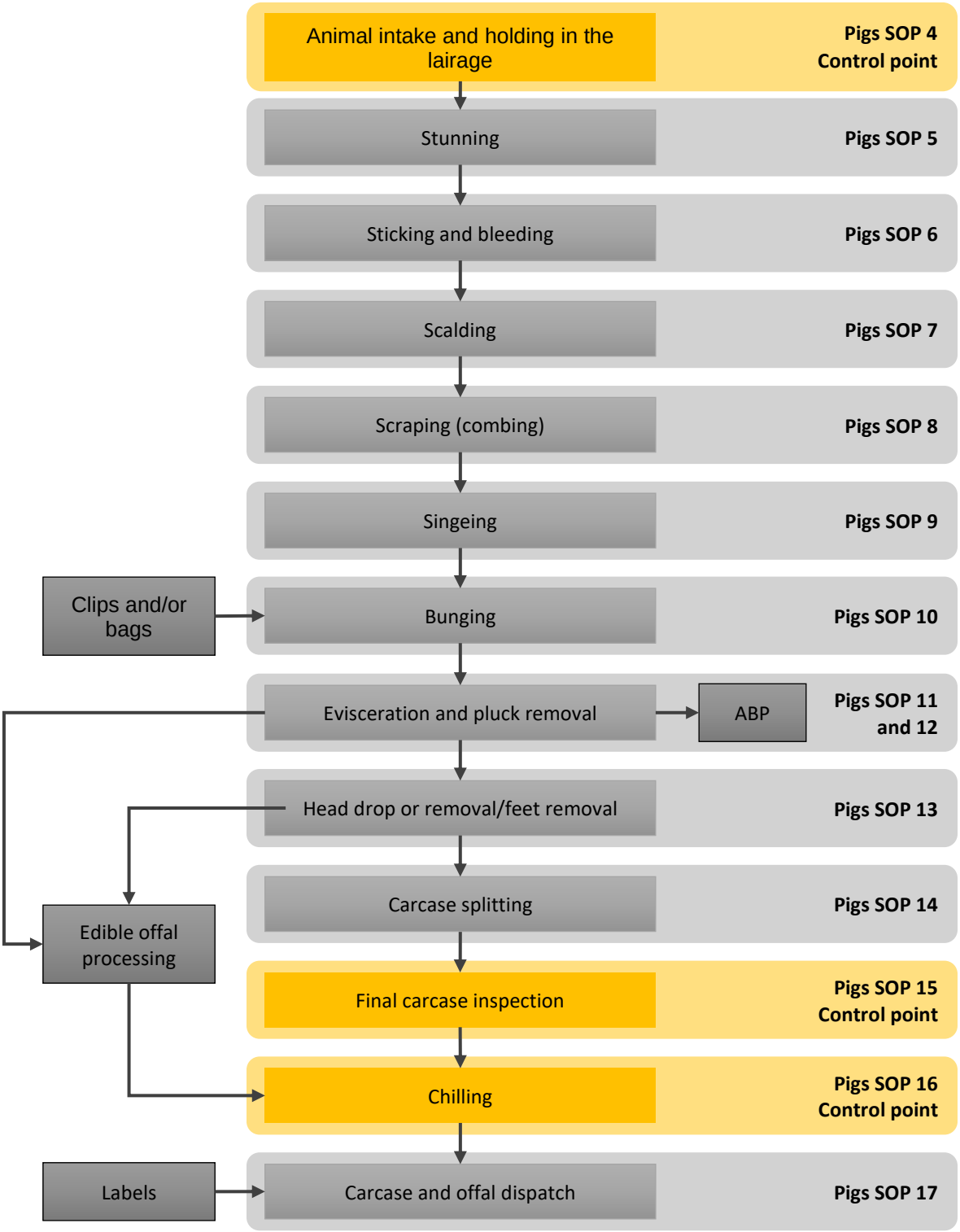
Stage/process step	B: Biological hazard C: Chemical hazard P: Physical hazard	Control measures/monitoring	Corrective actions	Comments
	Spinal cord of bovines over 12 months of age.	ensures that solid particles in the waste water passing through them are no larger than 6 mm.		
	C: None identified.			
	P: Damaged saw contaminating the carcase with metal.	Regular visual inspection and maintenance.	Routine inspection and maintenance of the saw Replace broken saw.	The likelihood of a piece of damaged saw remaining in the meat is low. This would be detected at final carcase inspection. If a consumer ingests a piece of broken saw, the most likely adverse health effect would be reversible or minor illness/injury. Therefore, the severity is deemed moderate.
12. Spinal cord removal (SOP 12)	**B:** SRM being left in the carcase with potential BSE prion contamination.	Follow SOP 12. Regular visual inspection.	Detain carcase until all SRM is removed. Reinspect the carcase. Retrain staff	The incidence of BSE positives in slaughtered animals is very low. However, the severity is deemed significant as vCJD is an incurable disorder.
	C: None identified.			
	P: None identified.			

Stage/process step	B: Biological hazard C: Chemical hazard P: Physical hazard	Control measures/monitoring	Corrective actions	Comments
13. Final Carcase Inspection (SOP 15)	**B:** Failure to carry out satisfactory carcase inspection and trimming will lead to visible contamination (which may contain pathogens) remaining on the carcase. Poor trimming technique may cause carcase contamination.	Follow SOP 13.	Trim and reinspect the carcase. Retrain staff.	**This is a CP.** Following all PRPs and SOPs will ensure that the likelihood of visible carcase contamination will be low. This is raw meat, intended to be cooked before consumption.
	C: Oil grease.	Regular inspection and correct maintenance and cleaning of overhead rails.	Trim and reinspect the carcase. Retrain staff.	Food-grade oil is aesthetically unsatisfactory but is not a food safety risk.
	P: (a) Rail dust/metal filings due to inadequate maintenance of overhead rails. (b) Glass/plastic from the processing environment. (c) Broken knife blade lodging in carcase.	(a)Regular visual inspection and maintenance. (b)Regular visual inspection and maintenance. (c)Maintenance of knives. Regular visual inspection of knife while in use.	(a)Trim and reinspect the carcase. (b)Trim and reinspect the carcase. (c) Assess the environment before recommencing operations. Replace the broken knife. Find and remove the piece of broken knife from the carcase.	Following all PRPs and SOPs will ensure that the likelihood of carcase contamination with physical hazards will be very low. The severity of ingesting meat containing physical hazards is low. The likelihood of a foreign body (e.g. a needle or knife blade) being present in a carcase is very low. The severity of ingestion is moderate. Thorough final carcase inspection and inspection at carcase dispatch is

Stage/process step	B: Biological hazard C: Chemical hazard P: Physical hazard	Control measures/monitoring	Corrective actions	Comments
				sufficient to safeguard against this hazard.
14. Chilling (SOP 14)	**B:** Incorrect temperature may result in the growth of food poisoning bacteria.	Follow SOP 14 and the following PRPs, Plant and equipment (PRP 3), maintenance (PRP 4) and Storage, distribution and transport (PRP 9). Regular inspection and correct maintenance and calibration of chill equipment and thermometers.	Retrain staff If the chill fails, repair immediately or move contents to an alternative chill.	**This is a CP.** The correct implementation and following of PRP 3, PRP 4 and PRP 9 make chill failure very unlikely. Where failure does occur, meat must be moved to an alternative chill.
	C: None identified.			
	P: None identified.			
15. Carcase and offal dispatch (sop 17)	**B:** Pathogens on carcase or offal at dispatch, e.g. faecal material.	Final Carcase Inspection (SOP 15) will prevent dirty carcases from entering the chill. GHPs maintain a clean environment, helping to prevent any contamination.	Trim the carcase. Retrain staff. Correct maintenance of equipment.	There is a low likelihood of carcase contamination at this step. Trimming at final inspection should remove visible surface contamination. The final product of this process is raw meat intended to be cooked before consumption.
	C: None identified.			

Stage/process step	B: Biological hazard C: Chemical hazard P: Physical hazard	Control measures/monitoring	Corrective actions	Comments
	P: Dust, environmental contaminants.	GHPs (i.e. PRPs 5 (Cleaning and sanitation) and 6 (Personal hygiene) at dispatch. Correct maintenance of equipment.	Trim the carcase. Retrain staff. Correct maintenance of equipment.	There is a low likelihood of carcase contamination at this step. Severity is negligible.

Figure E2. Pigs: Process flow diagram for pig slaughter using a scald tank



Hazard analysis: pig slaughter using a scald tank

LEGISLATION

Regulation (EC) No. 852/2004, Article 5.1

Food business operators shall put in place, implement and maintain a permanent procedure based on HACCP principles.

Note: This hazard analysis has determined that there are no CCPs in this process. All hazards are controlled by the PRPs. A number of steps are CPs. CPs are steps which are important for ensuring food safety and compliance with food law.

Stage/process step	B: Biological hazard C: Chemical hazard P: Physical hazard	Control measures/monitoring	Corrective actions	Comments
1. Animal intake and holding in the lairage (Pigs SOP 4)	**B:** Livestock may carry pathogens in their gut or on their skin. Livestock may be presented from a herd that is restricted for herd health or public health reasons, according to accompanying records, documentation or other information.	FCI must be presented and evaluated before animal intake and AM inspection All pigs must be assessed for cleanliness at intake (follow Pigs SOP 4).	Animals without complete FCI declaration documents must not be presented for slaughter. However, where the VI permits, the animal may be slaughtered and the carcase detained pending delivery of FCI within 24 hours. The carcase will be condemned if the FCI is not presented within this timeframe.	**This is a CP.** Carcase dressing procedures are designed to minimise carcase contamination. Visible contamination is trimmed at the final carcase inspection step.

Stage/process step	B: Biological hazard C: Chemical hazard P: Physical hazard	Control measures/monitoring	Corrective actions	Comments
	C: Livestock must be free of any substance which may render their meat unfit for human consumption, e.g. veterinary medicinal products.	The FCI declaration document must be signed by the keeper/person in charge before slaughter. Follow Pigs SOP 4.	Carcase will be detained pending delivery of the FCI within 24 hours; otherwise, the carcase will be condemned.	The FCI declaration document is signed by the animal's owner, who provides assurances regarding the use of veterinary medicines. There is a low likelihood of chemical residues being present. The results of the National Residue Control Plan report a very low level of residues in cattle, sheep and pigs at slaughter. In the event of consumers ingesting product with such residues remaining, the most likely adverse health effect, if any, would be reversible or minor damage, therefore the severity is deemed moderate, as the quantity that would be ingested would be very low.
	P: Needles or foreign bodies.	The extremely low risk of a needle or foreign body being present in meat is further reduced by subsequent inspections at slaughter, cutting and packing.		The likelihood of a foreign body being present in an animal is low. Any surface injury or damage should be evident at AM or PM meat inspection. If a consumer ingests a foreign body (e.g. a broken needle), the most likely adverse health effect, if any, would be reversible or minor illness/injury, therefore the severity is deemed moderate.
2. Animal intake and holding in the lairage (Pigs SOP 4)	**B**: Dirty lairage facilities may cause contamination of livestock skin.	Follow Pigs SOP 1 (Cleaning and sanitation) and Pigs SOP 4 and fill in the Daily Slaughter Record.	Clean lairage more often/thoroughly.	By following Pigs SOP 4 on animal intake and Pigs SOP 1 for keeping the lairage clean, the lairage will be maintained satisfactorily.

Stage/process step	B: Biological hazard C: Chemical hazard P: Physical hazard	Control measures/monitoring	Corrective actions	Comments
	Cross-contamination is possible from one animal to another.	Regular visual inspection.	Revise Pigs SOP 1 and Pigs SOP 4 Retrain staff.	
	C: None identified**.**			
	P: None identified.			
3. Stunning (Pigs SOP 5)	**B:** Introduction of pathogens into the bloodstream from the captive bolt.	Follow Pigs SOP 5 and fill in the Daily Slaughter Record. Regular visual inspection of captive bolt equipment. Proper sanitation and hygiene of the captive bolt.	Revise SOP 5. More frequent/thorough cleaning of the stun gun.	GHPs will ensure that the captive bolt is free of pathogens. The likelihood of occurrence is considered to be low. Only trained personnel who have a certificate of competence may stun animals.
	C: None identified.			
	P: None identified.			

Stage/process step	B: Biological hazard C: Chemical hazard P: Physical hazard	Control measures/monitoring	Corrective actions	Comments
4. Sticking and Bleeding (Pigs SOP 6)	**B:** Contamination with pathogens from the skin/knife into the bloodstream due to poor sticking technique.	Follow Pigs SOP 6. Regular visual inspection of sticking and bleeding. Only trained personnel who have a certificate of competence may stun, then hygienically and effectively bleed the animal.	Revise Pigs SOP 6. Retrain staff.	Any organisms introduced into the bloodstream will be few in number and are unlikely to survive in the deep tissues.[7] There is a medium likelihood of carcase contamination at this step. Subsequent trimming at final inspection can remove surface contamination.
	C: None identified.			
	P: Broken knife blade lodging in the carcase.	Maintenance of knives. Regular visual inspection of the knife while in use.	Replace broken knife. Find and remove the piece of broken knife from the carcase.	There is a very low likelihood of a knife blade breaking while cutting into the carcase and lodging in the carcase. The severity of biting into a piece of meat containing a piece of broken knife blade is moderate.
5. Scalding (Pigs SOP 7)	**B:** Scald water may contain many different bacteria originating from the pig's skin and gastrointestinal tract.	Maintain the scald water temperature at 60 °C or higher. Change the scald water as frequently as required in order to avoid excessively dirty water	Revise Pigs SOP 7. Retrain staff.	There is a medium likelihood of carcase contamination at this step. Subsequent trimming at final inspection can remove surface contamination.

[7] Mackey BM and Derrick CM (1979) Contamination of the deep tissues of carcases by bacteria present on the slaughter instruments or in the gut. *Journal of Applied Bacteriology*, **46**(2): 355–366.

Stage/process step	B: Biological hazard C: Chemical hazard P: Physical hazard	Control measures/monitoring	Corrective actions	Comments
		contributing to carcase contamination. Ensure that the scald lasts for at least five minutes at 61 °C or six minutes at 60 °C.		
	C: None identified**.**			
	P: None identified.			
6. Scraping (Combing) (Pigs SOP 8)	**B:** The combing tank can be a source of pathogens which are transferrable between carcases. Therefore, carcases may emerge from the tank heavily contaminated.	Follow Pigs SOP 1 (Cleaning and Sanitation) and Pigs SOP 2 (Preparation for slaughter). Thoroughly clean equipment as part of PRP 5 (Cleaning and sanitation) and as often as necessary. Follow Pigs SOP 8.	Revise the appropriate SOP or PRP (PRP 3, PRP 4, PRP 5, PRP 6, PRP 8) to correct the occurrence of dirty carcases. Retrain staff.	There is a medium likelihood of carcase contamination at this step. Subsequent singeing and trimming at final inspection can remove surface contamination.
	C: None identified**.**			
	P: None identified.			

Stage/process step	B: Biological hazard C: Chemical hazard P: Physical hazard	Control measures/monitoring	Corrective actions	Comments
7. Singeing (Pigs SOP 9)	**B:** None identified.			Singeing will reduce the microbial load on the carcase. Therefore, correctly following Pigs SOP 9 is important in reducing the risk of bacterial hazards on the carcase.
	C: None identified.			
	P: None identified**.**			
8. Bunging (Pigs SOP 10)	**B:** Biological contamination with pathogens from poor bunging technique may cause leakage of gut contents.	Follow Pigs SOP 10 and SOP 11 (including the evisceration accident protocol (burst belly procedure)). Regular visual inspection of operations.	Revise the appropriate SOPs. Retrain staff.	Subsequent trimming at final inspection will remove visible contamination. A breakdown in hygiene at this step can happen but is not frequent if Pigs SOP 10 is followed.
	C: None identified**.**			
	P: None identified.			
9. Evisceration (Pigs SOP 11) and Pluck Removal (Pigs SOP 12)	**B:** Poor technique may cause contamination from the gastrointestinal tract.	Follow Pigs SOP 10, SOP 11 and SOP 12. Regular visual inspection of operations.	Retrain staff. Corrective action as per the evisceration accident protocol (burst belly procedure).	Faecal contamination of the carcase can happen but is not frequent when Pigs SOP 10, Pigs SOP 11 and Pigs SOP 12 are followed. Visible contamination will be trimmed at the final carcase inspection step.
	C: Oil/grease from overhead railings due to inadequate cleaning/maintenance or excess greasing.	Regular visual inspection of operations.	Follow manufacturer's instructions for greasing railings. Use food-grade oil/grease.	Food-grade oil is aesthetically unsatisfactory but is not a food safety risk.

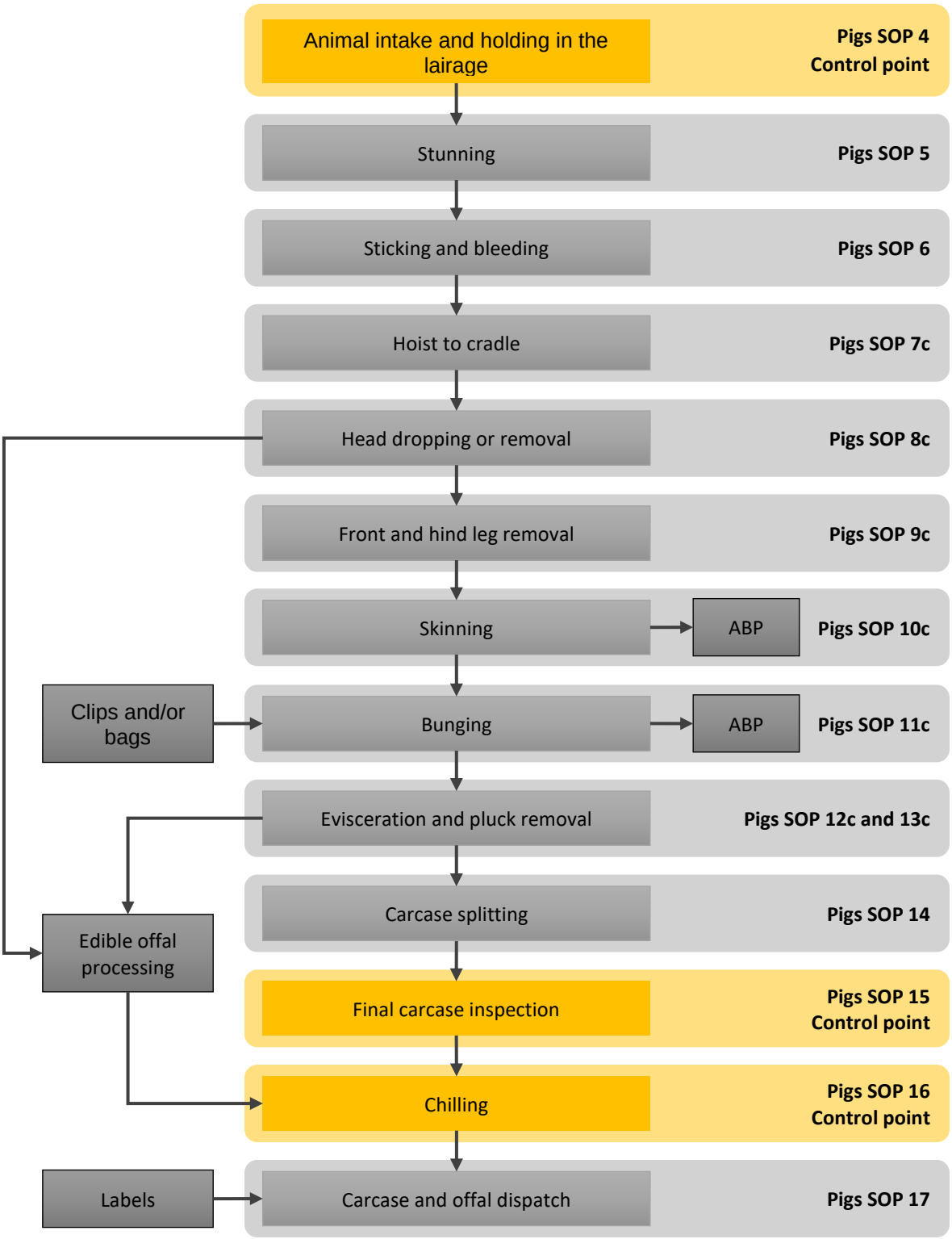
Stage/process step	B: Biological hazard C: Chemical hazard P: Physical hazard	Control measures/monitoring	Corrective actions	Comments
		Regular maintenance.	Trim and reinspect the carcase.	
	P: (a) Rail dust/metal filings due to inadequate maintenance of overhead rails. (b) Glass/plastic from the processing environment. (c) Broken knife blade lodging in the carcase.	(a) Regular visual inspection and maintenance. (b) Regular visual inspection and maintenance. (c) Maintenance of knives. Regular visual inspection of knife while in use.	(a) Trim and reinspect the carcase. (b) Trim and reinspect the carcase. (c) Assess the environment before recommencing operations. Replace the broken knife. Find and remove the piece of broken knife from the carcase.	The likelihood of these hazards ending up in the meat is low if the PRP 4 (maintenance) is in place and is being followed. The severity of ingesting any of these hazards is negligible as the most likely effect would be reversible or minor illness.
10. Head Drop or Removal/Feet Removal (Pigs SOP 13)	**B:** Poor technique may cause contamination with pathogens.	Follow Pigs SOP 13 (includes the two-knife technique). Regular visual inspection of operations.	Revise the SOP. Retrain staff.	Visible contamination of the carcase can happen but is not frequent when Pigs SOP 13 is followed. Visible contamination will be trimmed at the final carcase inspection step.
	C: None identified.			
	P: Broken knife blade lodging in the carcase.	Maintenance of knives. Regular visual inspection of knife while in use.	Replace the broken knife.	There is a very low likelihood of a knife blade breaking while cutting into the carcase and lodging in the carcase.

Stage/process step	B: Biological hazard C: Chemical hazard P: Physical hazard	Control measures/monitoring	Corrective actions	Comments
			Find and remove the piece of broken knife from the carcase.	The severity of biting into a piece of meat containing a broken knife blade is moderate. However, it is unlikely to be life-threatening.
11. Splitting (Pigs SOP 14)	**B:** Biological contamination with pathogens from poor technique or dirty equipment.	Follow Pigs SOP 14. Regular visual inspection.	Retrain staff. Revise Pigs SOP 14. Fix or replace defective equipment.	The likelihood of carcase contamination is low if GHPs are followed.
	C: None identified.			
	P: Damaged saw contaminating carcase with metal.	Regular visual inspection and maintenance.	Routine inspection and maintenance of the saw. Replace broken saw.	The likelihood of a piece of damaged saw remaining in the meat is low. This would be detected at final carcase inspection. If a consumer ingests a piece of broken saw, the most likely adverse health effect would be reversible or minor illness/injury. Therefore, the severity is deemed moderate.
12. Final Carcase Inspection (Pigs SOP 15)	**B:** Failure to carry out satisfactory carcase inspection and trimming will lead to visible contamination (which may contain pathogens) remaining on the carcase. Poor trimming technique may cause carcase contamination.	Follow Pigs SOP 15.	Trim and reinspect the carcase. Retrain staff.	**This is a CP.** Following all PRPs and SOPs will ensure that the likelihood of visible carcase contamination will be low. This is raw meat, intended to be cooked before consumption.

Stage/process step	B: Biological hazard C: Chemical hazard P: Physical hazard	Control measures/monitoring	Corrective actions	Comments
	C: Oil grease.	Regular inspection and correct maintenance and cleaning of overhead rails.	Trim and reinspect the carcase. Retrain staff.	Food-grade oil is aesthetically unsatisfactory but is not a food safety risk.
	P: (a) Rail dust/metal filings due to inadequate maintenance of overhead rails. (b) Glass/plastic from the processing environment. (c) Broken knife blade lodging in carcase.	(a)Regular visual inspection and maintenance. (b)Regular visual inspection and maintenance. (c)Maintenance of knives. Regular visual inspection of knife while in use.	(a)Trim and reinspect the carcase. (b)Trim and reinspect the carcase. (c)Assess the environment before recommencing operations. Replace the broken knife. Find and remove the piece of broken knife from the carcase. Retrain staff	Following all PRPs and SOPs will ensure that the likelihood of carcase contamination with physical hazards will be very low. The severity of ingesting meat containing physical hazards is low. The likelihood of a foreign body (e.g. a needle or knife blade) being present in a carcase is very low. The severity of ingestion is moderate. Thorough final carcase inspection and inspection at carcase dispatch is sufficient to safeguard against this hazard.
13. Chilling (Pigs SOP 16)	**B**: Incorrect temperature may result in the growth of food poisoning bacteria.	Follow Pigs SOP 16 and PRP 9. Regular inspection and correct maintenance and calibration of chill equipment and thermometers.	Retrain staff. If the chill fails, repair immediately or move contents to an alternative chill. Replace or fix malfunctioning/defective equipment.	**This is a CP.** The correct implementation and following of PRP 3, PRP 4 and PRP 9 make chill failure very unlikely. Where failure does occur, meat must be moved to an alternative chill.

Stage/process step	B: Biological hazard C: Chemical hazard P: Physical hazard	Control measures/monitoring	Corrective actions	Comments
	C: None identified.			
	P: None identified.			
14. Carcase and Offal Dispatch (Pigs SOP 17)	**B**: Pathogens on carcase or offal at dispatch, e.g. faecal material.	Following Pigs SOP 15 (final carcase inspection) will prevent dirty carcases from entering the chill. GHPs (i.e. PRPs 5 and 6) maintain a clean environment, helping to prevent any contamination.	Trim the carcase. Retrain staff Correct maintenance of equipment.	There is a low likelihood of carcase contamination at this step. Trimming at final inspection should remove surface contamination.
	C: None identified.			
	P: Dust, environmental contaminants.	GHPs (i.e. PRPs 5 (Cleaning and sanitation) and 6 (Personal hygiene)) at dispatch. Correct maintenance of equipment.	Trim the carcase. Retrain staff. Correct maintenance of equipment.	There is a low likelihood of carcase contamination at this step. Severity is negligible.

Figure E3. Pigs: Process flow diagram for pig slaughter using cradle and skinning method



Hazard analysis: pig slaughter (cradle and skinning method)

LEGISLATION

Regulation (EC) No. 852/2004, Article 5.1

Food business operators shall put in place, implement and maintain a permanent procedure based on HACCP principles.

Note: This hazard analysis has determined that there are no CCPs in this process. All hazards are controlled by the PRPs. A number of steps are CPs. CPs are steps which are important for ensuring food safety and compliance with food law.

Stage/process step	B: Biological hazard C: Chemical hazard P: Physical hazard	Control measures/monitoring	Corrective actions	Comments
1. Animal Intake (Pigs SOP 4)	**See Hazard analysis: pig slaughter using a scald tank**			
2. Holding in the Lairage (Pigs SOP 4)	**See Hazard analysis: pig slaughter using a scald tank**			
3. Stunning (Pigs SOP 5)	**See Hazard analysis: pig slaughter using a scald tank**			
4. Sticking and Bleeding (Pigs SOP 6)	**See Hazard analysis: pig slaughter using a scald tank**			
5. Hoist to Cradle (Pigs SOP 7c)	**B:** Contamination with pathogens from poorly cleaned cradle and/or equipment.	Follow Pigs SOP 7c and PRP 3 (plant and equipment), PRP 4 (maintenance) and PRP 5 (Cleaning and sanitation). Regular visual inspections.	Revise Pigs SOP 7c, PRP 3, PRP 4 or PRP 5 as appropriate. Retrain staff.	Subsequent skinning of the carcase will prevent contamination of the carcase with pathogens.

Stage/process step	B: Biological hazard C: Chemical hazard P: Physical hazard	Control measures/monitoring	Corrective actions	Comments
	C: None identified**.**			
	P: None identified.			
6. Head Dropping or Removal (Pigs SOP 8c) and Front and Hind Leg Removal (Pigs SOP 9c)	**B:** Poor technique may cause contamination with pathogens.	Follow Pigs SOP 8c and Pigs SOP 9c (includes the two-knife technique). Regular visual inspection of operations.	Revise the Pigs SOP 8c and Pigs SOP 9c as appropriate. Retrain staff.	Visible contamination of the carcase can happen but is not frequent when Pigs SOP 8c and Pigs SOP 9c are followed. Visible contamination will be trimmed at the final carcase inspection step.
	C: None identified**.**			
	P: None identified.			
7. Skinning (Pigs SOP 10c)	**B:** Biological contamination of the carcase with pathogens from poor technique or dirty equipment.	Follow Pigs SOP 10c (includes the two-knife technique). Regular visual inspection of operations.	Revise Pigs SOP 10c. Retrain staff.	Contamination of the carcase can happen but is not frequent when Pigs SOP 10c is followed. Visible contamination will be trimmed at the final carcase inspection step.
	C: None identified**.**			
	P: None identified.			
8. Bunging (Pigs SOP 11c)	**B:** Biological contamination with pathogens from poor bunging technique and/or applying the clip may cause leakage of gut contents	Follow Pigs SOP 11c. Regular visual inspection of operations.	Revise Pigs SOP 11c. Retrain staff.	Subsequent trimming at final inspection will remove visible contamination. A breakdown in hygiene at this step can happen but is not

Stage/process step	B: Biological hazard C: Chemical hazard P: Physical hazard	Control measures/monitoring	Corrective actions	Comments
				frequent if Pigs SOP 11c is followed.
	C: None identified**.**			
	P: None identified.			
9. Evisceration/Dressing (Pigs SOP 12c) and Pluck Removal (Pigs SOP 13c)	**B:** Poor technique may cause contamination from the gastrointestinal tract.	Follow Pigs SOP 12c and Pigs SOP 13c. Regular visual inspection of operations.	Retrain staff. Corrective action as per the evisceration accident protocol (burst belly procedure).	Faecal contamination of the carcase can happen but is not frequent when Pigs SOP 11c, Pigs SOP 12c and Pigs SOP 13c are followed. Visible contamination will be trimmed at the final carcase inspection step.
	C: Oil/grease from overhead railings due to inadequate cleaning/maintenance or excess greasing.	Regular visual inspection of operations. Regular maintenance.	Follow manufacturer's instructions for greasing railings. Use food-grade oil/grease. Trim and reinspect the carcase.	Food-grade oil is aesthetically unsatisfactory but is not a food safety risk.
	P: (a) Rail dust/metal filings due to inadequate maintenance of overhead rails. (b) Glass/plastic from the processing environment. (c) Broken knife blade lodging in the carcase.	(a) Regular visual inspection and maintenance. (b) Regular visual inspection and maintenance. (c) Maintenance of knives. Regular visual inspection of knife while in use.	(a) Trim and reinspect the carcase. (b) Trim and reinspect the carcase. (c) Assess the environment before recommencing operations.	The likelihood of these hazards ending up in the meat is low if the PRP 4 (maintenance) is in place and is being followed. The severity of ingesting any of these hazards is negligible as the

Stage/process step	B: Biological hazard C: Chemical hazard P: Physical hazard	Control measures/monitoring	Corrective actions	Comments
			Replace the broken knife. Find and remove the piece of broken knife from the carcase.	most likely effect would be reversible or minor illness.
10. Carcase Splitting (Pigs SOP 14)	**See Hazard analysis: pig slaughter using a scald tank**			
11. Final Carcase Inspection (Pigs SOP 15)	**See Hazard analysis: pig slaughter using a scald tank**			
12. Chilling (Pigs SOP 16)	**See Hazard analysis: pig slaughter using a scald tank**			
13. Carcase and Offal Dispatch (Pigs SOP 17)	**See Hazard analysis: pig slaughter using a scald tank**			

Annex I: Guidance on how to apply the HACCP Principles

The following pages describe how to apply the HACCP principles and how to prepare a HACCP plan for a food business.

Prior to the application of the HACCP-based procedures for any business, the food business operator (FBO) must have implemented the Prerequisite Programme (PRP). The HACCP-based procedures must be science/risk-based and systematic, identifying specific hazards and measures for control of those hazards, in order to ensure the safety of food.

HACCP-based procedures are tools to identify and assess hazards and to establish control systems that focus on prevention, as opposed to older systems that relied mainly on end-product testing.

The HACCP-based procedures are based on the following seven principles:

1. Identify any hazards that must be prevented, eliminated or reduced to acceptable levels (hazard analysis).
2. Identify critical control points (CCPs) at the step or steps at which control is essential in order to prevent or eliminate all relevant hazards or to reduce them to acceptable levels.
3. Establish critical limits at CCPs which separate acceptability from unacceptability for the prevention, elimination or reduction of identified hazards.
4. Establish and implement effective monitoring procedures at CCPs.
5. Establish corrective actions to be taken when monitoring indicates that a CCP is not under control.
6. Establish procedures which must be carried out regularly in order to verify that the measures outlined in principles 1 to 5 are working effectively.
7. Establish documents and records commensurate with the nature and size of the food business in order to demonstrate the effective application of the measures outlined in principles 1 to 6.

Application of the HACCP principles

- **Assemble a multidisciplinary HACCP team**

  The FBO should assemble a team that will prepare the HACCP document. The team picked by the FBO should involve members from all parts of the food business concerned. The team should include the whole range of specific knowledge and expertise appropriate to the product under consideration, including its production and consumption, and the associated potential hazards. It is essential that someone with HACCP training is part of the team, otherwise an external advisor or consultant will be required. Top management of the food business must be fully committed to product safety through the application of the HACCP principles in order to make the programme effective.

- **All products must be described**

  The description should include the products within the process, their distribution, their intended use, and potential customers. This step helps ensure that all areas of concern are addressed.

- **Construct a flow diagram (description of the manufacturing process)**

  The HACCP team should develop and verify a flow diagram for production of the products. This simple flow diagram includes every step from the beginning to end of production. The purpose of the flow diagram is to provide a clear and simple description of the steps in the process which are directly under the control of the facility.

- **Hazard analysis**

  All major potential biological, chemical or physical hazards that may be reasonably expected to occur at each process step (including production, acquisition, storage, transport, and handling of raw materials and ingredients, as well as delays during production) must be identified and listed. Next, the HACCP team should conduct a hazard analysis in order to identify which hazards are of such a nature that their elimination or reduction to acceptable levels is essential to the production of a safe food (end product).

  In conducting hazard analysis, the following must be considered:

  1. The likelihood of occurrence of hazards and the severity of their adverse health effects. It can be useful to use a risk matrix for this. See Table E3 for an example of a semi-quantitative risk-evaluation procedure.
  2. The qualitative and/or quantitative evaluation of the presence of hazards.
  3. The survival or multiplication of pathogenic microorganisms and unacceptable generation of chemicals in intermediate products, end products, production lines or line environments.
  4. The production or persistence in foods of toxins or other undesirable products of microbial metabolism, chemicals, or physical agents or allergens.
  5. The contamination (or recontamination) of a biological (e.g. microorganisms, parasites), chemical or physical nature of raw materials, intermediate products or end products.

Table E1: Defining the three levels of likelihood of hazard occurrence in the final product

Likelihood level	Definition
High: 3	Due to the failure or absence of a specific control measure, there is a high likelihood of this hazard occurring in the end product (i.e. frequent).
Medium: 2	Due to the failure or absence of a specific control measure, this hazard can be present in a certain percentage of the end product (i.e. not frequent).
Low: 1	There is a very limited likelihood of this hazard occurring in the end product (i.e. rare).

Table E2: Defining the three levels of hazard severity if consumed

Severity	Definition
Significant: 3	The consumer group belongs to a risk category and the hazard can result in serious symptoms, including permanent injury and mortality.
Moderate: 2	The hazard can result short- or long-term effects, which rarely result in mortality.
Negligible: 1	The hazard does not cause serious injuries and/or symptoms. The effects on health are negligible to mild.

Table E3: 3×3 risk matrix (likelihood *severity) model used to determine the level of risk associated with hazards

	Severity negligible (*1)	Severity moderate (*2)	Severity significant (*3)
Likelihood high (*3)	**Acceptable (3)**	**Unacceptable (6)**	**Unacceptable (9)**
Likelihood medium (*2)	**Acceptable (2)**	**Acceptable (4)**	**Unacceptable (6)**
Likelihood low (*1)	**Acceptable (1)**	**Acceptable (2)**	**Acceptable (3)**

- **Control measures**

  The FBO should consider and describe what control measures, if any, can be applied for each hazard. Control measures are the actions and activities that can be used to prevent hazards, eliminate them, or reduce their impact or likelihood of occurrence to acceptable levels. Many preventative control measures are part of the PRPs and are

intended to prevent contamination from the production environment (e.g. Personal hygiene, Pest control, maintenance). Other control measures aimed at reduction or elimination of hazards are more specifically linked to particular processes, e.g. pasteurisation or fermentation, and may result in the establishment of CCPs, control points (CPs) or operational PRPs (oPRPs).

- **Identification of CCPs**

  If one or more hazards have been identified at a step where control is necessary for safety, then this step may be a CCP. The identification of a CCP requires a logical approach. Such an approach can be facilitated by the use of a decision tree (see Figure E4) or other methods, e.g. a risk matrix (see Table E3), according to the expertise of the HACCP team.

  As previously mentioned, a CCP is defined as a step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level.[8] At this step, there must be a measurable critical limit.

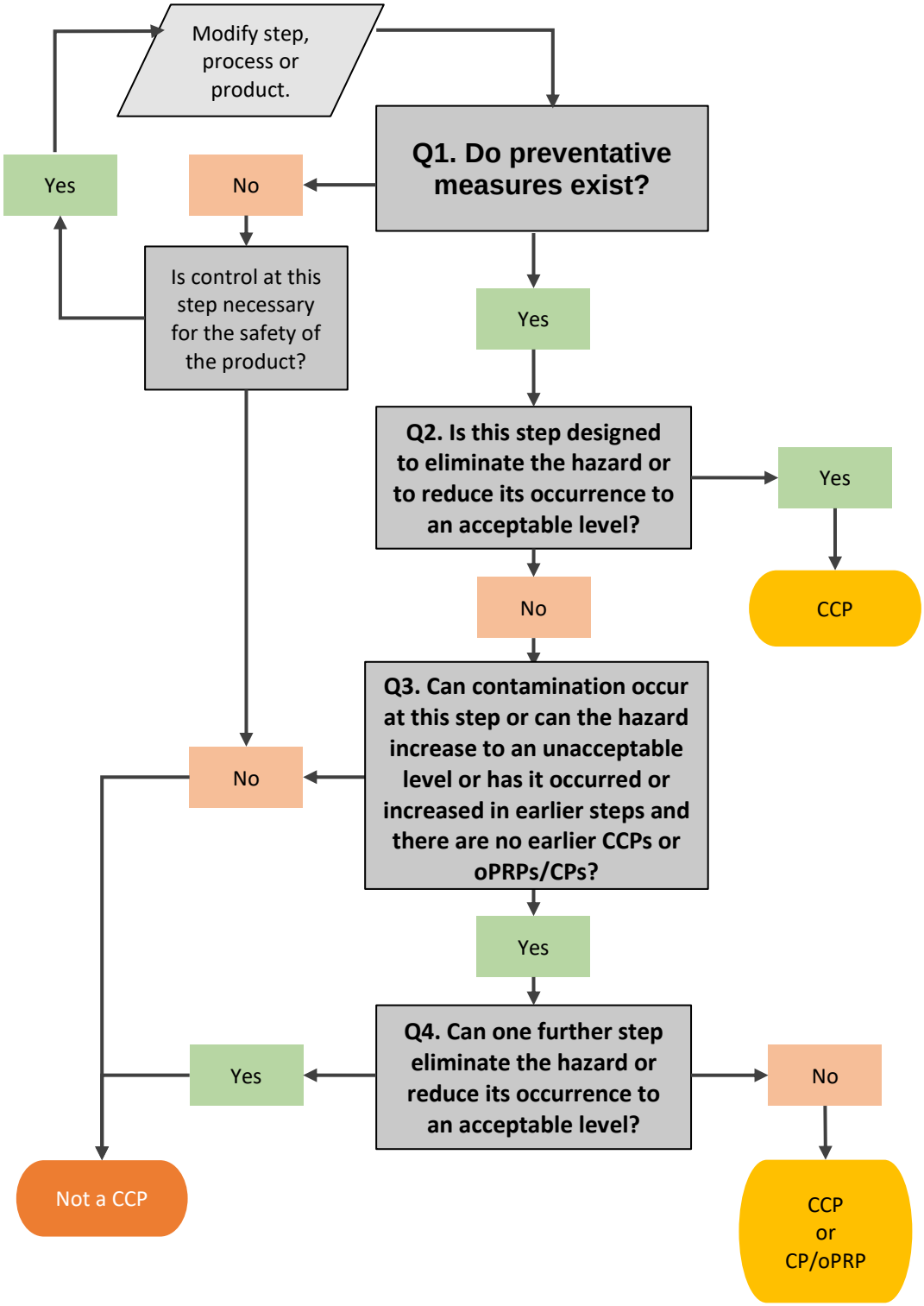
- **Identification of CPs**

  If one or more hazards have been identified at a step where control is necessary for safety, if this step is not identified as a CCP, it may be identified as a CP. Again, a logical approach is used to identify a CP. A decision tree (see Figure E4) and/or a risk matrix (see Table E3) can be used to facilitate this process.

  CPs are steps which are important for ensuring food safety. There are no measurable limits for the risks identified at CPs. A number of steps in the slaughter process were identified as being important for food safety and were categorised as CPs. The risks are controlled using PRPs. CPs are also known as oPRPs.

[8] Recommended international code of practice – general principles of food hygiene – *CAC/RCP 1-1969, Rev.4-200*3.

Figure E4. Example of a decision tree[9]



[9] Commission Notice on the implementation of food safety management systems covering prerequisite programs (PRPs) and procedures based on the HACCP principles, including the facilitation/flexibility of the implementation in certain food businesses (2016/C 278/01).

- **Critical limits at CCPs**

  For each CCP, critical limits must be specified and validated. Critical limits separate acceptability from unacceptability. They correspond to the extreme values acceptable with regard to product safety. Critical limits are set for measurable parameters which can demonstrate that the CCP is under control.

  Critical limits must be based on substantial evidence that the chosen values will result in process control (i.e. they must be validated).

- **Monitoring procedures at CCPs**

  An essential part of HACCP-based procedures is a programme of observations or measurements performed at each CCP in order to ensure compliance with specified critical limits. Observations or measurements must be able to detect loss of control at CCPs and provide information in time for corrective action to be taken.

  The HACCP plan should describe the methods, the frequency of observations or measurements and the recording procedure for monitoring at CCPs, including:

  1. Who is to perform monitoring and checking
  2. When monitoring and checking is to be performed
  3. How monitoring and checking is to be performed.

  The frequency of monitoring must be risk based, e.g. it should depend on the likelihood of hazard occurrence in the product, the volume of production, the distribution of the product, the potential consumers, the number of workers directly handling the product, etc.

  Records associated with monitoring CCPs must be signed by the person(s) doing the monitoring. The records must also be signed when they are verified by staff of the company responsible for reviewing them.

- **Corrective actions**

  For each CCP, the HACCP team should plan corrective actions in advance, so that these actions can be taken without hesitation when monitoring indicates a deviation from the critical limit. Corrective actions plan should include:

  1. Identification of the person(s) responsible for implementation of the corrective action
  2. Means and action required to correct the observed deviation
  3. Action to be taken with regard to products that have been manufactured during the period when the process was out of control
  4. Written records of measures taken indicating all relevant information (e.g. date, time, type of action and subsequent verification check).

- **Validation and verification procedures**

  Validation is the process of obtaining evidence that a control measure or combination of control measures, if properly implemented, is capable of controlling the hazard to a specified outcome. Before implementing a HACCP plan – or when there is any change to the HACCP plan – the plan must be validated.

  Verification is the application of methods, procedures, tests and other evaluations, in addition to monitoring, in order to determine compliance with the HACCP-based procedures. Verification is conducted periodically in order to demonstrate that the HACCP system is working as planned. The following examples may be used as inputs for verification:

  - General: verification of monitoring records of CCPs (frequency, outcome of measuring results over a period of time)
  - Specific: sampling and analysis can be done in order to demonstrate the effectiveness of the HACCP system in place
  - Temperature during storage and transport: compliance with process hygiene criteria for spoilage bacteria such as aerobic colony count
  - Time/temperature hazard reduction/elimination: follow-up of relevant pathogens in heat-treated food products, e.g. absence of *Listeria*, *Salmonella*, etc.
  - Damaged packages: testing for the most likely bacterial or chemical contamination a product might be exposed to if its package was damaged.

  The frequency of verification must be sufficient to confirm that HACCP-based procedures are working effectively.

- **Documentation and record keeping**

  Efficient and accurate record keeping is essential to the application of HACCP-based procedures. All HACCP-based procedures must be documented in the HACCP plan and continuously supplemented by records of findings. Documentation and record keeping must be appropriate to the nature and size of the operation and sufficient to assist the business to verify that the HACCP-based procedures are in place and are being maintained. The documented records need to be kept for a sufficient time period beyond the shelf life of the product for traceability purposes, for the regular revision of the procedures by the FBO, and to allow the competent authority to audit the HACCP-based procedures.

Food Safety Authority of Ireland

The Exchange, George's Dock, IFSC,
Dublin 1, D01 P2V6
T +353 1 817 1300
E info@fsai.ie

Join us on LinkedIn
Follow us on Twitter @FSAIinfo
Say hi on Facebook
Visit us on Instagram
Subscribe to our YouTube channel

www.fsai.ie