Guideline for Development and Implementation of HACCP Plan in Heat Treated Meat Processing Plants

Highlight:

HACCP is based on seven principles which include hazard analysis, identification of critical control points (CCPs), establishing critical limits at each CCP, monitoring of each CCP, and corrective actions at each CCP, HACCP verification/validation, and HACCP documentation. Each principle is briefly described in this guideline in different sub-sections as guidance to regulators, food business operators and clients of heat-treated meat products.

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DEFINITIONS OF TERMS

In this Guideline, unless the context otherwise requires:

1. Hazard-
2. HACCP-
3. “Corrective action” means procedures to be followed when a deviation occurs.
4. “Critical control point” means a point, step, or procedure in a food process at which control can be applied and, as a result, a food safety hazard can be prevented, eliminated, or reduced to acceptable levels.
5. “Critical limit” means the maximum or minimum value to which a physical, biological, or chemical hazard must be controlled at a critical control point to prevent, eliminate, or reduce to an acceptable level the occurrence of the identified food safety hazard.
6. “Food safety hazard” means any biological, chemical, or physical property that may cause a food to be unsafe for human consumption.
7. “HACCP System” means the HACCP plan in operation, including the HACCP plan itself.
8. “Preventive measure” means physical, chemical, or other means that can be used to control an identified food safety hazard.
9. “Process-monitoring instrument” means an instrument or device used to indicate conditions during processing at a critical control point.
10. “Responsible establishment official” means the individual with overall authority on-site or a higher level official of the establishment.
11. “Meat or edible offal/by-products” refer to raw materials derived from livestock and poultry, with or without the additives, having been marinated, brined, sauced, steamed, boiled, smoked, roasted, baked, dried, deep-fried, molded, fermented or modulated.
12. GMP-
13. GHP-

ABBREVIATIONS

CCP Critical Control Point

EAA Ethiopian Agriculture Authority

EFDA Ethiopian Food and Drug authority

FAO Food and Agriculture organization

GHP Good Hygienic Practice

GMP Good Manufacturing Practice

HACCP Hazard Analysis Critical Control Point

UNIDO United Nation Industrial Development Organization

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FOREWORD

The Ethiopian Food and Drug Authority and The Ethiopian Agriculture Authority are a regulatory body established by the proclamation 1263 /2021 and by the regulation 531/2023 and 509/2022 respectively. They are responsible for regulation and control of quality, safety and of raw, semi processed and processed food products according to the mandate given by the law. Therefore both EFDA and EAA through enforcement of the proclamations and regulations protects and promotes public health by ensuring quality, safety of food locally manufactured and imported. .

The achievement of their goal depends on the implementation of regulatory requirements and awareness and adherence to the law by all key players dealing in one way or another with products regulated under the regulation.

Food safety is a shared responsibility which lay down to all sector involved in the value chain. Food Business Operators (manufacturers) should play the major role that their prime concerns on the consumer's health. Therefore, they should take reasonable steps to ensure that the food supplied to the community is safe, of good quality, and at the same time they should ensure that the product produced meet the required set standard and maintained in a way that the safety and health of consumers is assured.

Implementation of HACCP in most perishable products set as a mandatory in most country requirement. This can ensure the safety of the product by the manufacturer. These guidelines are developed to provide guidance on application of requirement of HACCP principle for heat treated meat and regulatory bodies shall also enforce its implementation in accordance this guideline.

Introduction

Food safety is one of the concerns of several developing and developed countries and is one of the key issues addressed in their policy and legislative frameworks. Food safety aims to improve the quality of life (increasing quality and years of healthy life, and eliminating health disparities) of their citizens and is considered to be one of the challenging goals for the twenty-first century. Food safety has increasingly become a current issue, owing to changing consumer eating habits, changing products and production practices, changing population (aging of the population and the increased number of immunocompromised individuals), and increased food infections.

Hazard analysis and critical control points (HACCP) are considered worldwide to be essential to an effective and rational proactive methodology, which must be integrated into every step of the food chain, from primary production to final consumption, in order to assure food safety[1]. HACCP is defined as a management system in which food safety is addressed through the analysis and control of biological, chemical, and physical hazards from raw material production, procurement and handling, to manufacturing, distribution and consumption of the finished product.

The Hazard Analysis Critical Control Point (HACCP) system is a scientific approach to process control. It is designed to prevent the occurrence of problems by assuring that controls are applied at any point in a food production system where hazardous or critical situations could occur. Hazards include biological, chemical, or physical contamination of food products. There are a variety of potential hazards for most foods, including meat and meat products. Many of these hazards can occur during the processing stage[2]. The HACCP system is the most widely used and internationally accepted food safety management system in the world.

About heat treated meat here briefly to connect HACCP with heat treated meat in the next paragraph

Heat processed cooked meat products are products made from fresh (frozen) meat products as the main materials, which are cooked using one or multiple processes such as braising with soy sauce, stewing with soy sauce, smoking, roasting, grilling, steaming, boiling, frying, etc., stuffed meat products, fried meat products, dried cooked meat products, and other heat-processed cooked meat products directly edible after fermentation and maturation.

[1] Fidel Toldrá (2010). Handbook of meat processing.
[2] USDA, 2005. Guidebook for the Preparation of HACCP Plans and the Generic HACCP Models

The main goal of applying HACCP plans in meat processing plants is to ensure that the meat is handled under conditions that mean it will carry minimal public health risk. A HACCP plan has the following advantages[3]:

- it is proactive and preventive;
- it is owned by the meat plant;
- it is systematic, plant-specific and documented.

The primary purpose of HACCP is to help meat processors and suppliers to identify and to control potential hazards in meat and meat products and to ensure that the finished product will be safe for consumers[4]. HACCP is not a zero-risk system, but is designed to reduce the risk of manufacturing hazardous food to a minimum.

HACCP is based on seven principles which include hazard analysis, identification of critical control points (CCPs), establishing critical limits at each CCP, monitoring of each CCP, corrective actions at each CCP, HACCP verification/validation, and HACCP documentation. Each principle is briefly described in this guideline in different sub-sections as guidance to regulators, food business operators and customers/ clients of heat treated meat products.

Scope

This is a generic HACCP model for heat treated meat products that can be used as a starting point for the development of plant-specific plan(s) reflecting actual plant environments and the processes conducted. It is designed for use with the meat process category: thermally processed -commercially sterile meat. It is not intended to be used "as is" for other plant specific HACCP plans. Specific process flow diagram and technology depend on each of the different products manufactured by meat processing plant and hence only a generic model of HACCP is described in this guideline.

It must be stressed that this guideline outlines only the steps in building a HACCP system. Many of the hazards and the means to control them presented in it will be found in the specific meat plant. However, differences in processes and procedures between meat plants will result in hazards varying between meat plants. Because there is no set formula for developing a HACCP system, each plant must examine their operation and develop a HACCP system which best suits it.

Objectives

The goal of HACCP is to prevent and reduce the occurrence of food safety hazards through ensuring every product produced by an establishment (when the hazard analysis reveals any food safety hazard that is likely

[3] FAO 2004. Good Practices for the Meat Industry. FAO Animal Production and Health Manual 2. Rome.
[4] Tompkin (1990), cited in Brown, M.H. 2000. Implementing HACCP in a meat plant. In: HACCP in the meat industry, Brown, M. (ed), Woodhead Publishing Ltd., Cambridge.

to occur) must be produced according to a written HACCP plan. Many different products may be grouped within a single processing category, as long as the food safety hazards, critical control points, and critical limits are essentially the same.

This guideline is prepared with the following objectives:

1. To develop and avail a generic HACCP models that can readily be customized food businesses particularly meat processing plants to ensure food safety issues.
2. To describe the philosophical and practical aspects of HACCP approach to food safety
3. To describe the preliminary key steps and principles HACCP is based upon to vividly present a structured approach to analyzing the potential hazards in an operation; identifying the points in the operation where the hazards may occur; and deciding which points are critical to control to ensure consumer safety.
4. To facilitate and enable regulatory bodies to discharge their mandate in ensuring food manufacturing and handling legislative are complied with for the highest assurance of food safety.
5. To allow heat treated meat processing companies to do self-assessment of their HACCP plan using HACCP audits and take corrective actions before regulatory and third party audits.

Prerequisite for implementing HACCP: GMP/PRPs are the Foundation

Implementing HACCP depends on effective general hygiene principles known as good hygienic practice (GHP) or good manufacturing practice (GMP)-Prerequisite Programs (PRPs). GHP/GMP practices are the foundations on which a more specific HACCP system is built. Therefore, GHP/GMP is a prerequisite and there can be no effective implementation of a HACCP plan without pre-existing, effective GHP. While some lower-level risks for public health can be managed through GHP principles only, GHP alone is insufficient for managing some higher-level risks that require additional, more specifically targeted control measures provided by a HACCP system[5].

Once prerequisite programs (PRP/GMP) are in place, a HACCP plan should be implemented as per the steps depicted in Figure 1. Please refer to the GMP/Sanitary Guideline for heat treated meat (EFDA no…) before applying this HACCP.

HACCP plan and implementation: Preliminary Steps

The HACCP system, as described above, consists of seven principles. However, the sequence of applying HACCP comprises 12 steps (5 preparatory steps and 7 HACCP principles). Use of these 12 steps in relation to meat processing plant is summarized in Table (1) with sample description of each steps as an examples.

[5] FAO 2004. Good Practices for the Meat Industry.

Figure 1: HACCP Implementation Steps

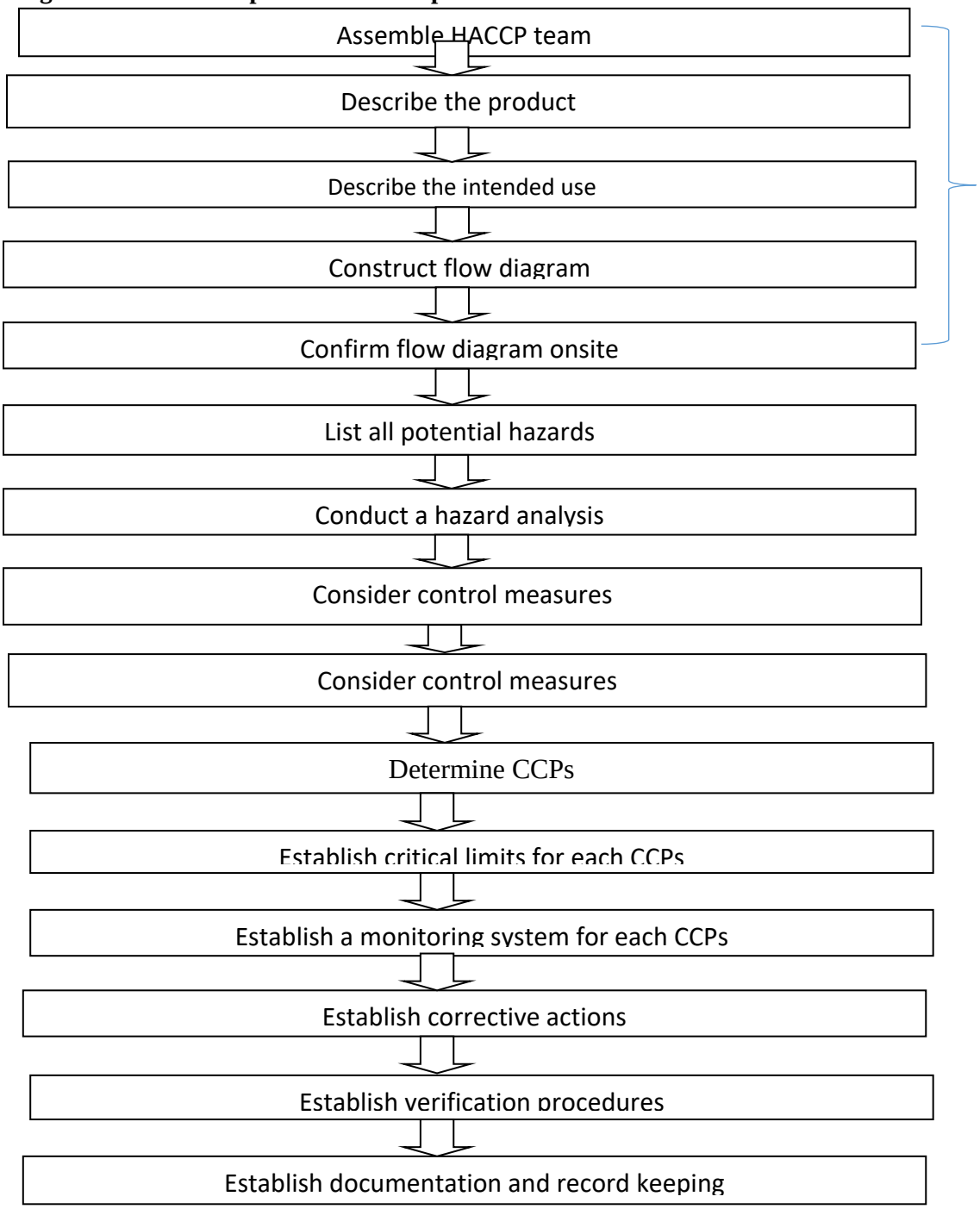


Table 1. The 12 steps of applying HACCP[6].

Steps	Description	Examples and general scopes
Step 1	Assemble the HACCP team (identification of the persons involved)	
Step 2	Description of products	Heat treated meat, smoked meat …
Step 3	Description of the intended use of the product	
Step 4	Develop the process flow diagram	
Step 5	Develop the plant schematic (on-site verification of flow diagram)	Allows specific adjustments and first review of potential hazards.
Step 6	Hazard analysis [Principle 1]	Listing of hazards at each process element; identification of all likely public health hazards associated with the operation, assessment of the risk of their occurring, identification of related control measures. The most important and elaborate elements of the HACCP system.
Step 7	Identification of critical control points (CCPs) [Principle 2]	Application of a HACCP decision tree (i.e., selection of CCP for each hazard); identification of the process steps where hazards pose a high-level risk and so must be controlled.
Step 8	Establish target levels and tolerance for each CCP [Principle 3]	Defining the line between acceptable and unacceptable hazard-related values, from the safety aspect, at individual CCPs.
Step 9	Establish a monitoring system [Principle 4]	Establishing the system for monitoring whether hazards are effectively controlled at all the CCPs. CCPs are linked to a monitoring system. Monitoring aims at detecting loss of control at an early stage, and at providing information for correction action.
Step 10	Establish corrective actions [Principle 5]	Development of actions/procedures to prevent transfer of hazards posing unacceptable risk to consumers if CCPs get out of control. Needed for each CCP selection. Correction also needed when monitoring indicates trend towards loss of control.
Step 11	Verification of the application [Principle 6]	Proving that all the measures are working and that all hazards are controlled. Check correct functioning with respect to steps 6–10 necessary for introducing and maintaining system.
Step 12	Documentation [Principle 7]	Practical, record-based proof that the checking/action activities are carried out and are effective. May include relevant processes, demonstrable control, certification and insurance.

[6] Adapted from Brown (2000) and FAO (2004).

Description of the five steps and seven principles of HACCP[7]

1. Assemble HACCP (Food Safety) Team - identification of the persons involved

Ideally, the development of the HACCP system is done by a team; not one individual. The team should be made up of a variety of individuals knowledgeable in the following areas: maintenance, production, distribution, and quality control. As well, one of these individuals should be familiar with HACCP.

As mentioned, in order for the HACCP system to succeed, management must provide the necessary leadership and resources. Successful HACCP systems are not a one-person effort. Everyone in the company, in one form or another, will be involved. The HACCP system will only succeed if management provides the HACCP team with the time, resources, and the authority necessary to implement an effective system.

Table 2: Plant HACCP (Food Safety) Team (sample format)

Name	**Job Title/ Role on team**	**HACCP Training and/or Experience**	**HACCP Program Development Task (s)**	**Task Completion Date**
	Chairman			
	Secretary			
	Member			
	Member		TOR for the team	
	Member			
	Consultant			
Company Name and Address				
Phone				
Email/ Fax				
Version/Date			Supersedes:	
Approved by (print)			Title:	
Approval Signature:			Date Signed:	

[7] BC Centre for Disease Control (2012). Guidelines for the Application of HACCP System in a Meat Plant. Vancouver, Canada. https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/food-safety/meat-inspection/meatplanthaccpmanual.pdf.

2. Describe the Product

For each type of heat treated meat products produced, all raw materials or ingredients used must be listed. Also included are the packaging materials. These are collectively known as inputs. Then with each input used, information regarding potential hazards is then gathered.

Questions to ask can include:

- Are dressing procedures adequate to remove condemned or high-risk materials from carcasses?
- Are there potential bacterial hazards with this ingredient? Does it need to be kept refrigerated? Does it have a shelf life? Where does it come from? Does the supplier perform bacterial testing? Can they provide bacterial test results?
- Is this ingredient a potential allergen? Does this ingredient's production lend itself to possible chemical contamination? Antibiotics? Pesticides?
- Is there any concern with this ingredient regarding glass or metal being present?

These questions are examples of questions that can be asked for each input. Questions to ask or information to be gathered will vary with ingredients and with how they will be later used or applied.

Table 3: Product Description of Heat Treated Meat (Sample example)

Product Description[1]	**Product**: Heat Treated Meat	Issue Date: Supersedes:

Product name(s)	Heat Treated Meat (Commercially Sterile Meat Product/s)
Important food safety characteristics (a_w, pH, processing, RTE, requires cooking, etc.)	High aw, neutral pH that needs further processing and can be RTE as well with mild re-heating.
Ingredient list	Raw meat
Packaging used	Metal, double-seamed("sanitary") can
Labeling requirements/ instructions for use	According to ES 73[8] labeling requirements of Ethiopia and Clients Requirements
Shelf-life	6 months -1 years under cool (e.g., 23.89°F or temperature), lower), dry conditions; or freezing.
Storage, distribution & handling	Cold vans
Distribution area and outlets	Domestic Retail, Middle East, China and Possibly EU countries
Intended consumers	All ages of people who are not allergic to meat.
Intended use	It can eaten "as is" or with further cooking, seasoning and sauces

[8] Compulsory Ethiopian Standard 2013. CES 73, General Standard for prepackaged foods – labelling.

3. Describe the Interned Use

With each finished heat treated meat products, it is necessary to identify its normal use by the consumer. There are a number of questions in this area that can be asked which might help identify any potential hazards in the processing steps:

a) Are the targeted consumers more susceptible to foodborne illness? i.e. seniors, hospital patients, infants
b) Is the food always well-cooked by the consumer?
c) Do some consumers only lightly cook the food?...i.e. rare hamburger
d) Do some consumers not cook the food at all…i.e. steak tartar
e) Would some consumers further process the food…i.e. aging, fermentation, salting, drying, etc.

Answers to these questions and others may help the HACCP team in assessing potential hazards and their risk to the finished product.

Table 3: Heat Treated Meat Intended Use (Sample)

Product Description	Heat Treated Meat
Composition	ES standard
Method of Preservation	Heat processing
Packaging-Primary	Cans
Packaging-Secondary	Plastic and Cartoons
Storage condition	Ambient or Cold Storage
Distribution Method	Bulk, Retails and Super Markets and Export
Shelf Life	6 months to 1 year
Special Labeling	Allergic labeling
Customer Precautions	None
Target Population	All people of ages
Sensitive Population	Meat Allergic people

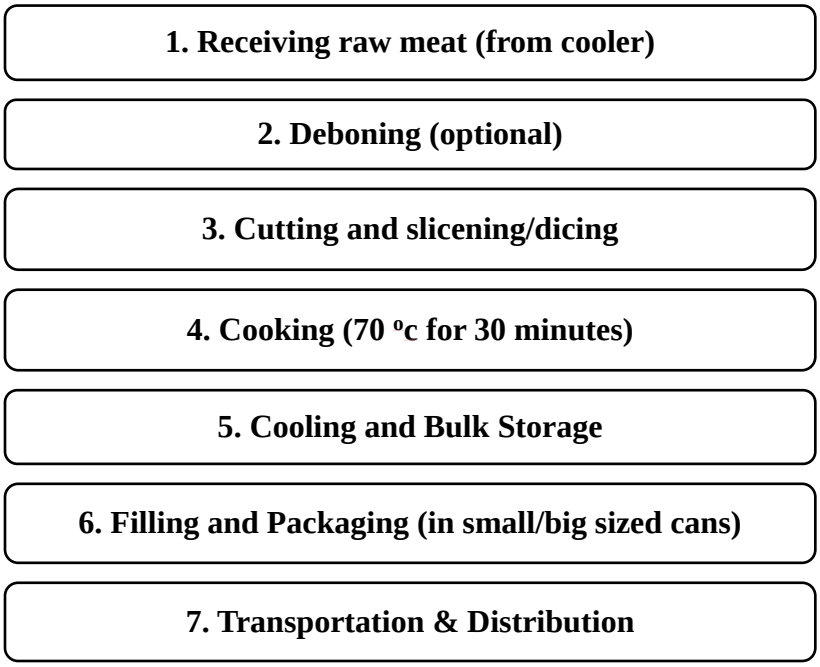
4. Process Flow Diagram of Heat Treated Meat

In this step, the HACCP team should identify the important process steps in the production of the specific heat treated meat product being assessed. With a HACCP team made up of individuals with different specialties, potential hazards can be identified identify with each of the various process steps. It may be useful for the HACCP team to consult with line personnel and ask for input - often people familiar with day to day problems are also most familiar with the potential hazards. Also useful, is simply observing the

operations during production. Sometimes standing back and just watching an operation for some time can help identify hazards that are not immediately obvious.

a) Construct a flow diagram of each process in your meat plant using the block diagram, as in figure 2 similarly or schematic diagrams can be used to illustrate each process.
b) The flow diagram should describe each process clearly and concisely. All processing steps must be included. As well, the actual equipment used, procedures, and operating practices should be described for each step.
c) Observe the process in operation identifying all potential hazards associated with each step in the process.

Figure 2: Heat Treated Meat Processing Flow Diagram (Sample)



Process Narrative/ Description

A process description seeks to explain what happens at a step in your process. It describes the equipment used, the purpose of the step, any interactions with people and raw materials or products involved. For the unfamiliar, it serves to provide a relatable narrative without physically witnessing the step in operation. Table 4 shows the process description of each steps/points for heat treated meat processing.

Table 4: Process Narrative of Heat Treated Meat

Receiving raw meat (beef, mutton, chevon, etc.)	The raw meat (beef, mutton and chevon) preparation, quality and hygiene standards shall be as per ES 1111:2019[9] and ES 6536:2019[10]
Deboning	The raw meat carcass received is subjected to deboning to remove all bone structures from the meat.
Cutting, slicing and dicing	The meat is first cleaned and cut in the size and width required to adequately cook at homogenous tender and color of the meat.
Cooking	Required temperature for cooking is 70°C for 30 minutes in furnace or cooking vat to achieve the microbial hazards are sufficiently killed.
Cooling and bulk storage	The bulk cooked /heat treated meat is stored in cooling store maintaining the sterility of the product until packaging.
Filling and packing	Cooled heat treated meat is filled in hermetic package small or big flexible pouches as required by the importing partner in aseptic containers to avoid recontamination.
Transportation and distribution	Transportation and distribution of the product uses cold chain vans to maintain cold temperature between +2°C to +8°C.

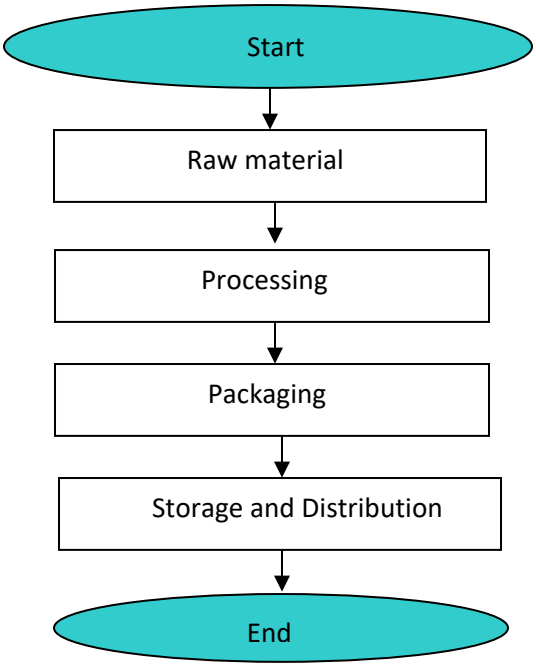
For other heat treated meat products

From the cooked (thermally treated) meat, other meat products can be produced with or without the additives, having been marinated, brined, sauced, steamed, boiled, smoked, roasted, baked, dried, deep-fried, molded, fermented or modulated (Figure 3). This guideline didn't cover each and every of the thermally treated meat products. Hence, each meat industry should develop their own HACCP plan as per the different type of meat product the company produce using this guideline as a model generic HACCP plan.

Figure 3 shows the overall product flow diagram that the food safety team shall prepare for other heat treated meat will follow the following pattern.

[9] Ethiopian Standard, ES 1111:2019. Third edition, Meat and Meat Products Beef Specification.
[10] Ethiopian Standard, ES 6536:2019. First edition, Mutton and Goat Carcass Cuts - Requirements

Figure 3: The overall product flow diagram



5. Verify the Flow Diagram (On site verification)

Once the HACCP flow chart is completed, the flow chart should be confirmed physically on site by the team by carrying out a walk through verifying all the steps identified. The HACCP team should then sign off a copy of the verified flow chart and this will be held on file. The purpose of the plant schematic is to show:

a. Location of equipment
b. Plant layout
c. Product (raw and finished)
d. Employee movement
e. Flow of ingredients and packaging materials

The plant schematic can also aid in the identification of potential hazards, in particular, with any areas of cross-contamination. Hence, it is very critical to verify the flow diagram on the ground because missing a step (point) will be a risk for entry of hazards in the food system without getting noticed or controlled.

The HACCP System - A Step-by-Step Approach of Implementing the Seven Principles of HACCP

After the pre-HACCP steps have been performed, it is time to begin building the HACCP system. A properly implemented HACCP will identify and control the critical steps in producing safe and wholesome meat products. The HACCP system has the following seven principles. When applied properly to a meat plant, they minimize the potential of a foodborne disease outbreak.

1) Identify the hazards (hazard analysis)
2) Determine critical control points (CCPs)
3) Establish critical limits for each CCP
4) Implement procedures to monitor CCPs and record data
5) Institute corrective action
6) Establish record keeping systems to document the HACCP plan
7) Verify the HACCP system is working

It may appear that the seven principles of the HACCP system, when applied to an entire meat plant, will be complicated and difficult to organize. However, when the meat plant is broken down into sections or processes, the number of CCPs becomes quite manageable. *How to develop the seven principles of HACCP for heat treated meat is described in the next pages of this guideline.*

6. Hazard Analysis

This is probably one of the most important and elaborate elements of the HACCP system; all other HACCP elements are either based on, or directly/indirectly generated from thorough hazard identification. It should address all individual steps, including technical aspects and any inputs (e.g. raw materials) along the production process[11].

Hazard analysis is a general assessment of the hazards involved in processing, handling, storage distribution, and the consumer abuse of a particular meat product. The product is potentially hazardous when all or some of the following risks occur:

- there are disease causing micro-organisms likely to be present if this step is not controlled.
- there is a possibility of microbial toxins.
- there is a possibility of chemical or physical contamination.
- there is a potential for consumer abuse.

[11] FAO 2004. Good Practices for the Meat Industry.

6.1. Identification of the hazards

A hazard is any biological, chemical or physical agent present in, or condition of, food that can cause harmful effects on human health.

- **Biological hazards** of greatest concern in meat processing plants include pathogenic micro-organisms (bacteria, fungi, viruses), microbial toxins and/or toxic metabolites, parasites and prions.
- **Chemical hazards** include residues (e.g. pesticides, polychlorinated biphenyls [PCBs], heavy metals, mycotoxins), veterinary medicines, growth promoters, cleaning/sanitation chemicals, lubricants/solvents, and pest baits.
- **Physical hazards** can include glass, plastic, metal, wood, rubber bands, string, hair, buttons, jewelry, bone splinters and insects.

To determine the risk of a hazard, first consider what can go wrong with a process step, and then what effect it will have on the consumer if this step is not controlled. This involves determining the likely hazards to consumers that could be presented by a meat product. These hazards and their seriousness must be communicated to the workforce and its management, or supervision, so that they understand the risks they run as a business and the consequences of selling unsafe products. Realistic hazards include microbiological contamination, natural toxins, any toxins formed in meat by decomposition, chemical contamination, drug residues and the presence of foreign bodies or other specified materials (such as offals) that may cause injury[12].

The following table (Table 5) contains examples of the three types of hazards in relation to meat. Please note that the list is not exhaustive.

Table 5: Most Common Hazards in Processed Meat

Biological (B) Hazard	Chemical (C)Hazard	Physical (P) Hazards
• Salmonella • *Escherichia coli* O157:H7 • *Listeria monocytogenes* • *Staphylococcus aureus* • *Yersinia enterocolitica* • *Bacillus cereus* • *Mycobacterium bovis* • *Brucella abortus* • *Brucella melitensis* • *Campylobacter jejuni*	• Cleaning chemicals • Antibiotics residue • Herbicides • Pesticides • Fungicides • Cosmetics • Lubricant • Aflatoxin M1 • Heavy metals (Pb)	• Insects • Plastics • Hair • Grass • Wood • Sand/soil, • Glass fragments

[12] Brown (2000). HACCP in the meat industry.

To aid implementation and identify the personnel that should be involved in implementation, hazards can be divided into[13]:

- **'Material-related'** that occur before raw or part-processed materials are received by the processor. Typically, these hazards have their origins in the environment or in the animal, or are introduced during harvest, pre- processing or transportation to the processor. For effective control, implementation should extend upstream of the factory gate, through the manufacturing stages to the retailer's shelf.
- **'Process-related'** that occur during processing, packaging or distribution. Implementation can start at the factory gate and should cover the downstream supply chain to the retailer's shelf or beyond.

The more severe the hazard the greater the efforts that should be made. The following examples illustrate the point:

- Contamination of meat (or animals) with salmonella or *E. coli* O157 may occur before the processor receives the raw material. Effective control prior to entry to the factory may, or may not, be possible. Because of the severity of the hazard from infectious pathogens, every effort should be made to extend control back onto the farm. The extent of control (e.g. the starting and finishing points) must be defined at the start by the scope of the HACCP plan.
- Meat products, such as steaks or burgers, may be eaten partially cooked. Normal butchery and manufacturing techniques cannot eliminate any pathogens present on meat. The minimum degree of control should ensure that numbers and the incidence of infectious pathogens are not increased by slaughter, butchery and manufacture and that any cooking instructions provide a safe, good quality product. Who needs to be involved in providing this protection should be clear from the scope of the HACCP plan.
- Raw meat may also be brought into the plant for further processing (e.g. cooking for making pie fillings). In these cases, depending on the process involved, contamination with infectious pathogens before processing poses a less serious hazard, because factory cooking can reliably eliminate it. The control measures, procedures and personnel required will be different from the example above, as the objective of manufacturing personnel is to ensure absence in the cooked material, rather than preventing contamination of the raw material.

In contrast, the presence of harmful microorganisms in a cooked, ready-to-eat bulk meat product bought from an outside factory for slicing and vacuum packaging is a serious hazard. Contamination may be due to either a failure of the cooking process (to achieve a temperature high enough to kill the micro- organisms) or contamination by poor handling or hygiene after cooking. It is essential that the scope of the HACCP

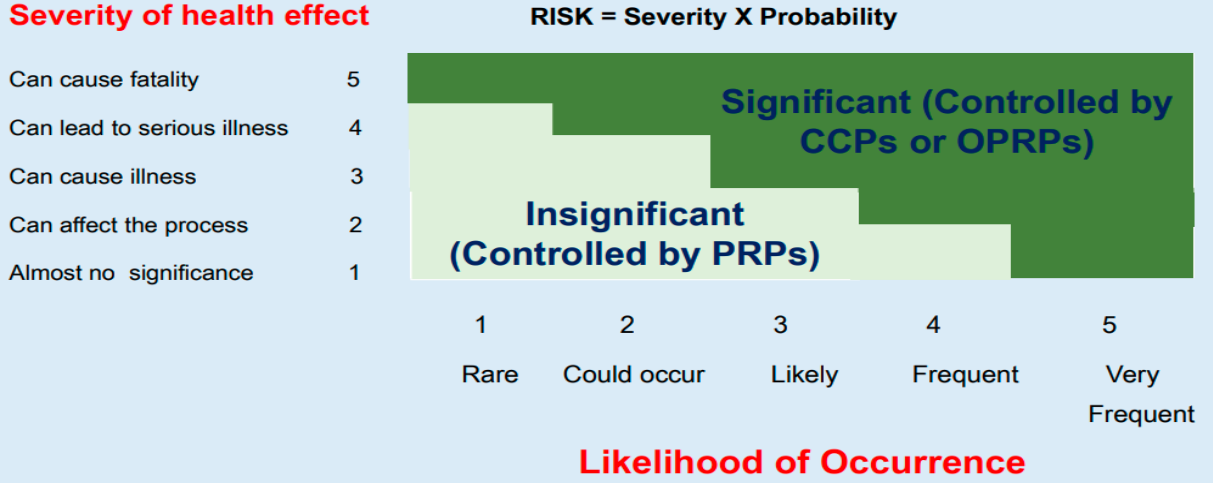
[13] Ibid.

plan identifies critical process stages and personnel in the original producer, to give reliable control of safety in the whole supply chain.

6.2. Hazard Assessment – identification and characterization

The HACCP team should conduct a hazard assessment (severity x likelihood) on identified hazards using the chart stated below for the production of heat treated meat and rank the hazards.

Figure 4: Hazard Assessment Matrix



Risk Matrix for Food Safety Hazard and Risk Assessment Form

Severity

1. Can cause fatality
2. Can lead to serious illness
3. Can cause a product recall
4. Can generate a customer complaint
5. Not of significance

Likelihood

1. Common occurrence
2. Known to occur or "it has happened at our premises"
3. Could occur or "I've heard of it happening" (Published information)
4. Not expected to occur
5. Practically impossible

Rating of: 1-10: Significant Hazard

11-25: Not a significant hazard

6.3. Selection and Categorization of control measure (s)

Control measures (CMs) can provide prevention, elimination or reduction of hazards. Most CMs are actually hygienic operating procedures normally used as part of GMP. In meat processing plants, most available CMs are effective in reducing hazards, rather than in eliminating them.

For each identified potential hazard, list any measures that may control it. CMs are steps or controls in the process designed to eliminate or control a hazard (e.g., knife sanitizing, proper refrigeration, etc.). In general, CMs focus on one of the following:

- raw materials and ingredients
- preservative factors (pH, water activity, etc.)
- time/temperature (either cooling or cooking)
- sanitation
- preventing cross-contamination
- employee practices and hygiene

The potential hazards and CMs, considered together, identify possible critical control points (CCPs). Since CMs are specific for each hazard type, Table6 provides CM examples for biological, chemical and physical hazards of heat treated meat using the hazard analysis and CCP.

Categorization of CMs is performed using the decision tree (Figure 5) to identify CCP (for HACCP) and also, OPRPs and PRPs for other food safety management systems like ISO 22000 and FSSC 22000.

7. Critical Control Points (CCP)

CCPs are those process steps that are vital for obtaining safe meat, and the points where the hazards must be effectively controlled (prevented, eliminated or reduced) through specified measures[14]. Consideration as to whether a given step is a CCP or not is based on the following questions: a) Is the hazard at this step at an unacceptable level? b) Are control measures to prevent unacceptable levels available at this step? If the answer to both is “no”, the step is not a CCP. If this is the case, it should be considered whether control measures are available at the previous step, i.e., through GMP.

[14] FAO (2004).

Once a possible CCP has been identified, the HACCP Decision-Making Chart (Figure 5) and Table 6, is used to confirm whether or not a CCP exists and requires answering the following questions:

- Does a control measure exist?
- Does the control measure control the hazard to an acceptable level?
- Could the hazard contaminate the product?
- Is this control measure the last option for controlling the hazard?

Mark each CCP on your flow diagram. Do not use the HACCP system for monitoring purely quality issues. Use HACCP only for direct hazards since non-essential monitoring may dilute out the detection of potential hazards.

It is common to identify too many CCPs in a HACCP plan. The result can be that implementation becomes unmanageable and important control issues cannot be distinguished from matters that are either GMP or have no real impact on control. Before starting implementation, the team should be confident that CCPs have been separated from other important aspects of processing. However failure to control the real CCPs within the production process will cause, or contribute to, the presence of a hazard in the product[15].

The CCPs identified in the flow diagrams are explained in Table 6 below. They will assist you in the identification of CCPs in your plant.

[15] Brown (2000). HACCP in the meat industry.

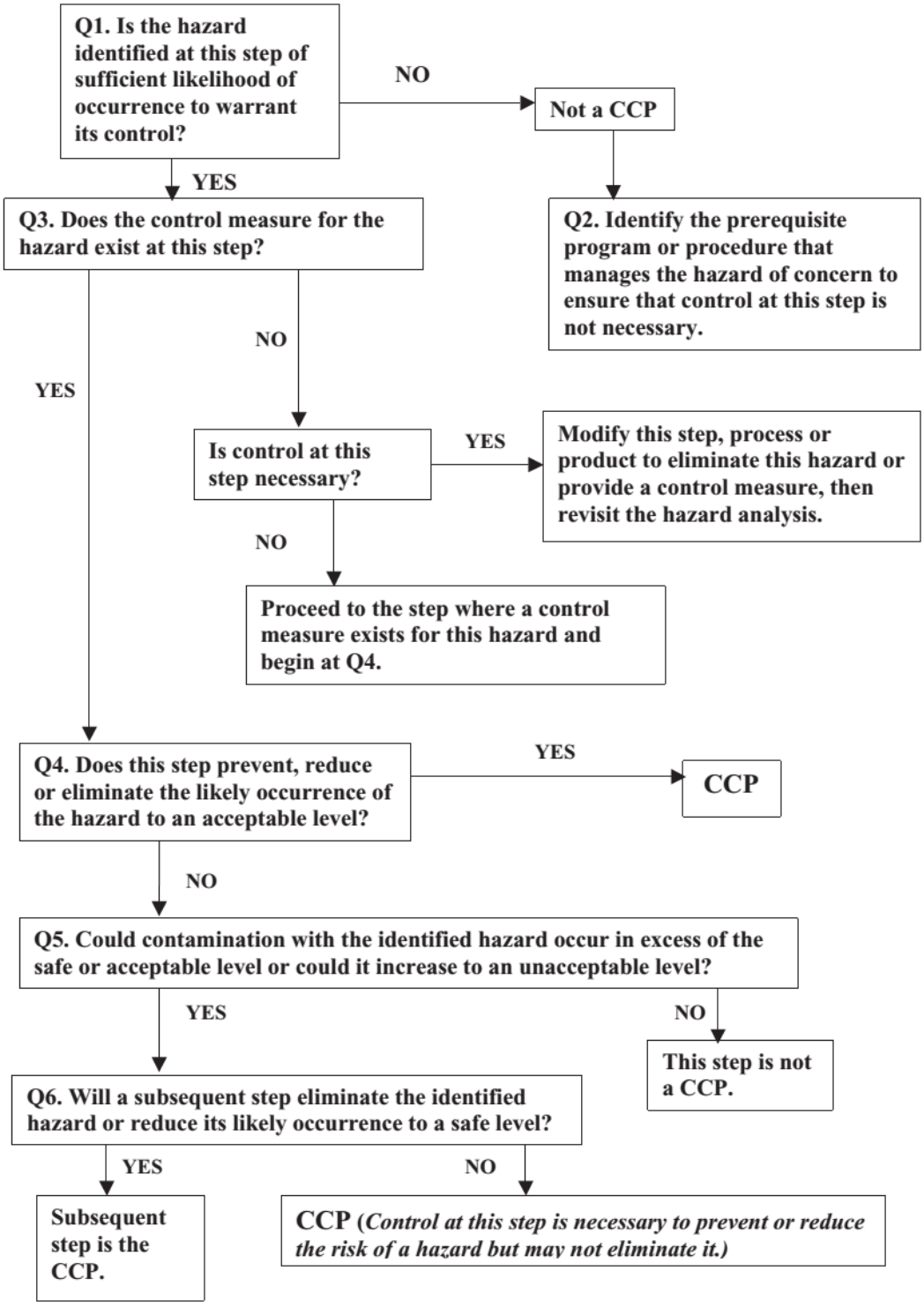


Figure 5: CCP decision tree

Table 6: Hazard Analysis and CCP Table (Sample Example)

No.	Process description	Potential hazards (physical, microbiological & and chemical	Reasonably likely to occur Yes/No	Is the hazard significant Yes/No	Justification for yes/No	Preventive measure to be taken	Is this step CCP Yes/No	CCP No
1	**Receiving raw meat**	B: Bactria, Virus: FMD (foot and mouth disease)	Yes	Yes	Pathogens maybe present on incoming raw product	Receiving	No	
		C: Veterinary drug	Yes	Yes	Veterinary drug residue may be found in raw meat from animals treated and slaughtered without obeying withdrawal period.	Cooking to appropriate level	No	
		P: Bone, metals, …	Yes	No	Plant records show that there has been no incidence of foreign materials in products received into the plant	Magnetic separator for the metal; Bone GMP (Good deboning practice)	No	
2	**Deboning**	B: bacteria, BSE	Yes	Yes			No	
		C: None					No	
		P: metal contamination	Yes	Yes	Metals maybe found from materials used for deboning		No	
3	**Cutting**	B: None					No	

		C: None					No	
		P: metal contamination	Yes	Yes	metal contamination during mechanical processing	Metal detection is located at a subsequent step in the process.	No	
4	**Cooking**	B: pathogens listeria monocytogenes *Salmonella Staphylococcus aureus* *E. coli* O157:H7 *T. spiralis*	Yes	Yes	Potential survival and growth of pathogens and toxigenesis from *S. aureus* with inadequate process time/temperature/humidity	Heat treatment using appropriate time/temperature/humidity to produce lethality/pasteurization	Yes	CCP1-4B
		C: None					No	
		P: None					No	
5	**Cooling and Bulk Storage**	B: Spore forming bacteria					No	
		C: No					No	
		P: No					No	

6	**Filling and Packaging/ Labeling in Cans**	B: Pathogens Growth of *Listeria monocytogenes*	Yes	Yes	*L. monocytogenes* growth precluded by previous drying step - water activity of product much less than 0.92 min required for Lm growth.	Sterilize caning material	Yes	CCP2-6B
		C: No					No	
		P: None					No	
7	**Transportation and distribution**	B: None					No	
		C: None					No	
		P: None					No	

8. Critical Limit

Critical limits are applicable only at CCPs. They represent a measurable and/or observable indicator of whether previously identified hazards have reached unacceptable levels of risk. Critical limits can differ in their nature and how they are measured. For example, chilling temperature (e.g. 4 °C) is a critical limit because it prevents the growth of some pathogenic bacteria; exceeding that temperature would pose a high risk from multiplication of the pathogens[16].

The HACCP study should have established critical limits for each CCP. **Critical limits**, such as temperatures, hygiene level, cooking time or residue concentration, draw the line between acceptable and unacceptable operation of a plant or supplier while **targets** are the working limits, related to the capability of the equipment and personnel[17]. They are usually set within the critical limits to ensure that process or operator variability does not cause the limits to be exceeded. Setting or validation of targets is an essential part of implementation; for example, if a temperature limit for a slicing area is 12 ºC, the room may be operated at 8–10 ºC to allow for temperature rises during door opening, etc. Such targets and limits must be consistently achievable by the personnel, equipment and procedures involved at the CCP (Brown, 2000).

In general[18]:

- Critical limits are tolerances or operating constraints set for each CCP to ensure control of the hazard or risk. They are monitored to determine whether the control measure for that CCP is within acceptable levels.
- Critical limits may be derived from a variety of sources, such as regulatory standards, literature surveys, experimental studies, or expert advice.
- Strict adherence to tolerances is important in maintaining a HACCP system. Product safety is not negotiable. There is no such thing as "almost risk-free".
- Critical limits may vary depending on the processes in your plant.
- For assistance in establishing critical limits, refer to the fourth column in the tables below.

N.B: Ethiopian standard or other standards need to be referred as reference for the critical limits as well. See Table 7 example for heat treated meat critical limit for the CCPs identified before.

[16] FAO (2004).
[17] Brown (2000).
[18] BC Centre for Disease Control (2012)

Table 7: Process Control (Sample Format)

Process Controls	Hazard(s)	Parameters, values or critical limits	Monitoring				CorrectiveAction	Verification	Records
			What	How	Frequency	Who			
CCP1-4B-Cooking	Pathogens (such as Listeria monocytogenes *Salmonella Staphylococcus aureus E. coli* O157:H7 *T. spiralis etc)*	Temperature of 70 ^{0}C for 30 minutes.	Cooker	using an internal probe and check 10 sticks in coldest part of smokehouse for each lot at completion of cook cycle and before removal from	Once per shift	QA technician or designee	If a deviation from a critical limit occurs, the QA supervisor or designee is responsible for corrective action protocols: 1. The cause of the deviation will be identified and eliminated. 2. The CCP will be under control after the corrective action is taken. 3. Measures to prevent recurrence are established. 4. No product that is injurious to health or otherwise adulterated as a result of the deviation will be permitted to enter commerce.	Once per shift the QA supervisor or designee will review the Smokehouse/Product Temperature Log, Corrective Action Log, and Thermometer Calibration Log. Once per shift QA supervisor or designee will observe the QA technician or designee perform the monitoring activity	cooking Temperature Log Thermometer Calibration Log Corrective Action Log
CCP2-6B Filling and Packaging/ Labeling in Cans	Growth of *Listeria monocytogenes*	Each individual package of finished products requiring further cooking must be labelled as such.	Packaging and labeling material	Ensure finished products are properly packaged and labelled	Each lot or batch.	QA technician or designee	Re-label incorrectly labelled finished products.		

9. Monitoring (of the CCP)

For each CCP, regular monitoring procedures have to be established, to ensure that the CCP is controlled effectively and to detect proactively any danger from exceeding critical limits. The monitoring should include established parameters such as the methods used (e.g. sampling plans and temperature recording checks are meaningful), the frequency, the allocation of related responsibilities and recording. CCP monitoring should provide an early warning of the danger of losing control, before critical limits are exceeded.

Monitoring should be done at a frequency proportional to the degree of consumer risk involved. The monitoring procedure should provide the necessary information to allow for corrective action to be taken before the process is out of control or, at least, minimize the time that it is.

Generally, monitoring of CCPs can best be accomplished through the use of physical and chemical tests (i.e. temperature recording charts or measurement of salt levels in salt brine) and through visual observations. The use of microbiological testing is rarely an effective means of monitoring CCPs because of the time required to obtain results.

However, microbiological criteria do play a role in verifying that the overall HACCP system is working. The monitoring procedures must provide useful and practical information. Records must be kept to ensure the CCPs are being monitored on a regular basis.

Monitoring in general should answer the following questions and see **Table 7** for monitoring example that answers these questions.

- Who?
- When?
- How?
- What?

10. Corrective Action

CCPs may fail in any HACCP system. When this happens corrective action plans must be in place to ensure that the operator knows exactly how to react to a detected problem and bring the critical control point back under control without delay. Immediately when there is an indication that for any CCP the critical limit has been exceeded and the process is getting out of control, a specific, pre-planned corrective action must be taken and these must include:

- a procedure for holding product pending completion of analysis to confirm product safety
- disposition of the product

- confirmation that the CCP has been brought under control

Corrective actions should be prompted by failure to meet a critical limit. Responsibilities for them should be allocated to production and supervisory staff during implementation

In addition, ensure the following are strictly observed:

- If the product cannot be proven safe, dispose of it.
- As well, the reasons for deviations must be found, documented and corrected.
- In the corrective action, "Action on Deviations" in each table shows the appropriate actions to take when CCP critical limits are not met.

Example:

- If a cooker does not reach its proper operating temperature, corrective action will be required to repair the equipment, but also to ensure that product is held at least until it can be determined whether it is safe for sale. This is necessary because undercooking may allow the survival of infectious pathogens in a ready-to-eat product.
- If a chiller is found to be above its critical temperature, then the department involved should initiate maintenance or repair work, and also block product until it has been determined whether safety has been impaired.

Corrective actions should be considered under the following three scenarios:

Immediate effects

The immediate aim of corrective actions is a rapid regaining of control. Examples include retaining a contaminated meat on the processing line and/or altering its disposition, or moving carcasses to another chiller if the temperature is moving out of control. See **Table 7** for example of corrective actions taken.

Longer-term effects

Corrective actions should also include elements that aim to prevent reoccurrence, together with determining what went wrong and considering any need for retraining staff, amending instructions and procedures, maintenance works, or replacement of equipment.

Organization

Crucial preconditions for corrective actions to be effective include specifying who is responsible for carrying out a given action, and maintaining accurate/updated records.

11. Verification and Validation: Is the HACCP System is Working

To be effective, the HACCP plan needs to be followed in terms of both the operations and the operators, resulting in identified hazards being effectively controlled.

HACCP verification

Verification procedures need to be defined, in order to prove that what was planned and what is actually happening do not differ. Various checks can be used for HACCP verification; either the HACCP team or external auditors, or both, can carry them out. Verification checks do not need to be carried out for the whole HACCP system simultaneously; different parts of the plan can be checked at different times. Nevertheless, all the parts have to be checked within a specified time frame. Examples of verification checks include microbiological sampling of the carcasses and the environmental surfaces, auditing by customers or regulatory authorities, and on-site review of the process flow diagrams.

HACCP validation

Validation procedures need to be defined, in order to prove that the HACCP plan is effective in controlling the identified hazards. The effectiveness of HACCP-based control of hazards should be at least equivalent to, but preferably exceed, those of controls based only on GMP. Validation checks include assessment of completeness, appropriateness, adequacy and justification of all aspects of the HACCP plan. Generally, it is good practice if validation includes comparison with in-house and national performance. A HACCP plan should be revalidated if any changes are made to the plan or the production process.

- Some meat plants in developed countries are now performing regular quality control testing of their finished products. Results from quality control tests may often indicate that a HACCP system is not performing as required. In such cases, the system must be reviewed to ensure:
    - the present HACCP system is being followed
    - all hazards were identified in the initial HACCP system.
- Other methods to verify the HACCP system is working include:
    - close monitoring of consumer complaints.
    - verification inspections: unannounced equipment inspections.
    - regular review of the current HACCP system. Have processes, procedures, or formulations changed since the initial HACCP system was implemented?
    - random sample collection and testing (separate from regular Q.C. testing protocol).

When first initiated it is particularly important to ensure that the HACCP system is working. As well, verification procedures must be made a priority wherever processing procedures or formulations are changed.

See Table 8 below for sample format of HACCP verification Format.

Table 8: HACCP System Verification (Sample Format)

PLANT NAME	**ISSUE DATE**	**PAGE**
ADDRESS	**SUPERSEDES**	**PRODUCT CODE**

Food Safety Plan ReanalysisChecklist				
Reason for reanalysis:				
Task	Date Reviewed and Initials	Is Update Needed? (yes/no)	Date Task Completed	Signature or Initials of Person Completing the Task
List of Food Safety Team with individual responsibilities				
Product flow diagrams				
Hazard analysis				
Process Preventive Controls				
Food Allergen Preventive Controls				
Sanitation Preventive Controls				
Supply-chain Program				
Recall Plan				
Updated Food Safety Plan implemented				
UpdatedFoodSafetyPlansignedby owner or agent in charge				
Reviewer Signature:			Date Review:	
Date issued: dd/mm/yy		Supersedes: dd/mm/yy		

12. Record Keeping (Documentation)

Documentation should provide general information, details of the HACCP plan itself, and records. All documentation should be updated, complete and informative, but be as simple as possible and accessible. Figure 6 summarizes the major documentation types required in HACCP plan.

General information

This includes a description of prerequisites, operating instructions, training records and similar information.

Plan information

This includes all necessary information on the HACCP team and responsibilities, product and production processes, and review procedures.

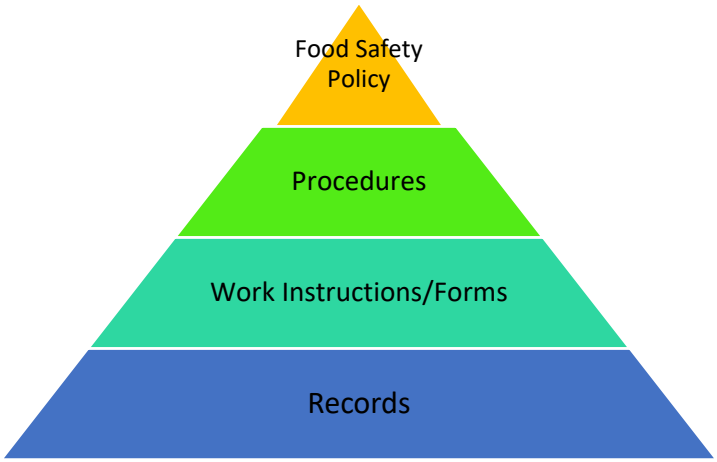
Records

These include data on monitoring, corrective actions and verification**.**

- Records are an integral part of a working HACCP system. Proper records can ensure that a product was prepared and handled in a safe manner. As well, they may identify the reason for a system malfunction, allowing the operator to correct a potential problem.
- A single individual should be made responsible for ensuring all data is recorded. This individual must have authority to ensure:
    - all data is collected
    - all data is centrally located and easy to retrieve
    - a record of all CCP deviations is kept, and, most importantly
    - appropriate action is taken when results deviate beyond the critical limits

The record keeping system must be as simple as possible. A single binder for smaller operations or a single filing cabinet for larger operations should be more than adequate.

Figure 6: Documentation types in HACCP Plan



Please see Table 9-12 for some of sample HACCP records (format) used for effective implementation of a HACCP system in heat treated meat processing facilities.

Table 9: Thermometer Calibration Log (Sample record 1)

Thermometer calibration Log							
Date	Time	Department or area	Thermometer ID#	Personal thermometer reading	Adjustment required (yes or No)	Initials	Comments

Table 10: Process Operation Log (Sample record 2)

Generic establishment X: Process operating Log Retort Operator_____

Product_____ Date_____

Code_____

Can size_____

No. cans/retort _____

Min. product int. temperature_____

Process time/temperature _____

Batch No.	Retort No.	Int. Temp	Time steam on	Time vent closed	Retort temp at end of vent	Actual process time			Temperature		Initial
						Start	Stop	Total	MIG	Chart	

Table 11: Corrective Action Log (Sample Record 3)

Corrective Action Form	
Date of Record:	Code or Lot Number:
Date and Time of Deviation:	
Description of Deviation:	
Actions Taken to Restore Order to the Process:	
Person (name and signature) of Person Taking Action:	
Amount of Product Involved in Deviation:	
Evaluation of Product Involved with Deviation:	
Final Disposition of Product:	
Reviewed by (Name and Signature):	Date of Review:

Table 12: Pre-shipment Review Log (Sample record 4)

Pre-shipment Review Log **Date_____**					
Product	Lot ID	Time records reviewed	By Whom	Lot released for shipment? Signature	Comments

*monitoring frequency as per plan; critical limits met; certification (if applicable) as per plan; deviations if occurred were reviewed for appropriate corrective actions; records complete and accurate.

Summary: Recap of HACCP

By following the HACCP system, your approach to product safety is pro-active rather than reactive. It's implementation may not always be easy, but it will minimize the potential lawsuits, prosecutions, and recalls that a company can be exposing itself to if a HACCP system is not an integral part of it's operation. As well, for the plant manager, a HACCP system will result in overall higher quality and therefore more saleable and profitable product with less loss to spoilage and wastage.

All meat plants should perform many of the functions required for a HACCP system and the effort required to implement it should be maximized. In doing so, more emphasis and direction should be given into the following areas:

a) Emphasize specifications for incoming ingredients.

b) Consider supplier qualifications in addition to just price.

c) Observe your process and operations.

d) Analyze the hazards and identify the critical control points.

e) Monitor the critical limits.

f) Keep careful track of material usage and production codes.

g) Systemize it all to keep it manageable.

h) Record the results and maintain them in an orderly manner.

Beyond HACCP: Implementing other ISO and FSSC Based Food Safety Management Systems

As needed, food companies could also establish other more extensive food safety management system like ISO 22000 and FSSC 22000 as well. These standards compliance depends on customers/ clients requirements.

Annex 1: Self-Assessment HACCP Checklist

Section	Question	Yes	No	Minor/Major/ Critical	If No – detail NC	NC#
Preliminary Steps	Is there a team with an assigned leader, responsible for the HACCP program at the operation,, with a leader assigned, if applicable, for and the development, implementation and on-going maintenance of the HACCP system?					
Preliminary Steps	Is there documented evidence that the HACCP team members have been trained on HACCP principles?					
Preliminary Steps	Does a product description exist for the products produced?					
Preliminary Steps	Has the process(es) been flow charted in sufficient detail to completely describe the process or product handling/processing steps?					
Preliminary Steps	Is there documented evidence that the flow chart(s) has been verified on-site?					
Development of the HACCP Plan	Has a documented hazard analysis for the processes been conducted, showing the various types of hazards, their likelihood of occurrence, their associated severity and their control measures?					
Development of the HACCP Plan	Have CCP decisions been made with documented justifications and where CCPs are implemented in a specific processing step, have they been developed to control the identified hazard(s)?					
Development of the HACCP Plan	Is the HACCP system reviewed when significant changes are made and at least once every 12 months?					

Development of the HACCP Plan	Have critical control point (CCP) processing steps been identified that eliminate or reduce food safety hazards to an acceptable level? Informational gathering. If answer is YES, continue with next question. If answer is NO, the rest of section 3 is not applicable.					
Development of the HACCP Plan	Have CCP critical control limits been established and are they supported by relevant validation documentation?					
Development of the HACCP Plan	Have monitoring requirements and frequencies been determined and documented for the CCPs?					
Development of the HACCP Plan	Have specific responsibilities been assigned for the monitoring, recording and corrective action implementation of each CCP?					
Development of the HACCP Plan	Have standard operating procedures (SOPs) been created for the monitoring process(es) of the CCPs, which would include how to carry out the monitoring activities?					
Development of the HACCP Plan	Have corrective action procedures been established for the CCPs, including a detailed action plan for operators to follow if the critical control limit(s) of a CCP are not met (loss of control/deviation) and plans to adjust the process back into control?					
Development of the HACCP Plan	Have recording templates (recording forms) been developed for monitoring the CCPs?					
Development of the HACCP Plan	Have verification plans and schedules been developed for each CCP?					

Execution of the HACCP Plan	Do all of the documents noted in the HACCP Plan accurately reflect plan requirements for the CCPs?					
Execution of the HACCP Plan	Are the CCP monitoring activities and frequencies in compliance with the HACCP Plan and CCP SOPs?					
Execution of the HACCP Plan	Is there documented evidence that all plant workers have attended a HACCP training, including training for CCP operators?					
Execution of the HACCP Plan	Do CCP operators understand basic HACCP principles and their role in monitoring CCPs?					
Execution of the HACCP Plan	Are CCP monitoring records signed off (or initiated) by the operator(s) who are carrying out and recording the CCP check?					
Execution of the HACCP Plan	Is there a deviation record detailing documented corrective actions when a deviation/loss of control of a CCP occurs (a critical control limit is exceeded)?					
Execution of the HACCP Plan	Are the CCP records reviewed and signed off by the quality control supervisor and/or management (second signatory)?					

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