Development of a HACCP plan for selected barbequed meat products

By

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DECLARATION

The work described in this thesis was carried out by me at the Department of Food Science & Technology, Faculty of Applied Sciences, Sabaragamuwa University of Sri Lanka, under the supervision of Mr. Janitha Liyanage, Lecturer, Department of Food Science & Technology, Faculty of Applied Sciences, Sabaragamuwa University of Sri Lanka & Mrs. Manel Perera, Food Safety Consultant, Mount Lavinia Hotel, Mount Lavinia. A report on this has not been submitted to any other university for another degree.

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BUTTALA

Affectionately

Dedicated

To

My Parents

&

Teachers

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ABSTRACT

Lifestyle and demographic changes in Sri Lanka over the past several decades have led to increased consumption of foods that are raw, minimally processed and ready-to-eat. These changes are believed to contribute to higher likelihood for the occurrences of food-borne illnesses. Pro-actively addressing any deficiencies in the existing food safety system and progressively moving to a science based preventive food safety approach such as HACCP will significantly enhance food safety. In the future HACCP will be an essential vehicle in consideration of the equivalence of food safety control systems for nationally as well as internationally traded and catered food where the hotel industry plays a prominent role in terms of consumer safety.

The present study was focused on the identification of potential hazards associated with selected barbequed meat products served at a leading hotel and the implementation of preventive and control measures by developing an HACCP plan. GMP and SOP manuals currently established for the hotel were critically evaluated in the preliminary study. The hazards within the production processes of barbequed meat products were identified and CCP's were determined for each. CCP's were assessed and incorporated to develop the HACCP plan for the selected barbequed meat products.

Evaluation of the prerequisite programme was used as the universal procedure to control the conditions of the hotel environment that significantly contribute to the overall quality and safety of the barbequed products. Microbiological hazards, contaminations of cleaning agents and contaminations of metal ware were the most risky hazards identified in biological, chemical and physical categories respectively. CCPs for barbequed chicken and barbequed pork were precooking and hot holding. CCPs for barbequed beef and medium cooked barbequed pork was grilling. Critical limits for CCPs were established, monitored, verified and documented. It is expected that a comprehensive verification of the developed HACCP system be carried out by an independent expert on annual basis. Verification activities should also be scheduled upon HACCP system change.

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LIST OF ABBREVATIONS

BBQ	- Barbeque
CCP	- Critical Control Point
^0C	- Centigrade
cm	- centimeter
GMP	- Good Manufacturing Practices
g	- gram
HACCP	- Hazard Analysis Critical Control Point
hr	- Hour
Kg	- Kilo gram
min	- Minutes
s	- Seconds
SOP	- Standard Operation Procedure

CHAPTER 1

Introduction

1.1 Background

Ready to Eat (RTE) meat products such as barbecued meat items are popular as well as convenient food products. They are widely distributed and consumed as picnic items, deli buffet foods, and in lots of other ways without subjecting to further food processing. They are truly convenient food for many consumers, and they are presumed to be safe to eat by consumers as purchased (Prince et al. 1993). The consumption of contaminated foods is known to cause many cases of food borne illness each year. Most food borne illnesses are caused by mishandling, malpractices in preparation or improper storage (Unnevehr and Jensen 1998).

The Mount Lavinia hotel is among the leading and outstanding hotels in Sri Lanka and is the largest tourist hotel to be fully managed by a dedicated Sri Lankan team. Meat is held in high esteem in many of the hotel menus. It has prestige value, it is often regarded as the central food around which meals are planned, and various types of barbequed meat products are sometimes made the basis of festive and celebratory occasions. The hotel is committed to produce and serve safe and superior quality food and beverages to surpass the customers' expectations and ensure that the food handlers work with confidence and devotion to maximize customer satisfaction along with ensuring food safety.

In order to control food safety problems and prevent food poisoning incidents, all food businesses including food service organizations should prepare their own food safety plan based on the internationally accepted principles of Hazard Analysis Critical Control Points (HACCP) system.

HACCP is 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. An HACCP programme can ideally maintain the

safety and wholesomeness of barbequed meat products because potential hazards that may occur during processing are anticipated, evaluated, controlled, and prevented (Northcutt and Rusell 2003). Seven basic principles are employed in the development of HACCP plan including hazard analysis, CCP identification, establishing critical limits, monitoring procedures, corrective actions, verification procedures, and record-keeping and documentation.

Under such system, if a deviation occurs indicating that control has been lost, the deviation is detected and appropriate steps can be taken to reestablish control in a timely manner to assure that potentially hazardous products do not reach the consumer. Benefits, in addition to enhanced assurance of food safety, are better use of resources and timely response to problems. HACCP's preventive focus is seen as more cost effective than testing a product and then destroying or reworking it. For successful implementation of a HACCP plan, management must be strongly committed to the HACCP concept. Prerequisite programs such as Good Manufacturing Practices (GMP), Standard Operation procedures (SOP), Supplier Quality Assurance (SQA) are an essential foundation for the development and implementation of successful HACCP plan (NFSA-MFSC 1993).

However, a "classic" HACCP system is generally not considered feasible in a food service organization such as a hotel due to the multiplicity of food products, lack of standardised methods, lack of systematic production planning as well as lack of expertise to develop the HACCP system (Rosenthal HACCP team 2000).

1.2 Overall Objective:

Identification of potential hazards associated with selected barbequed meat products and implementation of preventive and control measures by developing an HACCP plan.

1.3 Specific objectives:

i. Critical evaluation of the GMP manual currently established for the hotel.
i. Determination of CCPs for identified hazards within the processes.
ii. Incorporation of the CCPs in the development of HACCP plan for the selected barbequed meat products.

CHAPTER 2

Literature Review

2.1 Development of HACCP concept

The Pillsbury Company pioneered the HACCP concept for food production during its efforts to supply the U.S. space program in the early 1960s. Pillsbury decided that their existing quality control techniques were inadequate. The company found that the end-product testing necessary to assure against contamination during food production would be so extensive that little food would be available for space flights. The only way to ensure safety, Pillsbury concluded, would be to develop a preventive system that kept hazards from occurring during production. Since then, Pillsbury's system has been recognized worldwide as the state-of threat measure for hazard control. It is not a zero risk system, but it is designed to minimize the risk of hazards (AIS-HAACP, 2006).

However, HACCP was not introduced to the public until 1971. Initially, interest in HACCP was limited because it is a difficult system to implement. A 1985 report from the National Academy of Science, Food Protection Committee renewed interest in HACCP by suggesting that it was the most effective method for ensuring food safety. In 1996, the United States Department of Agriculture Food Safety and Inspection Service (USDA-FSIS) passed a new regulation known as the "FSIS Pathogen Reduction/HACCP Regulation," which requires meat and poultry plants to use HACCP in their operations. With the new regulation, the responsibility of providing safe foods rests on industry and not the USDA (Stolfa et al. 2000).

2.2 General overview on HACCP concept

HACCP (Hazard Analysis Critical Control Point) is a non-traditional, non-continuous inspection technique. It can be considered as a more scientific, analytical, and economical approach than that provided by traditional inspection and quality control methods. HACCP, which focuses on problem prevention and problem solving, relies heavily on proper monitoring and record keeping by the industry (Mortimore 2000).

HACCP offers benefits to the regulator, processor, and consumer. The regulator and processor are provided with a history of the operations and can concentrate on components related to controlling hazards. Through monitoring of CCPs, both can evaluate the effectiveness of the control methods. Furthermore, the processor can control the operation on continuous basis and prevent hazards, instead of reacting to what has already happened. Ultimately, the consumer benefits through access to a product manufactured under conditions where hazards have been identified and controlled (Marriott 1999).

2.2.1 Hazard

2.2.1.1 Definition

A hazard is a biological, chemical or physical property or condition of, food with the potential to cause an adverse health effect. Hazards may be biological, chemical, or physical and are the basis of every HACCP system.

2.2.1.2 Types of Hazards

Hazards can be categorized as physical hazards, chemical hazards, and biological hazards.

Physical hazards – The most common type of hazards that occur in foods, because of the possible presence of foreign material. However, the risk of consumer injury is quite low for most types of foreign material, as few items are sharp or hard enough to cause physical damage, or are of dimensions that might cause choking.

Material	Why a hazard
Glass	Cuts, bleeding; may require surgery to find or remove.
Metal	Cuts, broken teeth; may require surgery to remove.

Chemical hazards – Chemical contamination can happen at any stage in food production and processing. Chemicals can be helpful and are purposefully used with some foods, such as pesticides on fruits and vegetables. Chemicals are not hazardous if properly used or controlled. Potential risks to consumers increase when chemicals are not controlled or the recommended treatment rates are exceeded. The presence of a chemical may not always represent a hazard. The amount of the chemical may determine whether it is a hazard or not. Some may require exposure over prolonged periods to have a toxic effect. Regulatory limits are set for some of those contaminants.

Chemical hazards can be separated into three categories:

- Naturally occurring chemicals. (e.g. Aflatoxin in corn)
- Intentionally added chemicals. (e.g. Preservatives)
- Unintenionally or incidentially added chemicals. (e.g. Agricultural chemicals)

Biological hazards – Most food processing operations will be at risk from one or more biological hazards, either from the raw materials or during the process, and the HACCP plan will be designed to control these. Biological hazards can be either macrobiological or microbiological. Biological hazards usually present the greatest and broadest danger to consumers. Among the groups of microorganisms only bacteria, viruses and protozoa include the kinds of microorganisms that can make food unsafe. Generally, yeast and molds do not pose a biological hazard in food. Some molds produce hazardous toxins, but these toxins are considered chemical hazards. Macrobiological hazards cover a wide range of insects including flies, pests and the toxic plants and animals (Lee 1998).

2.2.2 Preliminary steps of developing an HACCP plan

In the development of HACCP plan five preliminary steps required to be accomplished before the application of HACCP principles to a specific product and process. Fig. 2.1 shows the five preliminary steps of HACCP plan.

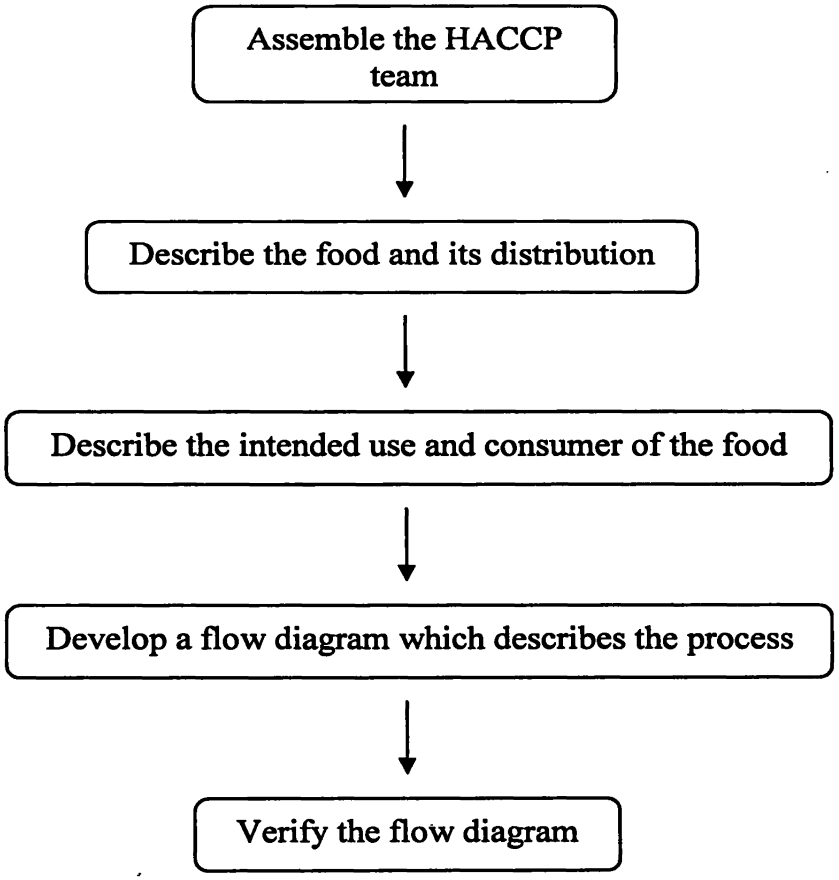


Fig. 2.1 Preliminary steps in the development of the HACCP plan (Mortimore 1998)

2.2.2.1 Assemble the HACCP team

HACCP is a program for the entire company; therefore, a team of individuals from different areas of production and processing should be involved in developing the HACCP plan. A team could be comprised of the owner and the chef or cook in the catering industry. The team must include individuals with specific expertise, such as live production, processing, quality control, sanitation, plant engineering, and Food and beverage. This should make it easier to identify the hazards associated with each product.

A HACCP coordinator should be chosen to work with the HACCP team and company management to develop, implement and manage the HACCP plan. Although managers are responsible for designing the system, implementation involves the efforts and commitment of every employee. Education and training of both management and employees are important in their respective roles of producing safe foods.

2.2.2.2 Describe the food an its distribution

Product description may be constructed for two important reasons. Firstly, it is essential that the HACCP team is fully familiarized with the products and process technologies to be covered by the HACCP plan. Secondly, the product description acts as an introduction and point of historical reference to the HACCP plan (Mortimore 1998). Some of the product description information that should be listed for each product includes:

- Product's common name.
- How the product will be used.
- Length of product's shelf-life, and at what temperature.
- Where product will be sold.
- Any special instructions for the product

2.2.2.3 Describe the intended use

Intended use would indicate whether the product is to be sold at retail, to food service or as an Ingredient for another food item. The intended consumers may be the general public or particular segment of the population (e.g. infants, immuno-compromised individuals, the elderly etc.) (Mortimore 1998).

2.2.2.4 Develop a Process Flow diagram

The flow diagram should be constructed by the HACCP team. During this step a Process Flow Diagram is prepared detailing all of the steps in the process from incoming raw materials through the finished product and product distribution. Raw materials should be identified as well as all processing activities. Time and temperature profiles including those for storage and distribution are important. It may also be useful to include a floor plan that details product flow through the facility.

2.2.2.5 Verify the Process Flow diagram

When the process flow diagram is complete, the HACCP team prior to the hazard assessment stage must verify it. This involves team members watching the process in action to make sure that what happens is the same as what is written down and may also involve going in on night shift to ensure that any alternatives are included. It is

essential to establish that right as the hazards analysis and all decisions about CCPs are based on the data (Mortimore 1998).

2.2.3 The Relationship between HACCP plan and Prerequisite programme

The production of safe food products requires that the HACCP system be built upon a solid foundation of prerequisite programs. Prerequisite programs are established and managed separately from the HACCP plan. Certain aspects, however, of a prerequisite program may be incorporated into a HACCP plan. For example, many establishments have preventive maintenance procedures for processing equipment to avoid unexpected equipment failure and loss of production. Prerequisite programs provide the basic environmental and operating conditions that are necessary for the production of safe, wholesome food.

It is extremely important that processors of RTE meat products develop and implement effective prerequisite programmes as Good Manufacturing Practices (GMPs) and Standard Operating Procedures (SOPs) as the foundations of a successful HACCP program. Combining strong GMPs, SOPs, SQA and HACCP will increase the total process control system and help these manufacturers continue to produce the safest products possible. The development and successful implementation of these programs requires full support and commitment of the management (Harris 1999).

Good Manufacturing practices

Good Manufacturing Practice (GMP) is that part of Quality Assurance which ensures that products are consistently produced and controlled to the quality standards appropriate to their intended use and as required by the manufacturing authorization. Good Manufacturing Practice is concerned with both production and quality control. Not required to be written, and not a justification for unlikely hazards, but if GMPs are written, easier to teach to new employees, and records kept can be an additional source of documentation to justify unlikely hazards (Harris 1999).

Standard Operation Procedures

A Standard Operating Procedure (SOPs) can be defined as established or prescribed methods to be followed routinely for the performance of designated operations or in designated situations. They are very concise and specific step-by-step instructions. Establishments are encouraged to have SOPs for every task or activity in the facility.

GMPs can help guide the development of SOPs. SOPs are also very useful in training employees and in establishing a consistent method for conducting daily operations. Therefore, individual establishments should develop SOPs for their operations.

Supplier Quality Assurance

One of the key areas for initial focus alongside HACCP development is raw material safety. It is important to know that the supplier is controlling hazards if these cannot be controlled in our process or by consumer action. For these reasons, an effective Supplier Quality Assurance system is one of the most important prerequisite programmes. There are a number of different elements to an effective SQA programme, including having agreed specifications, auditing suppliers and certificates of analysis. Supplier approval will depend on having confidence in the supplier's operation. It is therefore vital to develop good customer – supplier relationships, partners in the management of safe raw materials and products (Mortimore 1998).

2.2.4 Principles of HACCP

The HACCP system consists of seven principles which outline how to establish, implement, and maintain a HACCP plan for the operation under study. The HACCP principles have international acceptance and details of this approach have been published by the Codex Alimentarius Commission and the National Advisory Committee on Microbiological criteria for foods.

2.2.4.1 Principle 1 – Conduct Hazard Analysis

The first step in designing a HACCP plan is to conduct an analysis of hazards associated with each product. During hazard analysis, the HACCP team evaluates all of the procedures concerned with production, serving, and the use of raw materials for potential problems that could occur. The HACCP team should list the type of problem (biological, chemical or physical), and the appropriate preventive action necessary to keep the problem from occurring (Northcutt 2003). This step involves the expertise and perspective of all team members. It should also involve reference materials on HACCP, on microbiology, or on the product or product category. Every effort should be made to have a thorough and up-to-date file on the product or product category especially with respect to outbreaks or recalls and the reasons for them. Industry

associations, research associations, universities, and regulatory authorities are often good sources of this information.

Each hazard identified during brainstorming must be evaluated with respect to its severity and its likely occurrence in your operation. This is known as risk assessment. If the risk of the hazard is low or if it is unlikely to occur it can be eliminated from further consideration. However, it is essential to document the thought process behind eliminating a particular hazard.

Risk Assessment Framework –

The qualitative risk analysis model shown in Table 2.1 and Table 2.2 is used by the HACCP team to calculate the risk factor (i.e. score) for each identified hazard(s) arising from a hazardous event. The risk factor is defined as:

Risk Factor = Likelihood (L) x Severity of Consequences (S)

A simple numerical rating (i.e. a score between 1-5) has been assigned to the different levels of likelihood and severity of consequences. To perform the risk analysis the existing controls were determined and the risks analyzed in terms of likelihood and severity of consequences in the context of those controls. For each event, relative hazards are evaluated based on the general likelihood of an event occurring (Table 2.1) compared with the potential consequences or impacts of the event to the system (Table 2.2).

Table 2.1 Risk Assessment likelihood scale

Likelihood Rating	Description	Descriptor Example
1	Rare	May occur only in exceptional circumstances.
2	Unlikely	Could occur at some time.
3	Possible	Might occur at some time/the event should occur at some time.
4	Likely	Will probably occur in most circumstances.
5	Almost Certain	Is expected to occur in most circumstances.

(Source: Swierc et al. 2005)

Table 2.2 Risk Assessment severity scale

Severity Rating	Description	Descriptor Example
1	Insignificant	Insignificant impact, little disruption to normal operation low increase to normal operating costs.
2	Minor	Minor impact, some manageable operation disruption, some increase in operating costs.
3	Moderate	Minor impact, significant modification to normal operation but manageable, operating costs increased, increased monitoring.
4	Major	Major impact, systems significantly compromised and abnormal operation if at all, high level of monitoring required.
5	Catastropic	Major impact, complete failure of systems.

(Source: Swierc et al. 2005)

This approach recognizes that qualitative rather than quantitative information may be all that is available for decision making. However, the qualitative level of relative risk is determined based on the likelihood and potential impacts of an event which is evaluated using a matrix shown in Table 2.3.

Table 2.3 Risk factor score matrix

Risk Factor Matrix		Severity of Consequences				
		Insignificant Rating 1	Minor Rating 2	Moderate Rating 3	Major Rating 4	Catastrophic Rating 5
Likelihood	Rare Rating 1	Low	Low	Moderate	High	High
	Unlikely Rating 2	Low	Low	Moderate	High	Very High
	Possible Rating 3	Low	Moderate	High	Very High	Very High
	Likely Rating 4	Moderate	High	High	Very High	Very High
	Almost Certain Rating 5	Moderate	High	Very High	Very High	Very High

(Source: Swierc et al. 2005)

This approach provides a relative measure of potential risk that allows hazards present in a system to be prioritized for evaluation. Filtering was applied to distinguish significant hazards from those considered to be of less significance, and to separate hazards related to aesthetic concerns which did not result in food becoming unsafe to consume. Risks with a risk factor equal to or greater than moderate were classified as significant risks were assigned a higher priority for further investigation. Risks with a risk factors less than moderate (i.e. risks with a risk factor score of "low") were classified as risks that did not pose a significant risk to food. These hazards were assigned a lower priority for further investigation.

Control measures are any factor or activity which can be used to prevent, eliminate or reduce to an acceptable level, a food safety hazard. For each identified potential hazard on the hazard analysis worksheet, control measures that may be used to control or prevent the hazard are described. This can dilute the ability to focus efforts and control the truly significant hazards. Biological hazards due to pathogenic microorganisms might be controlled by preventing their growth through acidification of the product (e.g., acidifying garlic prior to adding it to oil). Physical hazards due to metal fragments might be prevented by a metal detector.

2.2.4.2 Principle 2 – Determine Critical Control Points (CCPs)

When all the hazards and control measures have been described, the HACCP team establishes the points where control is critical to assuring the safety of the product. These are Critical Control Points or CCPs. The CCP is usually a specific processing procedure or activity that can be monitored with record keeping reflecting trends and assuring compliance with the HACCP program (AIS-HAACP 2006).

CCP Determination

To assist in finding where the correct CCPs should be, a tool is available known as the CCP Decision tree. It is a logical series of questions that are asked for each hazard. In the case of the CCP decision tree this is for each hazard at each process step. The answer to each question leads the HACCP team through a particular path in the tree and to a decision whether or not a CCP is required at that step.

Using a CCP Decision tree promotes structural thinking and ensures a consistent approach at every process step and for each identified hazard. It also has the benefit of forcing and facilitating team decision, further enhancing teamwork and HACCP study.

2.2.4.3 Principle 3 – Establish Critical Limits

They are control measures associated with each identified CCP. The Critical limits describe the difference between safe and unsafe product at the CCPs. They must involve a measurable parameter and may also be known as the absolute tolerance or safety limit for the CCPs. Tests may need to be conducted or information gathered from sources such as scientific publications, regulatory guidelines, experts, or experimental studies. If the information needed to define controls is not available, a conservative value should be selected.

If monitoring shows a trend towards lack of control at a CCP, the relevant person should take action before the control limit is exceeded. The point where personnel take such an action is called the operating limit. Operating limits should not be confused with control limits. Operating limits are more stringent and thus established at a level that would be reached before the control limit is violated.

2.2.4.4 Principle 4 – Establish a system to monitor control of the CCP

Team should specify monitoring requirements for management of the CCP within its Critical Limits. This will involve specifying monitoring actions along with monitoring

frequency and responsibility. Further, monitoring should ideally provide this information in time to make adjustments to ensure control of the process to prevent violating the critical limits. Where possible, process adjustments should be made when monitoring results indicate a trend towards loss of control at a CCP. The adjustments should be taken before a deviation occurs. Data derived from monitoring must be evaluated by a designated person with knowledge and authority to carry out corrective actions when indicated. If monitoring is not continuous, then the amount or frequency of monitoring must be sufficient to guarantee the CCP is in control. Most monitoring procedures for CCPs will need to be done rapidly because they relate to on-line processes and there will not be time for lengthy analytical testing. Physical and chemical measurements are often preferred to microbiological testing because they may be done rapidly and can often indicate the microbiological control of the product. All records and documents associated with monitoring CCPs must be signed by the person(s) doing the monitoring and by a responsible reviewing official(s) of the company.

2.2.4.5 Principle 5 – Establish the Corrective actions

This is to be taken when monitoring indicates that a particular CCP is not under control. When controls are violated at a CCP, institute the predetermined, documented corrective actions. These corrective actions should state procedures to restore process control and determine the safe disposition of the affected product. It may be possible, and is always desirable, to correct the problem immediately. The corrective action plan must include:

1) Responsible person for regaining control of the process
2) Method of regaining control
3) Measures to be carried out with the product that was produced during the loss of control
4) Methods to handle a product recall.

2.2.4.6 Principle 6 – Establish procedures for verification

Verification is required to confirm that the HACCP system is working correctly. Verification procedures must be developed to maintain the HACCP system and

ensure that it continues to work effectively. Additionally, CCP verification includes supervisory review of CCP calibration, monitoring, and corrective action records to confirm compliance with the HACCP plan. CCP verification may also include targeted sampling and testing. The frequency of verification should be sufficient to confirm that the HACCP system is working effectively.

Once established, each HACCP plan will change as the company adds new products, updates old products, installs new equipment, or changes product-handling procedures. It is important to periodically verify that the HACCP plan is working.

Verification procedures may include:

- Routine check of all HACCP plans and records.
- Routine check of monitoring procedures and equipment.
- Random microbiological sampling of all product contact surfaces, as well as a portion of the product.
- Official evaluation of product.
- Review of all critical limit deviations and product handling (Rosenthal HACCP team 2000).

2.2.4.7 Principle 7 – Establish record keeping procedures

HACCP support documents include the information and data used to develop the plan. This includes the written hazard-analysis worksheet and records of information used in performing the hazard analysis and establishing the controls. Records must be kept to demonstrate that the HACCP system is operating under control and that appropriate corrective action has been taken for any deviations from the critical limits. This will provide evidence of safe product manufacture. Effective record keeping includes:

- List of HACCP team members and their responsibilities
- All products and their intended use should be identified
- HACCP flow diagrams with all CCPs
- List of all critical limits and preventive measures
- Monitoring and verification plans
- Course of action when a critical limit deviation occurs, and person(s) responsible for corrective actions
- Procedures for product handling when deviation from critical limit occurs

2.2.5 Catering industry and HACCP concept

Catering businesses include such premises as hotels, restaurants, public houses, take-aways, coffee shops, street vendors, mobile shops, vending machines, outside catering companies, hospitals and other institutions conducting catering operations.
For more than 20 years industry and regulators have been exploring use of the HACCP principles in food catering establishments. During that time, much has been learned about how these principles can be used in the varied operations, collectively referred to as retail food establishments. Most of this exploration has centered on the focal question of how to stay true to the definitions of HACCP and still make the principles useful to an industry that encompasses the broadest range of conditions.

Despite this diversity and range of conditions, those involved have discovered that the HACCP principles are useful tools for managing food safety. Over time, ways have been discovered to slightly modify the applications of HACCP to better fit retail food establishments. The following chart suggests some adaptations of applying the HACCP principles to retail food establishments (Rosenthal HACCP team 2000).

Table 2.4 Application of HACCP principles specific to catering establishments

HACCP Principle	Applications Specific to Catering Food Establishments
Hazard Analysis	Analyze and organize by process rather than commodity because food items are intertwined in catering operations. Simplify by combining like operations into categories.
Define Critical Control Points	No change.
Establish Critical Limits	No change. Use of Food Code provisions.
Monitoring	Simplify monitoring by standardizing procedures to a level of confidence that ensures safety, detects problems, and reduces the monitoring frequency.
Corrective Actions	No change.
Verification	No change.
Record Keeping	Simplify by using records already in existence, such as invoices, work schedules, and recipes.

(Source: Stolfa et al. 2000)

HACCP system guides for catering businesses to assist in the development and implementation of their own HACCP only after appropriate prerequisites are in place. The nature and the complexity of each individual HACCP will, in practice, depend on the nature and complexity of the specific catering business. It allows you to predict potential risks to food safety and to prevent them before they happen. By using HACCP, catering businesses will no longer have to rely solely on routine inspections to spot potential food safety hazards (Lee and Hathaway 1998).

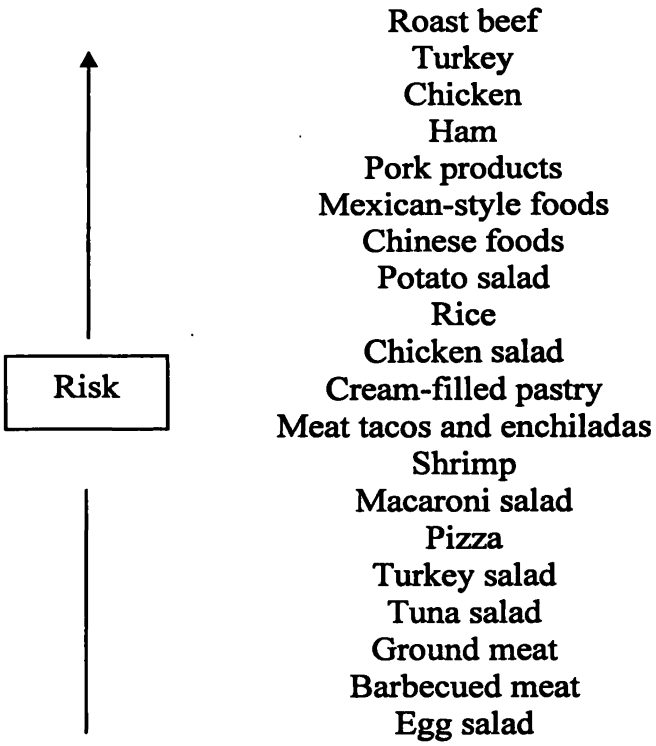


Fig. 2.2 Prepared foods tied to outbreaks of food poisoning (Stolfa et al. 2000)

Foods at the top of the list have the greatest risk. Those at the bottom have the lowest risk.

2.2.6 Management and Maintenance of HACCP

Management support is essential to the maintenance of an acceptable HCCP plan. HACCP team leader should be responsible for the maintenance of HACCP. The responsibility includes coordination of input from others, monitoring of activities, review, validation, verification, and documentation. Furthermore, the coordinator should ensure that the HACCP team has access to the variety of information required to conduct the various assignments. Each individual assigned to HACCP related tasks should be provided appropriate written instructions and descriptions of responsibilities and tasks.

An HACCP plan should be evaluated frequently and revised as needed. Evaluation should involve the review and interpretation of results and verification and validation of the plan. Proposed changes to the plan should be evaluated. A mandatory evaluation proposed guarantees that a systematic evaluation will be made of any changes in the process, thus assuring that any revisions affecting product safety will

be evaluated before implementation. Verification assures that the HACCP plan will be evaluated and revised as needed (Marriott 1999).

2.2.7 Benefits of implementing HACCP

The HACCP system can be applied to control any stage in the food system, and is designed to provide enough feedback to direct corrective activities. This focus on measurable indicators provides a more cost-effective approach to control than product sampling and testing, which is more expensive and may not provide timely results. This is especially important for foodborne microbial pathogens, because their incidence is low and costs of testing are high.

HACCP was originally developed as a quality control tool in food processing, where branded product liability creates industry incentives for hazard control. It was intended to be flexible enough to adapt to different firms, plants, or processes within plants. Its application as a regulatory standard to an entire industry or sector, or at different stages in the supply chain, is necessarily different. HACCP allows firms a great deal of flexibility in designing and implementing controls to fit specific circumstances. This allows identification of the likely sources of hazards and the scientific basis for reducing them. HACCP implementation focuses on reducing hazards where they are most likely to occur and most effectively controlled, and thus encourages efficient resource use in hazard control. Adoption of HACCP as a regulatory standard has been motivated by a desire to facilitate trade (NFSA-MFSC 1993).

2.2.8 Draw backs of Implementing HACCP

If HACCP is not properly applied, then it may not result in an effective control system. This may be due to improperly trained or untrained personal not following the principles correctly. It may be that the outcome of the HACCP study is not implemented in the work place or it may be the implemented system fails through lack of maintenance. The effectiveness may be lost if the company carries out the hazard analysis and then tries to make its findings fit with existing controls.

Other problems may arise if HACCP is carried out by only one person, rather than a multi disciplinary team, where it is done at the corporate level with little or no input from processing facility (Mortimore. and Wallace 1998).

2.2.9 Barbequed Meat Products

Barbequed meat products are fully cooked or rare ready to eat products that do not require further heating before consumption. Therefore, it is important that appropriate heat treatments are applied and that all possible steps are taken to reduce potential contamination after the heat treatment or post-processing. It should be noted that each processor must validate the cooking process for these products and meals as part of the HACCP development and implementation. Barbequed meat items are delicious, flavorful, and rich in protein, iron, zinc, selenium, phosphorus and some B vitamins, such as niacin, thiamin, riboflavin, and B_{12} (Prince et al. 1993).

2.2.9.1 Barbequing process

Meat can be cooked in many different ways, either by itself or combined with other foods such as grains, vegetables or fruits. It can be used in appetizers, soups, salads, sandwiches and main dishes. Deep-fat frying, barbequing, broiling, roasting, baking, stir-frying and braising are the more common cooking methods. Among these, deep fat frying and barbequing are probably the most popular, dry-heat cooking methods. While fried meat is juicy with a crispy crust, barbequed chicken is tasty with appealing smoke flavor. In catering industry fried meat and barbequed meat are two of the hottest sales of meat products. To meet consumer needs, catering industries produce meat products of various flavors by different cooking methods as fully cooked, rare etc (Rosenthal HACCP team 2000).

Seasoning of meat with spices prior to cooking is a preparation frequently used for meat. Meat is seasoned for a variety of reasons, including improvement of flavor, tenderness and moistness of the cooked products, etc. Besides, seasoning can reduce carcinogenic compounds formed during cooking. Studies showed that seasoning can significantly reduce total heterocyclic amines in barbequed chicken.

However, there are some chemical compounds that form during the processing or cooking that are invisible to the consumers. These compounds include cholesterol oxidation products (COPs), heterocyclic amines (HCA) and polycyclic aromatic

hydrocarbons (PAH), which are bad for health. Some of these compounds are even carcinogenic.

Both fried and barbequed meats are cooked at high temperature. The frequency and amount of consumption of them significantly correlate to exposure to HCA and thus the risk of some cancers. In addition, barbequed meat may also contain PAH, some of which are potent carcinogens. Adequate temperature control and less burning on the surface can prevent carcinogenicity.

2.2.9.2 Barbequed meat products and Food safety issues

The role of barbequed meat as a vehicle or source of infection of a number of pathogens is well documented. The primary etiologic agents for meat related outbreaks are *Staphylococcus aureus* (20%), *Salmonella* species (18%), and *Clostridium perfringens* (10%). During receiving, storage and processing phases meat is quite vulnerable to contamination from species of *Salmonella* and *Campylobacter*, *Listeria monocytogenes* and other microorganisms of public health concern. *Campylobacter* has presented a serious problem for the meat processing because it is commonly present in raw meat (Marriott 1999).

An outbreak of *Listeria* in Cargill Inc. turkey deli meat, which was suspected in four food-poisoning deaths and three miscarriages, could undermine the meat industry's struggle to fend off stronger food-safety regulations. Mutated deadly form known as *E. coli* O157:H7 has been found in hamburgers and inadequately cooked BBQ meat items. A common but unusually virulent type of *Salmonella*, called phage type 4, has been found in chickens. Both pathogens have contributed to a number of foodborne illness outbreaks. In addition to bacteria, foodborne diseases and illnesses can be caused by viruses, parasites, and fungi, directly, or by toxins produced by the pathogens. Chemical or drug residues found in food can also have adverse health effects.

Most cases of foodborne illnesses are classified as "acute." These are usually self-limiting and of short duration, although they can range from mild to severe. Gastrointestinal problems and vomiting are common acute symptoms of many foodborne illnesses. Deaths from acute foodborne illnesses are rare. However, FDA estimates that 2 to 3% of all acute cases develop secondary long-term illnesses, called "chronic sequellae." Chronic sequellae of foodborne illness can occur in any part of the body and subsequently can affect the joints, nervous system, kidneys, or heart.

These chronic illnesses may afflict the patients for the remainder of their lives or result in premature death. About 15% of *E. coli* O157:H7 disease patients in USA develop haemolytic uremic syndrome (also known as HUS), which involves red blood cell destruction, kidney failure, and neurological complications such as seizures and strokes.

When something goes wrong with a food product there may be localized or widespread illness and suffering, and the cost to company can be huge. Even when no illness has been caused, the discovery of safety hazards in a product intended to consumption can lead to prosecutions often resulting from foreign material being discovered in food, but microbiological hazards have much greater impact.

An effective HACCP system is one way of preventing incidents such as the above from happening. It is a system where all hazards to food safety are identified and effective control mechanisms are put in place (Mortimore 1998).

CHAPTER 3

Materials and Methodology

3.1 Identification of the scope of HACCP study and hotel policy

Scope of HACCP study was identified at the commencement of the HACCP study. The hotel food safety policy was recorded due to the importance of understanding the assistance of hotel voluntary implementation of HACCP principles and to identify the commitment of hotel for its safe foods.

3.2 Identification of HACCP team

HACCP team was designated to consist of members with specific knowledge and expertise appropriate to the product and process. Selection criteria were emphasized on production and quality assurance knowledge. The team was appointed with a team leader with a good knowledge of hotels activities and experiences in the development of HACCP plans. Selected team was confined to an appropriate number of persons to enable easy control and management.

3.3 Product description and Intended use of barbequed meat products

The product description and intended use of barbequed meat products were prepared as it serves as an introduction and point of historical reference to the HACCP plan. This was included with a product name, food safety characteristics, ingredients, intended consumer and intended use.

3.4 Construction of process flow diagram

Process flow diagram of the four barberqued products was identified and constructed by covering all the stages from raw materials to end products. The catering flow layout was identified including the potential delay stages. Simultaneously all possible cross contamination risks that would happen were identified. When the process flow diagram was completed, verification was also planned prior to the hazard assessment stage.

3.5 Development of Prerequisite programme

3.5.1 Development of GMP manual

Good manufacturing practices were selected and adopted as a prerequisite programme before HACCP was implemented. It was developed by considering several legal and hotel practices. The areas addressed through this manual included personnel hygiene and other practices, building and other facilities, equipment and utensils, and production and process controls.

3.5.2 Development of Supplier Quality Assurance documentation

Questionnaire required for the supplier quality assurance was prepared for initial assessment of suppliers.

3.6 Implementation of principles of HACCP

3.6.1 Conduct the Hazard analysis

Hazard analysis was carried out by analyzing and organizing by process rather than commodity because food items are intertwined in catering operations. All potential hazards such as microbiological, chemical, and physical were identified, documented and discussed with the HACCP team to identify any other hazards to be considered. Significance of hazards and possible control measures were decided and documented.

3.6.2 Determination of Critical Control Points

CCP decision tree was used to assist in the identification of CCPs. CCPs were located at the points where hazard require prevention, elimination or reduction to acceptable levels. The number of established CCPs were kept to a minimum to simplify monitoring and documentation and to avoid dilution of the HACCP programme effectiveness.

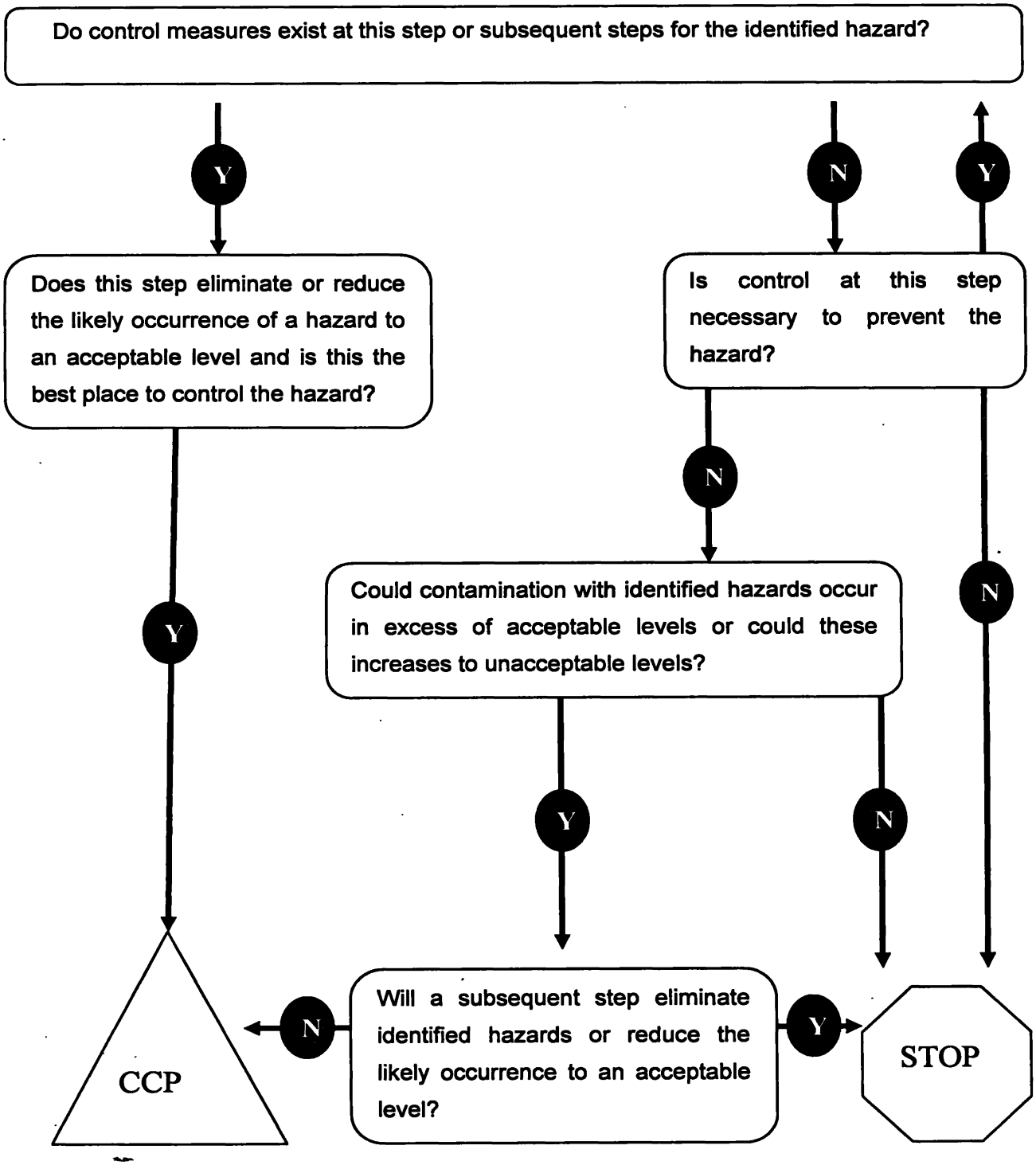


Fig. 3.1 CCP decision tree for process flow (Mortimore 1998)

3.6.3 Establish Critical limits

Once CCPs were identified HACCP control charts were established and documented as all essential details about the steps are clearly visualized. The critical limits for preventative measures were specified for time, temperature or other physical dimensions. Development of these critical limits was required for the determination of maximum numbers of microorganisms in the product, as well as sources such as regulatory standards and guidelines.

3.6.4 Establishment of Monitoring systems

Monitoring procedures for identified control points were established. Monitoring of relevant limits, responsible persons, the way that monitoring is done, and monitoring frequency were established.

3.6.5 Establish Corrective action procedure

Corrective action procedures were established for each CCP when deviations of critical take place.

3.6.6 Establishment of Verification procedure

Verification procedure and the responsible person of the verification were established for each CCP.

3.6.7 Establishment of Record keeping and Documentation procedure

Control limit establishment records, log sheets, CCP determination forms, all hazard identification forms were named and documented.

Chapter 4
Results and Discussion

4.1 Scope of HACCP study and hotel policy

4.1.1 Scope of HACCP plan

The HACCP manual was developed to prevent, eliminate and reduce hazards related with barbequed meat products from receiving of raw materials to consumption of end products.

4.1.2 Company safety policy

Mount Lavinia Hotel (Pvt) Ltd is committed to produce and serve safe and superior quality food and beverages to surpass the customers' expectations and ensure that the food handlers work with confidence and devotion to maximize customer satisfaction along with food safety.

The food safety policy in the hotel has been established to define top management commitments to comply with requirements and to continually improve effectiveness of food safety management system. Food safety objectives were the link between food safety policy and commitments to continual improvements. Food safety objectives of Mount Lavinia hotel are to reduce food wastage incidences by 2% quarterly and to increase the customer satisfaction index by 1% annually.

4.1.3 Catering floor layout

The equipment layout in the catering area was examined. Employee traffic pattern was identified for possibility of cross contamination in the area. This was useful to conduct the hazard analysis and trace out the potential hazards.

4.2 Composition of HACCP team

The HACCP team was assembled consisting of individuals who have specific knowledge and expertise appropriate to the product and process. The team was multi disciplinary and inclusive of expertise individuals from areas such as engineering, production, sanitation, and quality assurance. The Team was leaded by the HACCP Coordinator. The team members are as follows.

HACCP Team member	Designation
A.R.M Dissanayake	HACCP Coordinator – Team leader
Ralf W.Vogt	Director Kitchen
Keerthi Senevirathne	Executive chef
Ramond Rodrigoe	Chief Steward
Asela Karurathilake	Assistant Training Manager
Shantha Jayasekara	Chief Engineer
J.E Tarcious	Receiving officer

4.3 Product description and Intended use of barbequed meat products

4.3.1 Barbeque Chicken

4.3.1.1 Product Description and Intended use

Product Name: Barbequed Chicken

Raw materials:

Chicken drumsticks	Onion
Pepper	Garlic
Mustard cream	Herbs
Olive oil	Salt

Chemical characteristics:

NaCl content	- 2.5% by mass (max.)
Fat content	- 12% by mass (max)
P^H	- 6.2 - 6.4
Moisture content	- 47.2% by mass (max)

Microbial specifications:

TPC per g (48 hours at 37^0C)	- 10^3
Total coliform count per g	- 10
E coli count per g	- Nil

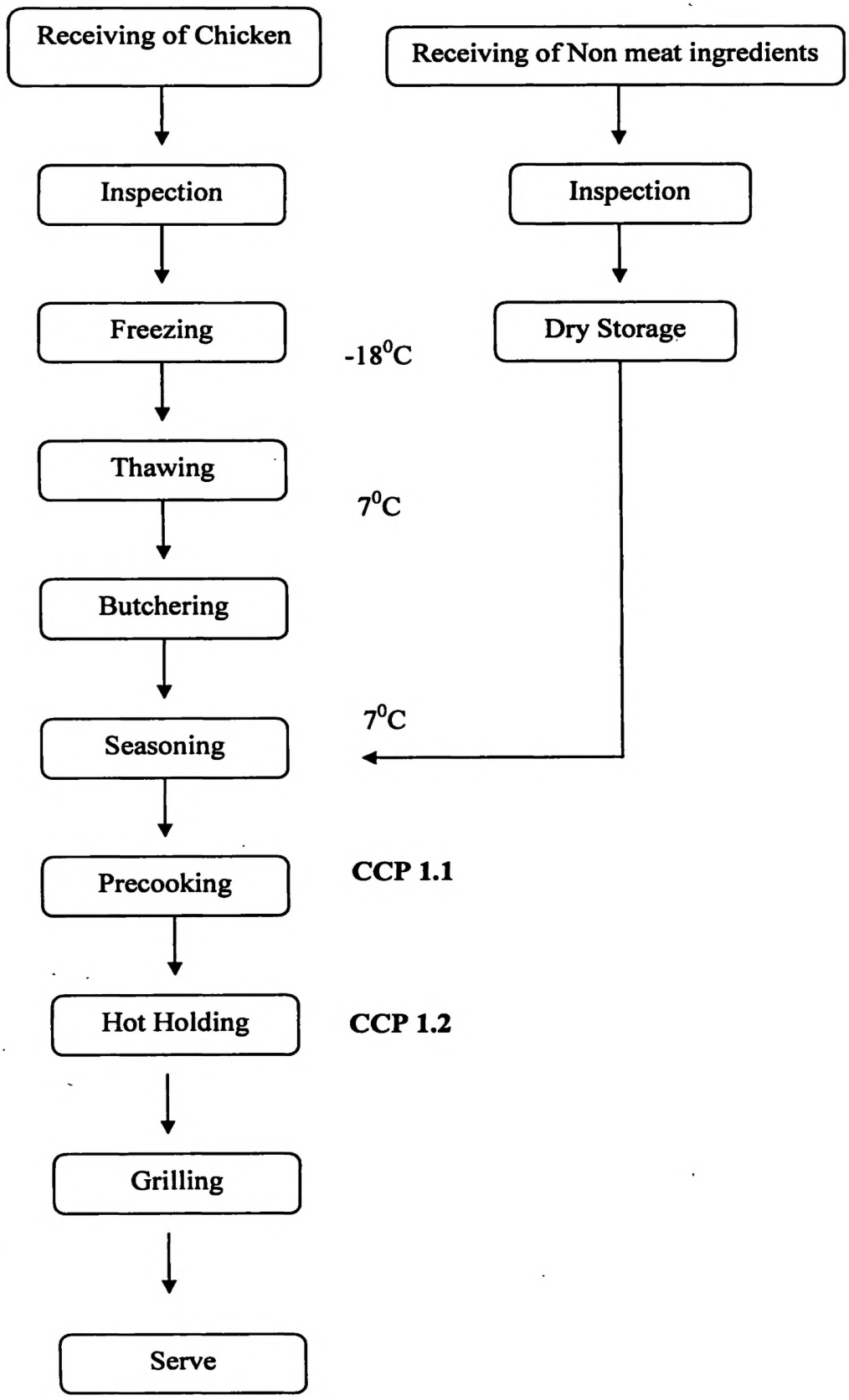
Intended consumer:

Customers at all ages

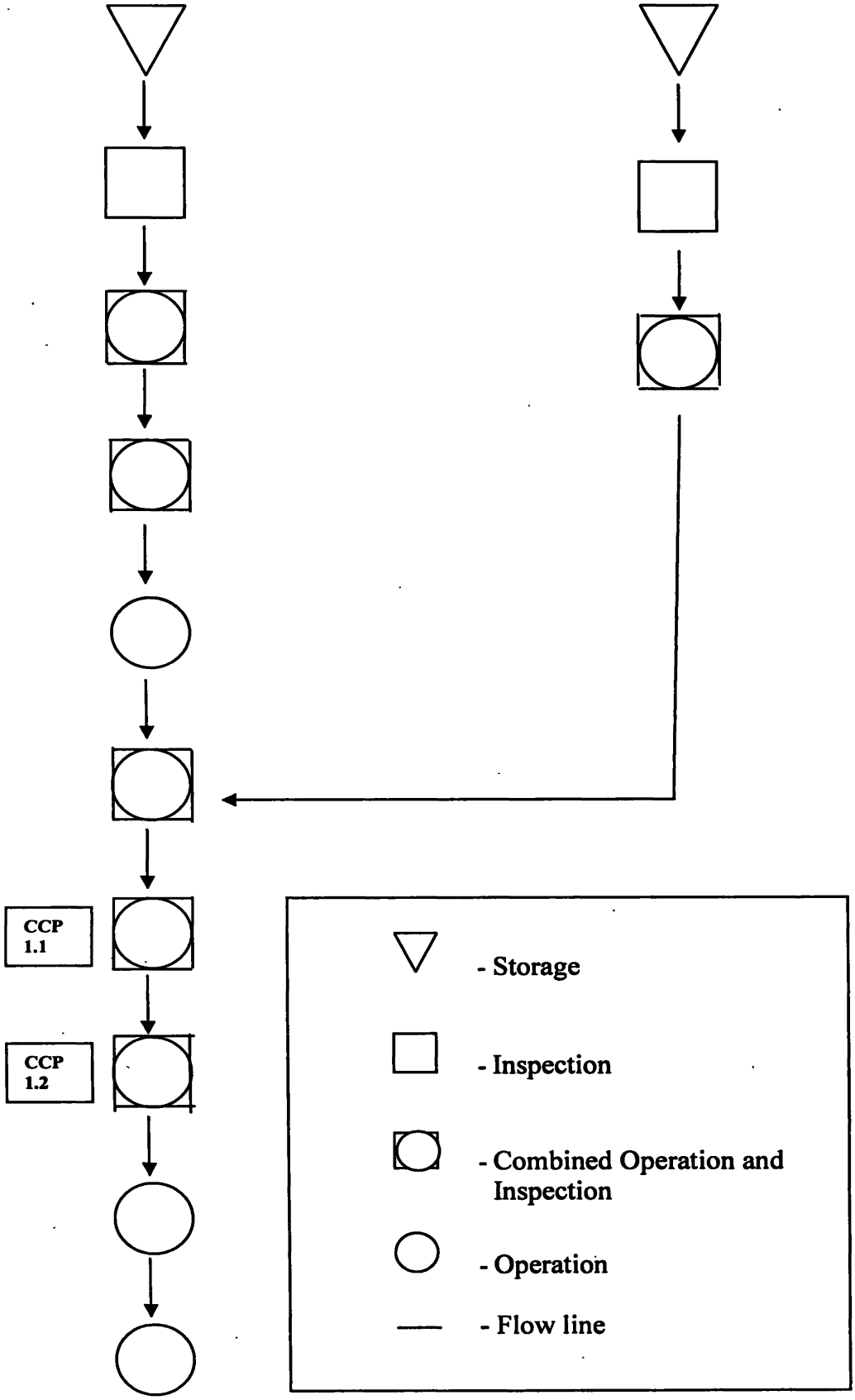
Intended use:

Ready to Eat

4.3.1.2 Developed Process flow diagram for Barbeque Chicken



4.3.1.3 Flow chart in standard icons for Barbeque Chicken



4.3.2 Barbeque Beef

4.3.2.2 Product Description and Intended use

Product Name: Barbeque Beef

Raw materials:

Beef fillets	Onion
Pepper	Garlic
Mustard cream	Herbs
Olive oil	Salt

Chemical characteristics:

NaCl content	- 2.6% by mass (max.)
Fat content	- 15% by mass (max)
P^H	- 5.3 - 5.8
Moisture content	- 45.3 – 47.2% by mass (max)

Microbial specifications:

TPC per g (48 hours at 37^0C)	- 10^3
Total coliform count per g	- 10
E coli count per g	- Nil

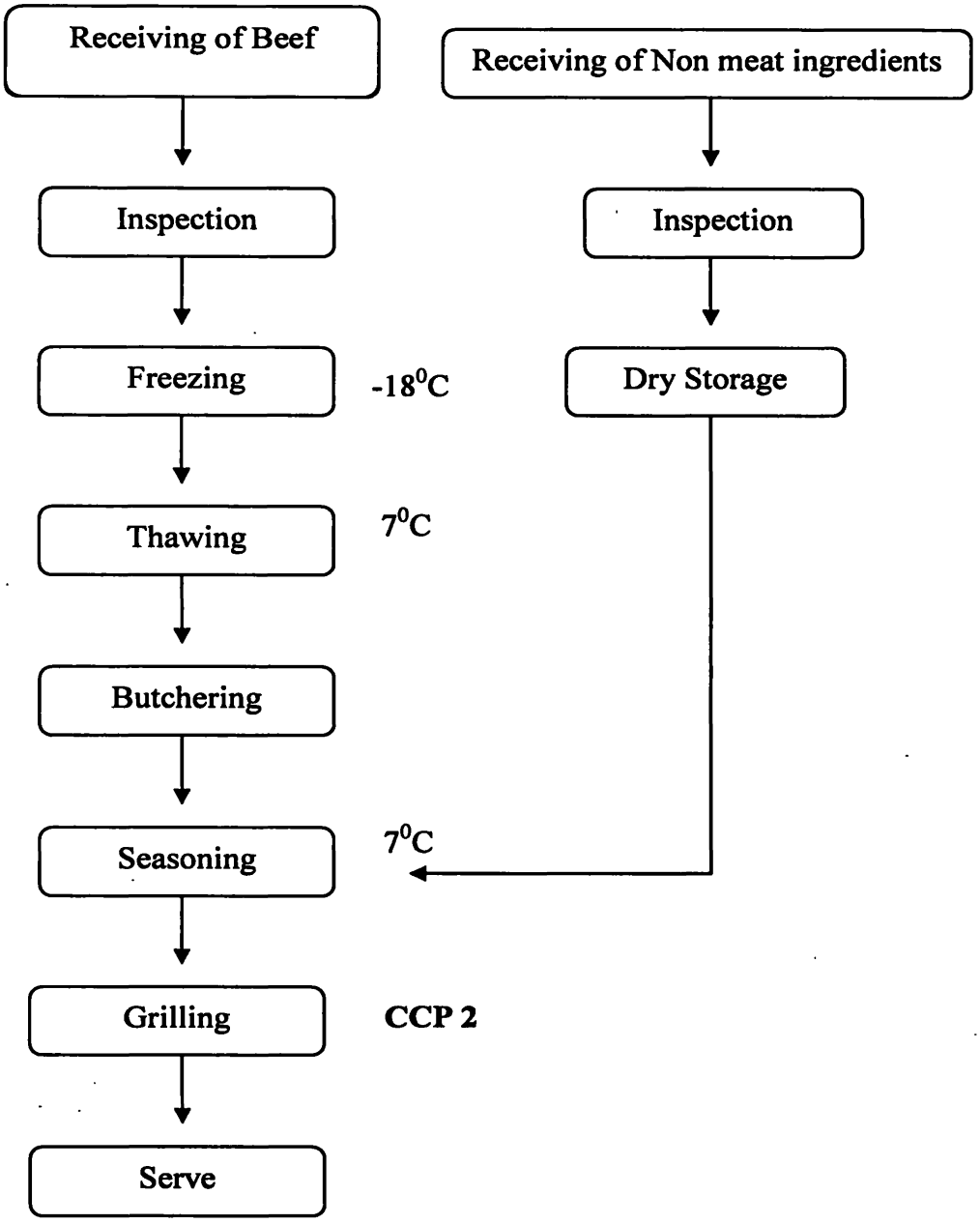
Intended consumer:

Customers at all ages

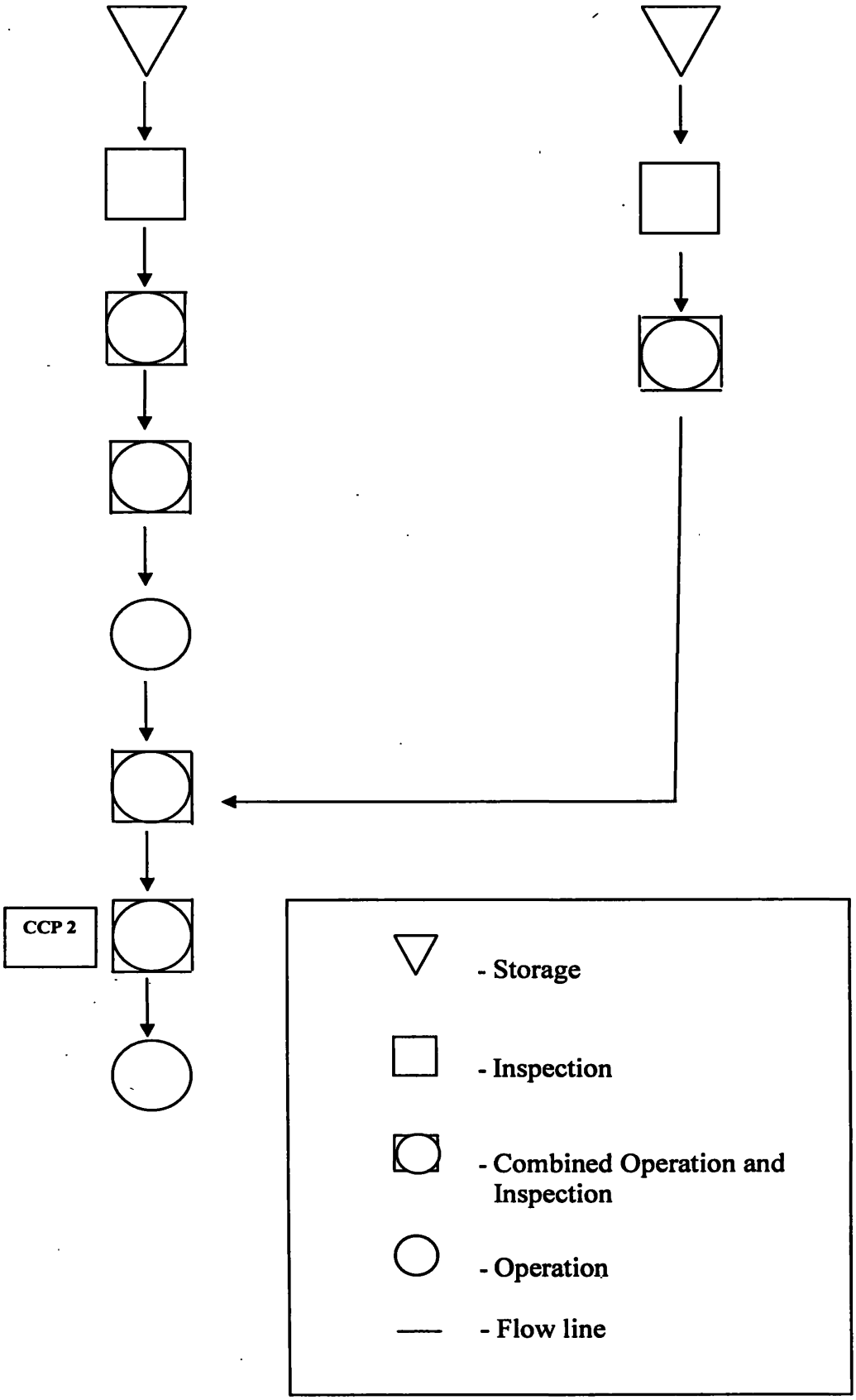
Intended use:

Ready to Eat

4.3.2.3 Developed Process flow diagram for Barbeque Beef



4.3.2.4 Flow chart in standard icons for Barbeque Beef



4.3.3 Barbeque Medium cooked beef

4.3.3.1 Product Description and Intended use

Product Name: Barbeque Medium cooked beef (Rare)

Raw materials:

Beef fillets	Onion
Pepper	Garlic
Mustard cream	Herbs
Olive oil	Salt

Chemical characteristics:

NaCl content	- 2.6% by mass (max.)
Fat content	- 15% by mass (max)
P^H	- 5.6 - 6.2
Moisture content	- 47.4 – 47.8

Microbial specifications:

TPC per g (48 hours at 37^0C)	- 10^3
Total coliform count per g	- 10
E coli count per g	- Nil

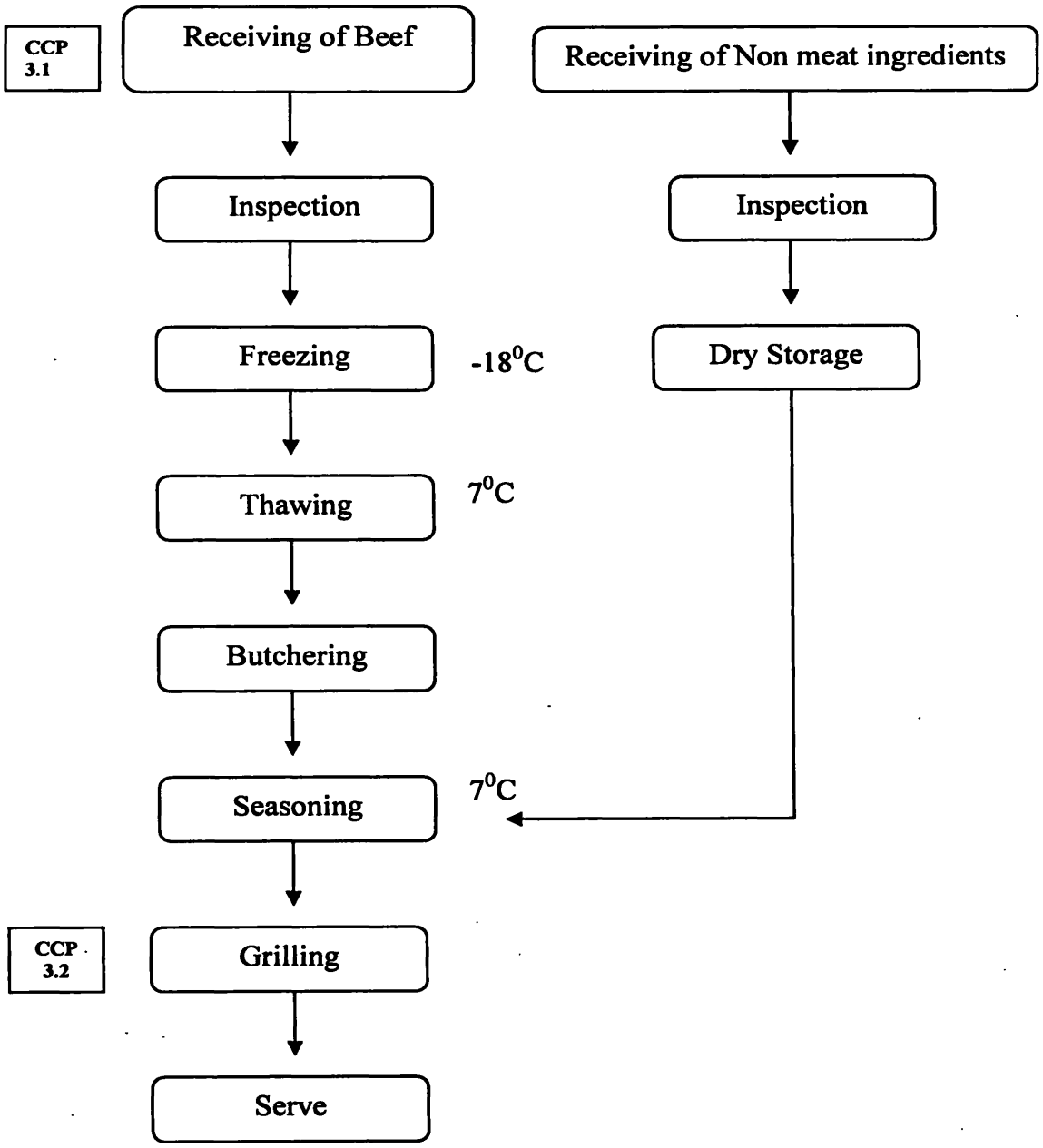
Intended consumer:

Customers at all ages

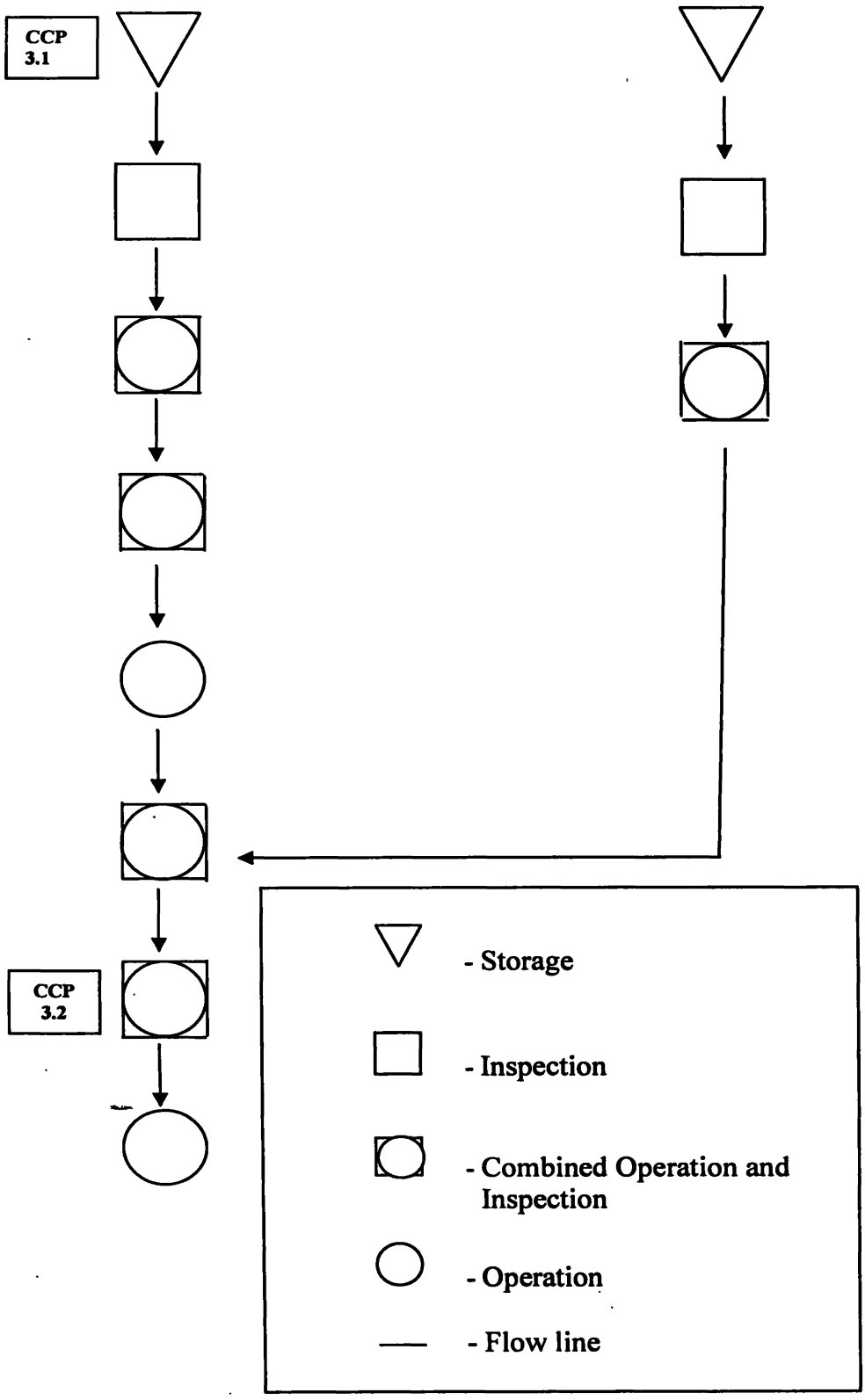
Intended use:

Ready to Eat

4.3.3.2 Flow chart in standard icons for Medium cooked Barbeque Beef



4.3.3.3 Flow chart in standard icons for Medium cooked Barbeque Beef



4.3.4 Barbeque Pork

4.3.4.2 Product Description and Intended use

Product Name: Barbeque Medium cooked beef (Rare)

Raw materials:

Pork Loin	Onion
Pepper	Garlic
Mustard cream	Herbs
Olive oil	Salt

Chemical characteristics:

NaCl content	- 2.6% by mass (max.)
Fat content	- 15% by mass (max)
P^H	- 5.7 - 6.2
Moisture content	- 42.4% by mass (max)

Microbial specifications:

TPC per g (48 hours at 37^0C)	- 10^3
Total coliform count per g	- 10
E coli count per g	- Nil

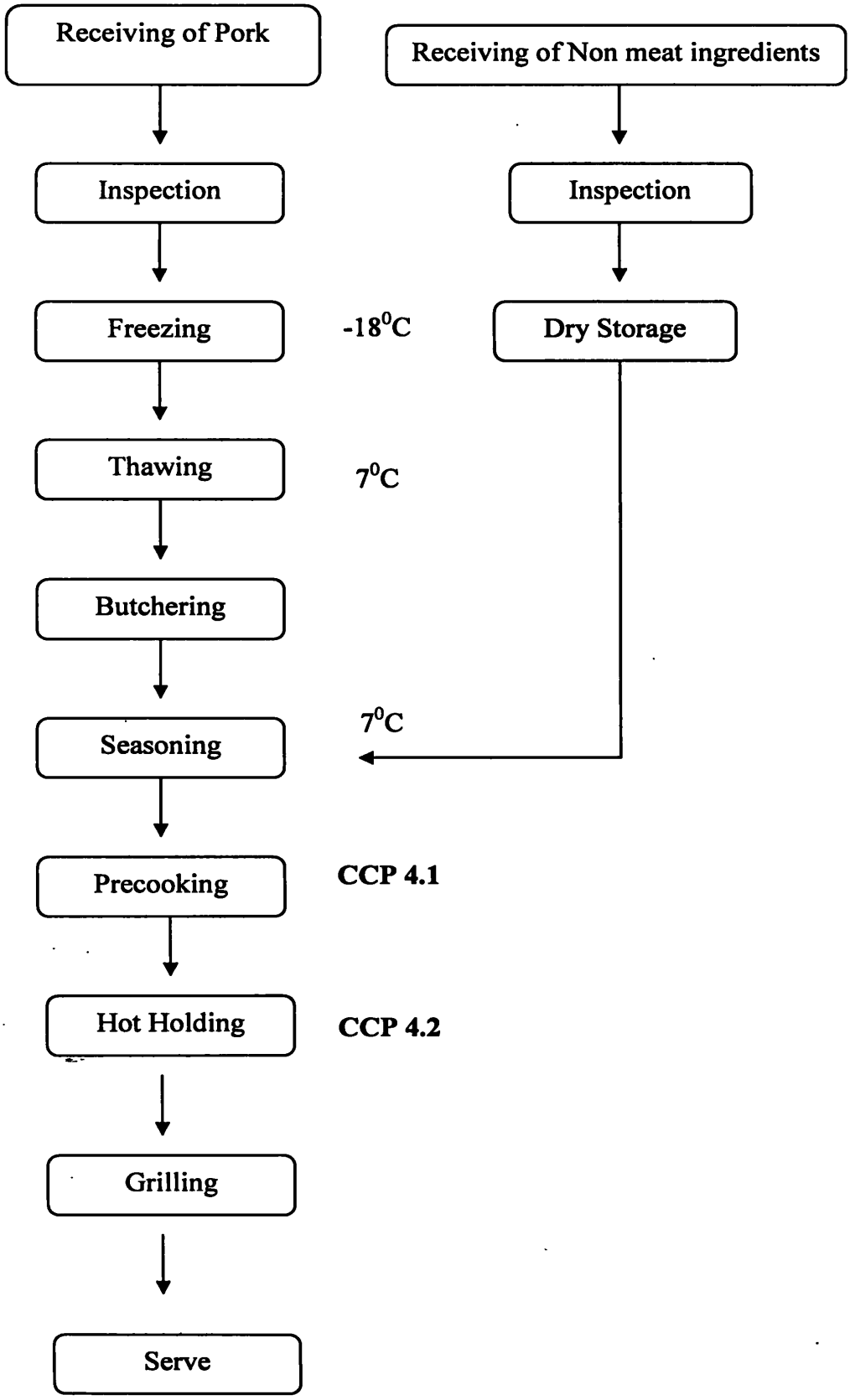
Intended consumer:

Customers at all ages

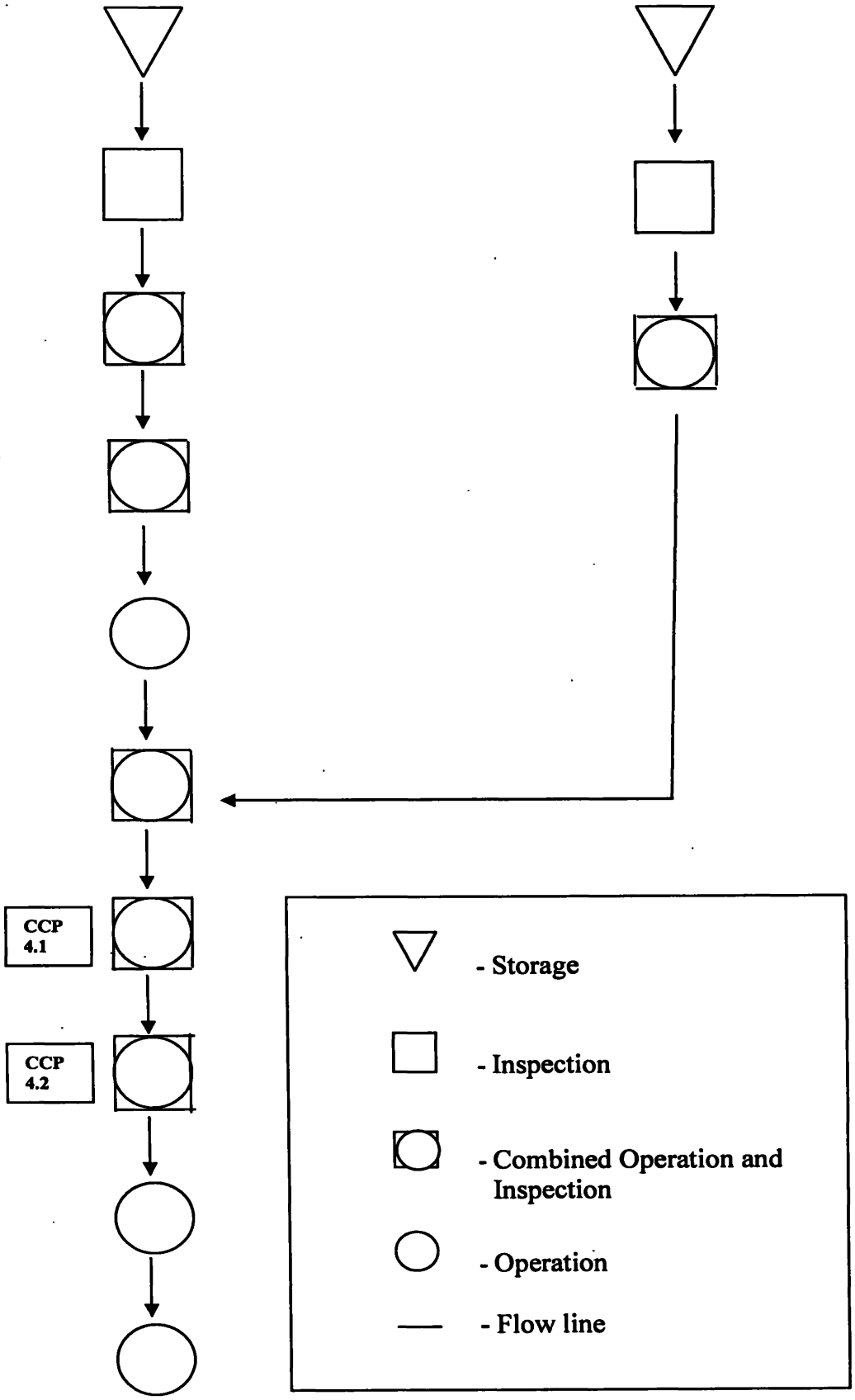
Intended use:

Ready to Eat

4.3.4.3 Flow chart in standard icons for Barbeque Pork



4.3.4.4 Flow chart in standard icons for Barbeque Pork



4.4 Evaluation of Prerequisite programme

4.4.1 Evaluation of GMP and SOP manual

HACCP is not a stand-alone program, but is part of a larger control system. The evaluation of prerequisite programme was used as the universal procedures to control the conditions of the hotel environment. This was identified to significantly contribute to the overall safety of the barbequed products. These were represented by the sum of programs, practices and procedures that must be applied to produce and distribute safe products in a clean, sanitary environment. They were different from CCPs in that they were basic sanitation programs and standard operation procedures that reduce the potential occurrence of a barbequed meat product safety hazards. But both CCPs in the HACCP Plan and prerequisite programmes were simultaneously used to control a food safety hazard.

An audit review was launched to evaluate and verify that a program was implemented for the company with that indicating how the company monitored and controlled each of the prerequisite programmes. Prerequisite programmes were established and managed separately from the HACCP Plan.

4.4.2 Development of Suppler Quality Assurance documentation

The control of a hazard of this kind involves actions that could be carried out by the supplier and the control measure was based upon a supplier guarantee to this effect implemented as part of the HACCP plan developed.

4.1.7 Implementation of HACCP principles

4.1.7.1 Conduct Hazard Analysis

Hazard analysis was focused on the development of a list of potential hazards associated with each process step under direct control of the food operation. The knowledge of any adverse health-related events historically associated with the product was a value in this exercise. The hazard analysis was included with food safety hazards that could occur before, during, and after entry into the establishment. The hazard analysis was not conducted until the prerequisite programs had been developed, implemented and

documented. This Hazard and Controls guide was used to aid in constructing and evaluating those prerequisite programs to be considered in the hazard analysis.

Pesticides are applied widely to treat grass (e.g. for insect control), grains that feed meat animals, and could be present in small amounts as residues on these foods. Experience in Sri Lanka has demonstrated that domestically grown grass and grains have a high level of compliance with Sri Lankan pesticide tolerance regulations and that the occurrence of unlawful pesticide residues in food is likely to be infrequent and unlikely to have a severe public health impact. Based on current regulatory programs, pesticide residues could not present food hazard likely to occur in meat products and do not need to be addressed in the hazard analysis.

Animal drug residues were present at low levels in a very low percentage of raw meat in Sri Lanka. These residues were monitored under WHO/ FAO programme for both the traditional and the HACCP alternative systems.

Foreign material could include such things as metal, glass, or plastic fragments or any other material that might cause injury or present a choking hazard. Consideration of potential hazards associated with metal fragments could be a part of the hazard analysis.

Microbiological hazard was the most risky hazard type within all the biological hazards identified in the four barbequed meat products. Contamination of cleaning agents was the most risky chemical hazard, while contamination of metal was rated as the most risky physical hazard. Theses results were obtained according to Risk factor score matrix in Table2.3.

Table 3.1.1 Hazard Analysis for barbequed Chicken

Processing step	Potential hazard B: Biological C: Chemical P: Physical	Could potential hazard be Significant	Judgment for significance	Preventive measure(s)
Receiving of chicken	B: Microbiological – bacterial pathogens *Salmonella, E coli 0157:H7*	Yes	Raw chicken is a potential source of pathogens	Receive supplier certification Maintain appropriate product temperature
	C: Antibiotics and pesticide residues	No	Low risk/ Low incidence based on National residue monitoring programme	
	P: Foreign material	No	No reported incidences of these hazards have been made at this facility from 2005.06.01	Visual inspection
Receiving of non-meat ingredients	B: Microbiological – bacterial pathogens	Yes	Potential for growth of microbial pathogens	Product testing
	C: Pesticide residues	No	Low risk/ Low incidence based on National residue monitoring programme	Visual inspection
	P: Foreign material, Adulterants	Yes	No reported incidences of these hazards have been made at this facility from 2005.06.01	
Storage of chicken	B: Microbiological – bacterial pathogens *Salmonella, E coli 0157:H7*	Yes	Potential for growth of microbial pathogens	Monitor appropriate freezer temperature
	C: Not applicable	No		
	P: Foreign matter	Yes	Internal rusting of freezers were observed	Proper maintenance of Freezers
Storage of non-meat ingredients	B: Microbiological – bacterial pathogens	Yes	Potential for growth of microbial pathogens	Product testing Visual inspection
	C: Not applicable	No		
	P: Foreign material	Yes	Low risk/ Low incidence	Visual inspection

Processing step	Potential hazard B: Biological C: Chemical P: Physical	Could potential hazard be Significant	Judgment for significance	Preventive measure(s)
Thawing	B: Microbiological – bacterial pathogens due excessive thawing period and cross contamination	Yes	Excessive thawing may allow growth of bacterial pathogens	Monitor adequate thawing time and temperature
	C: Cleaning agents, sanitizers	No	Low risk/ Low incidence	Water testing
	P: Non identified in this step	No		
Butchering	B: Microbiological – bacterial pathogens	Yes	Potential for growth of microbial pathogens	Immediate butchering after thawing
	C: Non identified in step	No		
	P: Foreign material	Yes	Low risk/ Low incidence	Visual inspection
Seasoning	B: Microbiological – bacterial pathogens	Yes	Potential for growth of microbial pathogens	Monitor adequate seasoning time and temperature
	C: Not applicable	No		
	P: Foreign matter	Yes	Internal rusting of fridges were observed	Proper maintenance of Fridges
Pre cooking	B: Microbiological – bacterial pathogens *Salmonella* spp.	Yes	Insufficient microbial destruction may occur due to inadequate cooking	Proper time/temperature relationship during cooking will reduce potential pathogen survival.
	C: Not applicable	No		

Processing step	Potential hazard B: Biological C: Chemical P: Physical	Could potential hazard be Significant	Judgment for significance	Preventive measure(s)
Pre cooking	P: Foreign matter	No	Low risk/ Low incidence	Visual Inspection
Hot holding	B: Microbiological – *L. monocytogenes*	Yes	Microbial growth may occur due to inadequate holding temperature and cross contaminations	Storage in air tight containers Maintain adequate temperature
	C: Not applicable	No		
	P: Foreign matter	No	Low risk/ Low incidence	Storage in air tight containers
Grilling	B: Microbiological – bacterial pathogens	Yes	Insufficient microbial destruction may occur due to inadequate cooking	Adequate grilling of chicken
	C: Not applicable	No		
	P: Foreign matter	No	Low risk/ Low incidence	Visual inspection
Serve	B: Not applicable	No	Immediate serve after grilling	
	C: Not applicable	No	Immediate serve after grilling	
	P: Not applicable	No	Immediate serve after grilling	

Table 3.1.2 Hazard Analysis for barbequed beef

Processing step	Potential hazard B: Biological C: Chemical P: Physical	Could potential hazard be Significant	Judgment for significance	Preventive measure(s)
Receiving of beef fillets	B:Microbiological – bacterial pathogens *C.jejuni*	Yes	Raw beef is a potential source of pathogens	Receive supplier certification Maintain appropriate product temperature
	C: Antibiotics and pesticide residues	No	Low risk/ Low incidence based on National residue monitoring programme	
	P: Foreign material	No	No reported incidences of these hazards have been made at this facility from 2005.06.01	Visual inspection
Receiving of non meat ingredients	B:Microbiological – bacterial pathogens	Yes	Potential for growth of microbial pathogens	Product testing
	C: Pesticide residues	No	Low risk/ Low incidence based on National residue monitoring programme	Visual inspection
	P: Foreign material, Adulterants	Yes	No reported incidences of these hazards have been made at this facility from 2005.06.01	Visual inspection
Storage of beef	B:Microbiological – bacterial pathogens	Yes	Potential for growth of microbial pathogens	Monitor appropriate freezer temperature
	C: Not applicable	No		
	P: Foreign matter	Yes	Internal rusting of freezers were observed	Proper maintenance of Freezers

Processing step	Potential hazard B: Biological C: Chemical P: Physical	Could potential hazard be Significant	Judgment for significance	Preventive measure(s)
Storage of non meat ingredients	B:Microbiological – bacterial pathogens	Yes	Potential for growth of microbial pathogens	Product testing, Visual inspection
	C: Not applicable	No		
	P: Foreign material	Yes	Low risk/ Low incidence	Visual inspection
Thawing	B:Microbiological – bacterial pathogens due to excessive thawing period and cross contamination	Yes	Excessive thawing may allow growth of bacterial pathogens	Monitor adequate thawing time and temperature
	C: Cleaning agents, sanitizers	No	Low risk/ Low incidence	Water testing
	P: Non identified in this step	No		
Butchering	B:Microbiological – bacterial pathogens	Yes	Potential for growth of microbial pathogens	Immediate butchering after thawing
	C: Non identified in this step	No		
	P: Foreign material	Yes	Low risk/ Low incidence	Visual inspection

Processing step	Potential hazard B: Biological C: Chemical P: Physical	Could potential hazard be Significant	Judgment for significance	Preventive measure(s)
Seasoning	B: Microbiological – bacterial pathogens	Yes	Potential for growth of microbial pathogens	Monitor adequate seasoning time and temperature
	C: Not applicable	No		
	P: Foreign matter	Yes	Internal rusting of fridges were observed	Proper maintenance of Fridges
Grilling	B: Microbiological – bacterial pathogens	Yes	Insufficient microbial destruction may occur due to inadequate cooking	Adequate grilling of chicken
	C: Not applicable	No		
	P: Foreign matter	No	Low risk/ Low incidence	Visual inspection
Serve	B: Not applicable	No	Immediate serve after grilling	B: Not applicable
	C: Not applicable	No	Immediate serve after grilling	C: Not applicable
	P: Not applicable	No	Immediate serve after grilling	P: Not applicable

Table 3.1.3 Hazard Analysis for barbequed Medium cooked Barbeque beef

Processing step	Potential hazard B: Biological C: Chemical P: Physical	Could potential hazard be Significant	Judgment for significance	Preventive measure(s)
Receiving of beef fillets	B:Microbiological – bacterial pathogens	Yes	Raw beef is a potential source of pathogens	Receive supplier certification Maintain appropriate product temperature
	C: Antibiotics and pesticide residues	No	Low risk/ Low incidence based on National residue monitoring programme	
	P: Foreign material	No	No reported incidences of these hazards have been made at this facility from 2005.06.01	Visual inspection
Receiving of non meat ingredients	B:Microbiological – bacterial pathogens	Yes	Potential for growth of microbial pathogens	Product testing
	C: Pesticide residues	No	Low risk/ Low incidence based on National residue monitoring programme	Visual inspection
	P: Foreign material, Adulterants	Yes	No reported incidences of these hazards have been made at this facility from 2005.06.01	
Storage of beef	B:Microbiological – bacterial pathogens	Yes	Potential for growth of microbial pathogens	Monitor appropriate freezer temperature
	C: Not applicable	No		
	P: Foreign matter	Yes	Internal rusting of freezers were observed	Proper maintenance of Freezers

Processing step	Potential hazard B: Biological C: Chemical P: Physical	Could potential hazard be Significant	Judgment for significance	Preventive measure(s)
Storage of non meat ingredients	B:Microbiological – bacterial pathogens	Yes	Potential for growth of microbial pathogens	Monitor appropriate freezer temperature
	C: Not applicable	No		
	P: Foreign material	Yes	Low risk/ Low incidence	Visual inspection
Thawing	B:Microbiological – bacterial pathogens due excessive thawing period and cross contamination	Yes	Excessive thawing may allow growth of bacterial pathogens	Monitor adequate thawing time and temperature
	C: Cleaning agents, sanitizers	No	Low risk/ Low incidence	Water testing
	P: Non identified in this step	No		
Butchering	B:Microbiological – bacterial pathogens	Yes	Potential for growth of microbial pathogens	Immediate butchering after thawing
	C: Non identified in this step	No		
	P: Foreign material	Yes	Low risk/ Low incidence	Visual inspection

Processing step	Potential hazard B: Biological C: Chemical P: Physical	Could potential hazard be Significant	Judgment for significance	Preventive measure(s)
Seasoning	B:Microbiological – bacterial pathogens	Yes	Potential for growth of microbial pathogens	Monitor adequate seasoning time and temperature
	C: Not applicable	No		
	P: Foreign matter	Yes	Internal rusting of fridges were observed	Proper maintenance of Fridges
Grilling	B:Microbiological – bacterial pathogens	Yes	Insufficient microbial destruction may occur due to inadequate cooking	Adequate grilling of chicken
	C: Not applicable	No		
	P: Foreign matter	No	Low risk/ Low incidence	Visual inspection
Serve	B: Not applicable	No	Immediate serve after grilling	B: Not applicable
	C: Not applicable	No	Immediate serve after grilling	C: Not applicable
	P: Not applicable	No	Immediate serve after grilling	P: Not applicable

Table 3.1.4 Hazard Analysis for Barbeque Pork

Processing step	Potential hazard B: Biological C: Chemical P: Physical	Could potential hazard be Significant	Judgment for significance	Preventive measure(s)
Receiving of pork meat	B:Microbiological – bacterial pathogens	Yes	Raw beef is a potential source of pathogens	Receive supplier certification Maintain appropriate product temperature
	C: Antibiotics and pesticide residues	No	Low risk/ Low incidence based on National residue monitoring programme	
	P: Foreign material	No	No reported incidences of these hazards have been made at this facility from 2005.06.01	Visual inspection
Receiving of non meat ingredients	B:Microbiological – bacterial pathogens	Yes	Potential for growth of microbial pathogens	Product testing
	C: Pesticide residues	No	Low risk/ Low incidence based on National residue monitoring programme	Visual inspection
	P: Foreign material, Adulterants	Yes	No reported incidences of these hazards have been made at this facility from 2005.06.01	
Storage of pork	B:Microbiological – bacterial pathogens	Yes	Potential for growth of microbial pathogens	Monitor appropriate freezer temperature
	C: Not applicable	No		
	P: Foreign matter	Yes	Internal rusting of freezers were observed	Proper maintenance of Freezers

Processing step	Potential hazard B: Biological C: Chemical P: Physical	Could potential hazard be Significant	Judgment for significance	Preventive measure(s)
Storage of non meat ingredients	B:Microbiological – bacterial pathogens	Yes	Potential for growth of microbial pathogens	Monitor appropriate freezer temperature
	C: Not applicable	No		
	P: Foreign material	Yes	Low risk/ Low incidence	Visual inspection
Thawing	B:Microbiological – bacterial pathogens due excessive thawing period and cross contamination	Yes	Excessive thawing may allow growth of bacterial pathogens	Monitor adequate thawing time and temperature
	C: Cleaning agents, sanitizers	No	Low risk/ Low incidence	Water testing
	P: Non identified in this step	No		
Butchering	B:Microbiological – bacterial pathogens	Yes	Potential for growth of microbial pathogens	Immediate butchering after thawing
	C: Non identified in this step	No		
	P: Foreign material	Yes	Low risk/ Low incidence	Visual inspection

Processing step	Potential hazard B: Biological C: Chemical P: Physical	Could potential hazard be Significant	Judgment for significance	Preventive measure(s)
Seasoning	B:Microbiological – bacterial pathogens	Yes	Potential for growth of microbial pathogens	Monitor adequate seasoning time and temperature
	C: Not applicable	No		
	P: Foreign matter	Yes	Internal rusting of fridges were observed	Proper maintenance of Fridges
Pre cooking	B:Microbiological – bacterial pathogens *Salmonella* spp.	Yes	Insufficient microbial destruction may occur due to inadequate cooking	Proper time/temperature relationship during cooking will reduce potential pathogen survival.
	C: Not applicable	No		
	P: Foreign matter	No	Low risk/ Low incidence	Visual Inspection
Grilling	B: Microbiological – bacterial pathogens	Yes	Insufficient microbial destruction may occur due to inadequate cooking	Adequate grilling of chicken
	C: Not applicable	No		
	P: Foreign matter	No	Low risk/ Low incidence	Visual inspection
Serve	B: Not applicable	No	Immediate serve after grilling	B: Not applicable
	C: Not applicable	No	Immediate serve after grilling	C: Not applicable
	P: Not applicable	No	Immediate serve after grilling	P: Not applicable

4.1.7.2 Determination of Critical Control Points

The critical control points were those specific stages in various food processing operations which needed careful control and the absence of efficient control cause the end product to be either unacceptable or their consumption was associated with high risk for customers.

Table 3.2.1, 3.2.2, 3.2.3, and 3.2.4 list the critical control points in various processing operations of barbequed meat products in Mount Lavinia hotel.

Table 3.2.1 Barbeque Chicken – Process flow decision matrix

Process step	Hazard	Q 1	Q 2	Q 2a	Q 3	Q 4	Q 5	CCP
Receiving of chicken	B:	Y	Y	_	N	N	_	No
	C:	Y	N	N	_	_	_	No
	P:	Y	Y	_	N	N	_	No
Receiving of non-meat ingredients	B:	Y	Y	_	N	N	_	No
	C:	Y	N	N	_	_	_	No
	P:	Y	Y	_	N	N	_	No
Storage of chicken	B:	Y	Y	_	N	N	_	No
	C:	N	_	_	_	_	_	No
	P:	Y	Y	_	N	N	_	No
Storage of non- meat ingredients	B:	Y	Y	_	N	N	_	No
	C:	N	_	_	_	_	_	No
	P:	Y	Y	_	N	N	_	No
Thawing	B:	Y	Y	_	N	Y	Y	No
	C:	Y	Y	_	N	N	_	No
	P:	N	_	_	_	_	_	No
Butchering	B:	Y	Y	_	N	Y	Y	No
	C:	Y	Y	_	N	N	_	No
	P:	N	_	_	_	_	_	No
Seasoning	B:	Y	Y	_	N	Y	Y	No
	C:	N	_	_	_	_	_	No
	P:	Y	Y	_	N	N	_	No
Pre cooking	B:	Y	Y	_	Y	_	_	Yes
	C:	N	_	_	_	_	_	No
	P:	Y	Y	_	N	N	_	No
Hot holding	B:	Y	Y	Y	_	_	_	Yes
	C:	N	_	_	_	_	_	No
	P:	N	_	_	_	_	_	No
Grilling	B:	Y	Y	_	N	Y	Y	No
	C:	Y	Y	_	N	N	_	No
	P:	Y	Y	_	N	Y	Y	No
Serving	B:	Y	Y	_	N	N	_	No
	C:	N	_	_	_	_	_	No
	P:	Y	Y	_	N	Y	Y	No

Table 3.2.2 Barbeque Beef – Process flow decision matrix

Process step	Hazard	Q 1	Q 2	Q 2a	Q 3	Q 4	Q 5	CCP
Receiving of Beef	B:	Y	Y	_	N	N	_	No
	C:	Y	N	N	_	_	_	No
	P:	Y	Y	_	N	N	_	No
Receiving of non- meat ingredients	B:	Y	Y	_	N	N	_	No
	C:	Y	N	N	_	_	_	No
	P:	Y	Y	_	N	N	_	No
Storage of Beef	B:	Y	Y	_	N	N	_	No
	C:	N	_	_	_	_	_	No
	P:	Y	Y	_	N	N	_	No
Storage of non- meat ingredients	B:	Y	Y	_	N	N	_	No
	C:	N	_	_	_	_	_	No
	P:	Y	Y	_	N	N	_	No
Thawing	B:	Y	Y	_	N	Y	Y	No
	C:	Y	Y	_	N	N	_	No
	P:	N	_	_	_	_	_	No
Butchering	B:	Y	Y	_	N	Y	Y	No
	C:	Y	Y	_	N	N	_	No
	P:	N	_	_	_	_	_	No
Seasoning	B:	Y	Y	_	N	Y	Y	No
	C:	N	_	_	_	_	_	No
	P:	Y	Y	_	N	N	_	No
Grilling	B:	Y	Y	_	Y	_	_	Yes
	C:	N	_	_	_	_	_	No
	P:	Y	Y	_	N	N	_	No
Serving	B:	N	_	_	_	_	_	No
	C:	N	_	_	_	_	_	No
	P:	N	_	_	_	_	_	No

Table 3.2.3 Medium cooked Barbeque Beef – Process flow decision matrix

Process step	Hazard	Q 1	Q 2	Q 2a	Q 3	Q 4	Q 5	CCP
Receiving of Beef	B:	Y	Y	_	N	N	_	No
	C:	Y	N	N	_	_	_	No
	P:	Y	Y	_	N	N	_	No
Receiving of non- meat ingredients	B:	Y	Y	_	N	N	_	No
	C:	Y	N	N	_	_	_	No
	P:	Y	Y	_	N	N	_	No
Storage of Beef	B:	Y	Y	_	N	N	_	No
	C:	N	_	_	_	_	_	No
	P:	Y	Y	_	N	N	_	No
Storage of non- meat ingredients	B:	Y	Y	_	N	N	_	No
	C:	N	_	_	_	_	_	No
	P:	Y	Y	_	N	N	_	No
Thawing	B:	Y	Y	_	N	Y	Y	No
	C:	Y	Y	_	N	N	_	No
	P:	N	_	_	_	_	_	No
Butchering	B:	Y	Y	_	N	Y	Y	No
	C:	Y	Y	_	N	N	_	No
	P:	N	_	_	_	_	_	No
Seasoning	B:	Y	Y	_	N	Y	Y	No
	C:	N	_	_	_	_	_	No
	P:	Y	Y	_	N	N	_	No
Grilling	B:	Y	Y	_	Y	_	_	Yes
	C:	N	_	_	_	_	_	No
	P:	Y	Y	_	N	N	_	No
Serving	B:	N	_	_	_	_	_	No
	C:	N	_	_	_	_	_	No
	P:	N	_	_	_	_	_	No

Table 3.2.4 Barbeque Pork – Process flow decision matrix

Process step	Hazard	Q 1	Q 2	Q 2a	Q 3	Q 4	Q 5	CCP
Receiving of Pork	B:	Y	Y	_	N	N	_	No
	C:	Y	N	N	_	_	_	No
	P:	Y	Y	_	N	N	_	No
Receiving of non-meat ingredients	B:	Y	Y	_	N	N	_	No
	C:	Y	N	N	_	_	_	No
	P:	Y	Y	_	N	N	_	No
Storage of Pork	B:	Y	Y	_	N	N	_	No
	C:	N	_	_	_	_	_	No
	P:	Y	Y	_	N	N	_	No
Storage of non- meat ingredients	B:	Y	Y	_	N	N	_	No
	C:	N	_	_	_	_	_	No
	P:	Y	Y	_	N	N	_	No
Thawing	B:	Y	Y	_	N	Y	Y	No
	C:	Y	Y	_	N	N	_	No
	P:	N	_	_	_	_	_	No
Butchering	B:	Y	Y	_	N	Y	Y	No
	C:	Y	Y	_	N	N	_	No
	P:	N	_	_	_	_	_	No
Seasoning	B:	Y	Y	_	N	Y	Y	No
	C:	N	_	_	_	_	_	No
	P:	Y	Y	_	N	N	_	No
Pre cooking	B:	Y	Y	_	Y	_	_	Yes
	C:	N	_	_	_	_	_	No
	P:	Y	Y	_	N	N	_	No
Hot holding	B:	Y	Y	Y	_	_	_	Yes
	C:	N	_	_	_	_	_	No
	P:	N	_	_	_	_	_	No
Grilling	B:	Y	Y	_	N	Y	Y	No
	C:	Y	Y	_	N	N	_	No
	P:	Y	Y	_	N	Y	Y	No
Serving	B:	Y	Y	_	N	N	_	No
	C:	N	_	_	_	_	_	No
	P:	Y	Y	_	N	Y	Y	No

4.1.7.3 Establish Critical limits

Once CCPs were identified Critical Limits that would reduce or eliminate potential hazards were determined. Information gathered from test results and sources such as scientific publications, regulatory guidelines, experts, or experimental studies were used to establish critical limits. If the information needed to define controls was not available, a conservative value was selected. The rationale and reference material was used to establish controls.

If monitoring shows a trend towards lack of control at a CCP, the relevant personnel should take action before the control limit is exceeded. The point where personnel take such an action is called the operating limit. The established Operating limits are more stringent and thus established at a level that could be reached before the control limit is violated.

Table 3.3.1 Established Critical limits for Barbeque meat products

Product	CCP No.	Critical Limit	Operating Limit
Barbeque Chicken	CCP 1.1 Precooking	i)Oven Temperature not less than 250^{0}C ii)Precooking time not less than 45 min	i)Oven Temperature not less than 260^{0}C ii)Precooking time not less than 45 min
	CCP 1.2 Hot holding	i)Hot cupboard Temperature not less than 62^{0}C ii)Holding time not more than 2 hours	i)Hot cupboard Temperature not less than 65^{0}C ii)Holding time not more than 2 hours
Barbeque Beef	CCP 2 Grilling	i)Max. weight per piece – 80g ii)Max thickness – 0.5cm iii)Product Temperature not less than 72^{0}C for 90s iv)Grilling time not less than 5 min	i)Max. weight per piece – 80g ii)Max thickness – 0.5cm iii)Product Temperature not less than 72^{0}C for 120s iv)Grilling time not less than 6 min

Product	CCP No.	Critical Limit	Operating Limit
Medium Cooked Barbeque Beef	CCP 3 Grilling	i)Max. weight per piece – 80g ii)Max. thickness – 0.5cm iii)Product Temperature not less than 63^{0}C for 90s iv)Grilling time not less than 2 ½ min	i)Max. weight per piece – 80g ii)Max. thickness – 0.5cm iii)Product Temperature not less than 65^{0}C for 120s iv)Grilling time not less than 3 min
Barbeque Pork	CCP 4.1 Precooking	i)Oven Temperature not less than 250^{0}C ii)Precooking time not less than 45 min	i)Oven Temperature not less than 260^{0}C ii)Precooking time not less than 45 min
	CCP 4.2 Hot holding	i)Hot cupboard Temperature not less than 62^{0}C ii)Holding time not more than 2 hours	i)Hot cupboard Temperature not less than 65^{0}C ii)Holding time not more than 2 hours

Table 3.3.2 Validation of Critical limit

CCP No.	Justification	Validation
CCP 1.1 Precooking	Middle temperature does not reach 72^{0}C within 45 min if the oven temperature reach less than 250^{0}C	Test Results (Appendix ii)
CCP 1.2 Hot holding	Proliferation of microorganisms due to favourable temperature	Maintain temperature below 62^{0}C not more than 2 hours (Prince et al. 1993)
CCP 2 Grilling	Middle temperature does not reach 72^{0}C within 5 min if the weight per piece higher than 80g and thickness of the piece higher than 0.5cm	Test Results (Appendix ii)
CCP 3 Grilling	Middle temperature does not reach 63^{0}C within 2 ½ min if the weight per piece higher than 80g and thickness of the piece higher than 0.5cm	Test Results (Appendix ii)
CCP 4.1 Precooking	Middle temperature does not reach 72^{0}C within 45 min if the oven temperature reach less than 250^{0}C	Test Results (Appendix ii)
CCP 4.2 Hot holding	Proliferation of microorganisms due to favourable temperature	Maintain temperature below 62^{0}C not more than 2 hours (Prince et al., 1993)

4.1.7.4 Establishment of Monitoring systems

Monitoring is the process that personnel rely upon to maintain control at a CCP. The preventive measures discussed in hazard analysis and the control limits discussed in table 3.3.1 were intended to control the hazards at each CCP. Monitoring procedures were used to determine if the preventive measures had been enacted and the control limits were met. Accurate monitoring was indicated when there was a loss of control at a CCP and a deviation from a control limit.

Table 3.4.1 Monitoring control chart

CCP No.	What	How	Frequency	Who
CCP 1.1 Precooking	Oven Temperature	IR thermometer	Daily	Butchery Sous chef
CCP 1.2 Hot holding	Hot cupboard Temperature	Digital stem thermometer	2 times a day	Coffee shop Sous chef
CCP 2 Grilling	Product time - Temperature	Digital stem thermometer	Once every 2 hours	Coffee shop Sous chef
CCP 3 Grilling	Product time - Temperature	Digital stem thermometer	Once every 2 hours	Coffee shop Sous chef
CCP 4.1 Precooking	Oven Temperature	IR thermometer	Daily	Butchery Sous chef
CCP 4.2 Hot holding	Hot cupboard Temperature	Digital stem thermometer	2 times a day	Coffee shop Sous chef

To monitor CCP 1.1 and CCP 4.1, the butchery sous chef was observed for the digital display on the front of the oven to reach 260 ^{0}C within 45 minutes. At this point the employee was instructed to compare the IR thermometer temperature to the temperature indicated by the chart recorder on the side of the oven, and the date, time, temperature were recorded.

Monitoring procedures for CCP 2 and CCP 3 included checking final, internal product temperature in the geometric center of the barbeque meat, at the end of the cooking cycle, using digital stem thermometer. This time-temperature combination satisfies the Salmonella Lethality Performance Standards.

For CCP 1.2 and CCP 4.2, the designated employee was assigned to check the temperature of the hot cupboard at the beginning and end of hot holding, and both temperatures were recorded on log sheets. Monitoring procedures were rapid because they relate to on-line, "real-time" processes and there was not sufficient time for lengthy analytical testing.

4.1.7.5 Establish Corrective action procedure

The HACCP system for food safety management was designed to identify health hazards and to establish strategies to prevent, eliminate, or reduce their occurrence. However, ideal circumstances were not always prevailing and deviations from established processes could occur. An important purpose of corrective actions was to prevent foods which could be hazardous from reaching consumers.

Table 3.5.1 Corrective Actions

CCP No.	Corrective Action
CCP 1.1 Precooking	If the oven temperature is less than 260°C, the supervisor or person in charge will: 1. Determine the reason for not meeting the CL. 2. Subject the product to additional thermal processing until it exceeds the required critical limits. Prevent the potentially hazardous product from entering into serve. Take corrective actions to prevent re-occurrence of same root cause of deviation
CCP 1.2 Hot holding	1. Identify and eliminate cause of deviation. 2. Bring CCP under control after corrective action is taken. 3. Measures to prevent recurrence are established. 4. No product that is kept under lower than 65^0C or longer than 2 hours enters serve.
CCP 2 Grilling	If the grilling temperature is less than 72°C, the supervisor or person in charge will: 1. Determine the reason for not meeting the CL. 2. Subject the product to additional thermal processing until it exceeds the required critical limits. Prevent the potentially hazardous product from entering into serve. Take corrective actions to prevent re-occurrence of same root cause of deviation

CCP No.	Corrective Action
CCP 3 Grilling	If the grilling temperature is less than 63°C, the supervisor or person in charge will: 1. Determine the reason for not meeting the CL. 2. Subject the product to additional thermal processing until it exceeds the required critical limits. Prevent the potentially hazardous product from entering into serve. Take corrective actions to prevent re-occurrence of same root cause of deviation
CCP 4.1 Precooking	If the oven temperature is less than 260°C, the supervisor or person in charge will: 1. Determine the reason for not meeting the CL. 2. Subject the product to additional thermal processing until it exceeds the required critical limits. Prevent the potentially hazardous product from entering into serve. Take corrective actions to prevent re-occurrence of same root cause of deviation
CCP 4.2 Hot holding	1. Identify and eliminate cause of deviation. 2. Bring CCP under control after corrective action is taken. 3. Measures to prevent recurrence are established. 4. No product that is kept under lower than 65^0C or longer than 2 hours enters serve.

4.1.7.6 Establishment of Verification procedures and Record keeping

Verification activities developed for CCPs were essential to ensure control procedures used are properly functioning and that they were operated and calibrated within appropriate ranges for hazard control. Verification activities included calibration of monitoring devices or review of calibration records to assure the accuracy of measurements.

Verification also included targeted sampling, testing, and other periodic activities. These records were valuable management tools, providing documentation that CCPs are operated within established safety parameters and that deviations were handled appropriately. System verification should occur at a frequency that ensures the plan is

being routinely followed. This frequency depended on a number of conditions, such as the variability of the process and product.

Table 3.6.1 Verification and Record Keeping

Verification	Records
Visual observation of monitoring activity by Chef in charge of buffet. On days of barbeque production, designated chef will review records. Weekly calibration and/or verification of temperature monitoring device by HACCP coorinartor.	Temperature/Time Log Deviation/Corrective Action Log Temperature Monitoring Device Calibration and/or Verification Log

Another important aspect of verification was the initial validation of the HACCP plan to determine that the plan was scientifically and technically sound, that all hazards had been identified and that whether the HACCP plan was properly implemented these hazards could be effectively controlled. Information needed to validate the HACCP plan included expert advice, scientific studies, in-hotel observations, measurements, and evaluations. For example, validation of the grilling process for barbeque beef was included the scientific justification of the heating times and temperatures needed to obtain an appropriate destruction of pathogenic microorganisms (i.e., enteric pathogens) and studies to confirm that the conditions of cooking would deliver the required time and temperature to each barbeque beef.

Subsequent validations were performed and documented by a HACCP team. For example, validations were conducted when there was an unexplained system failure; a significant product, or process change occurred; or new hazards were recognized.

In addition, a periodic comprehensive verification of the HACCP system should be conducted by an unbiased, independent authority. Such authorities can be internal or external to the food operation. This should include a technical evaluation of the

hazard analysis and each element of the HACCP plan as well as on-site review of all flow diagrams and appropriate records from operation of the plan. A comprehensive verification is independent of other verification procedures and must be performed to ensure that the HACCP plan is resulting in the control of the hazards. If the results of the comprehensive verification identify deficiencies, the HACCP team modifies the HACCP plan as necessary. Verification activities could be carried out by individuals within a company, third party experts, and regulatory agencies.

Table 3.6.2 Verification Schedule

Activity	Frequency	Responsibility	Reviewer
Verification Activities scheduling	Yearly or Upon HACCP system change	HACCP Coordinator	FS consultant
Initial Validation of HACCP Plan	Prior to and during initial implementation of plan	Independent Expert(s)	HACCP Team
Subsequent validation of HACCP plan	When Critical Limits changed, Significant changes in Process, Equipment changed, After system failure, etc.	Independent Expert(s)	HACCP Team
Verification of CCP Monitoring as Described in the Plan	According to HACCP Plan (e.g., once per shift)	HACCP Coordinator	FS consultant
Review of Monitoring, Corrective action Records to show compliance with the plan	Monthly	HACCP Coordinator	HACCP Team
Comprehensive HACCP System Verification	Yearly	Independent Expert(s)	FS consultant
Verification Activities Scheduling	Yearly or Upon HACCP System Change	HACCP Coordinator	FS consultant

Chapter 05

CONCLUSIONS AND RECOMMENDATION

The evaluation performed for the prerequisite programme serves as a universal procedure to control the conditions of the hotel environment with particular reference to processing and handling of catered food items. Hence it could be considered as the major contributor to the overall safety of the barbequed products as well. These were actually represented by the sum of programs, practices and procedures that must be applied to produce and distribute safe products in a clean, sanitary environment.

Microbiological hazard was the most risky hazard within all the biological hazards identified in four barbequed meat products. Contamination of cleaning agents was the most risky chemical hazard, while contamination of metal was rated as the most risky physical hazard.

The study enabled the identification of CCPs associated with the products. Thus, CCPs for barbequed chicken and barbequed pork were Precooking and hot holding. While the CCP for barbequed beef and medium cooked barbequed pork was grilling. Critical limits for all the CCPs were established, monitored, verified and documented thereby fulfilling the necessary criteria for the HACCP plan.

Evaluated GMP and PRP manual should be maintained continuously. Supplier of beef should be rigorously warned to maintain supplier quality assurance scheme. A comprehensive HACCP system verification should be carried out by independent expert in annual basis. Verification activities should also be scheduled upon HACCP system changes as they arise.

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APPENDIX I
Time – Temperature log sheets

Receiving Temperature Log Sheet

Date	Temperature
16 May 2007	-6°C
18 May 2007	-5°C
22 May 2007	-6°C
25 May 2007	-3°C
27 May 2007	-6°C
28 May 2007	-3°C
30 May 2007	-5°C
2 June 2007	-4°C
4 June 2007	-3°C
6 June 2007	-4°C
10 June 2007	-4°C
16 June 2007	-4°C
23 June 2007	-5°C
30 June 2007	-4°C
3 July 2007	-5°C
5 July 2007	-4°C
12 July 2007	-5°C
15 July 2007	-4°C
18 July 2007	-5°C

Freezer Temperature Log sheet

Date	Temperature
16 May 2007	-15°C
18 May 2007	-13°C
22 May 2007	-15°C
25 May 2007	-17°C
27 May 2007	-18°C
28 May 2007	-16°C
30 May 2007	-16°C
2 June 2007	-17°C
4 June 2007	-17°C
6 June 2007	-15°C
10 June 2007	-14°C
16 June 2007	-14°C
23 June 2007	-14°C
30 June 2007	-15°C
3 July 2007	-15°C
5 July 2007	-14°C
12 July 2007	-18°C
15 July 2007	-16°C
18 July 2007	-15°C

Chiller Temperature Log Sheet

Date	Temperature
16 May 2007	-6°C
18 May 2007	-5°C
22 May 2007	-6°C
25 May 2007	-3°C
27 May 2007	-6°C
28 May 2007	-3°C
30 May 2007	-5°C
2 June 2007	-4°C
4 June 2007	-3°C
6 June 2007	-4°C
10 June 2007	-4°C
16 June 2007	-4°C
23 June 2007	-5°C
30 June 2007	-4°C
3 July 2007	-5°C
5 July 2007	-4°C
12 July 2007	-5°C
15 July 2007	-4°C
18 July 2007	-5°C

Precooking Log Sheet (BBQ Chicken)

Date	Temperature	Time(min)
18 May 2007	245°C	45
22 May 2007	252°C	45
26 May 2007	248°C	50
30 May 2007	253°C	50
1 June 2007	251°C	50
5 June 2007	260°C	50
7 June 2007	265°C	45
12 June 2007	268°C	45
15 June 2007	255°C	45
23 June 2007	252°C	45
24 June 2007	252°C	52
28 June 2007	256°C	55
30 June 2007	262°C	45
1 July 2007	261°C	45
3 July 2007	262°C	50
6 July 2007	261°C	45
12 July 2007	262°C	45
15 July 2007	261°C	45
16 July 2007	261°C	45

Hot Holding Log sheet (BBQ Chicken)

Date	Temperature	Time(hrs)
18 May 2007	65°C	1.5
22 May 2007	65°C	1.5
26 May 2007	66°C	1.4
30 May 2007	66°C	1.45
1 June 2007	66°C	1.4
5 June 2007	66°C	1.4
7 June 2007	65°C	1.45
12 June 2007	66°C	1.5
15 June 2007	65°C	1.3
23 June 2007	66°C	1.5
24 June 2007	65°C	1.6
28 June 2007	66°C	1.4
30 June 2007	65°C	1.5
1 July 2007	66°C	1.3
3 July 2007	67°C	1.3
6 July 2007	66°C	1.4
12 July 2007	65°C	1.5
15 July 2007	65°C	1.6
16 July 2007	66°C	1.4

Grilling (BBQ Beef)

Date	Temperature	Time(hr)
18 May 2007	72°C	6.2
22 May 2007	72°C	6.2
26 May 2007	73°C	6.1
30 May 2007	72°C	6.5
1 June 2007	72°C	6.3
5 June 2007	74°C	6.3
7 June 2007	72°C	6.5
12 June 2007	72°C	6.6
15 June 2007	75°C	6.5
23 June 2007	74°C	6.6
24 June 2007	72°C	6.1
28 June 2007	72°C	6.1
30 June 2007	74°C	6.3
1 July 2007	74°C	6.4
3 July 2007	74°C	6.2
6 July 2007	75°C	6.1
12 July 2007	74°C	6.3
15 July 2007	74°C	6.2
16 July 2007	74°C	6.2

Grilling (Medium cooked BBQ Beef)

Date	Temperature	Time(min)
18 May 2007	65°C	3.2
22 May 2007	66°C	3.5
26 May 2007	66°C	3.5
30 May 2007	65°C	3.2
1 June 2007	65°C	3.5
5 June 2007	65°C	3.1
7 June 2007	65°C	3.1
12 June 2007	65°C	3.2
15 June 2007	65°C	3.4
23 June 2007	66°C	3.5
24 June 2007	64°C	3.8
28 June 2007	63°C	3.5
30 June 2007	66°C	3.1
1 July 2007	66°C	3.2
3 July 2007	66°C	3.2
6 July 2007	67°C	3.3
12 July 2007	65°C	3.5

Pre cooking Log sheet (BBQ Pork)

Date	Temperature	Time(min)
18 May 2007	245°C	45
22 May 2007	252°C	45
26 May 2007	248°C	50
30 May 2007	253°C	50
1 June 2007	251°C	50
5 June 2007	260°C	50
7 June 2007	265°C	45
12 June 2007	268°C	45
15 June 2007	255°C	45
23 June 2007	252°C	45
24 June 2007	252°C	52
28 June 2007	256°C	55
30 June 2007	262°C	45
1 July 2007	261°C	45
3 July 2007	262°C	50
6 July 2007	261°C	45
15 July 2007	261°C	45

Hot holding Log sheet (BBQ Pork)

Date	Temperature	Time(min)
18 May 2007	65°C	1.5
22 May 2007	65°C	1.5
26 May 2007	66°C	1.4
30 May 2007	66°C	1.45
1 June 2007	66°C	1.4
5 June 2007	66°C	1.4
7 June 2007	65°C	1.45
12 June 2007	66°C	1.5
15 June 2007	65°C	1.3
23 June 2007	66°C	1.5
24 June 2007	65°C	1.6
28 June 2007	66°C	1.4
30 June 2007	65°C	1.5
1 July 2007	66°C	1.3
3 July 2007	67°C	1.3

APPENDIX II

Validation Tables for Critical limits

BBQ chicken and BBQ Pork

Time required to cook up to 72^{0}C	Oven Temperature
50 min	240^{0}C
55 min	239^{0}C
48 min	246^{0}C
45 min	250^{0}C
45 min	251^{0}C
53 min	239^{0}C
45 min	252^{0}C
45 min	252^{0}C
55 min	240^{0}C

BBQ Beef

Time required to cook up to 72^{0}C	Weight	Thickness
4.8 min	80g	0.5cm
4.5 min	80g	0.5cm
5 min	80g	0.5cm
4.7 min	80g	0.5cm
4.8 min	80g	0.5cm
4.9 min	80g	0.5cm
4.5 min	80g	0.5cm
5 min	80g	0.5cm

Medium cooked BBQ beef

Time required to cook up to 63^{0}C	Weight	Thickness
2.5 min	80g	0.5cm
2.5 min	80g	0.5cm
2.5 min	80g	0.5cm
2.4 min	80g	0.5cm
2.4 min	80g	0.5cm
2.5 min	80g	0.5cm
2.5 min	80g	0.5cm
2.5 min	80g	0.5cm

APPENDIX III

Critical Evaluation of GMP and SOP manual

1. Receiving

1.a All the products should be purchased from the approved list of suppliers and inspections of raw materials should be done by experienced sous chef.

1.b Designated employee should evaluate and document on a product receiving log, the condition of truck, container and carriers of raw material upon arrival. Items for evaluation may include:

- Cleanliness of truck — no foreign materials, dirt, free of debris, free of off odors
- Temperature of truck — Temperature of the truck must be acceptable to maintain product temperature, Plant may set specific temperature, Condition of door seals
- General truck condition — void of cracks, insulation in good condition, etc.

1.c If truck condition is acceptable, then designated employee (Experienced sous chef) should verify that incoming material meets plant purchase specifications and/or that required documentation is provided.

1.d Incoming meat should be evaluated to ensure that it meets the hotel-established purchase specifications.

Quality specifications for fresh meat

Fresh Meat Acceptable Quality	Poor Quality
Meat should be firm and elastic to touch,	Slimy, sticky or dry
Beef - should be bright cherry red in colour, Min.1 kg per no. Fresh/chilled	Beef – Brown or greenish
Pork – lean portion should be light pink and fat portion should be white, 8 – 10 kg, Fat layer ½ to ¾ inch	Pork – Darkening, rancidity and discolouration
Chicken – Flesh should be firm and pink colour, 1100 – 1200 grams per chicken	Darkening or bad odour

1.e Have a Letter of Guarantee (LOG) from suppliers of non-meat ingredients relating to the use of food grade substances, foreign materials, pest control programs, etc. After the company accepts the non-meat items, then these items should be stored, handled and used in a manner that will maintain the integrity of the items.

1.f All deliveries must be checked for freshness, temperature, colour, odor, contamination, satisfactory

packing & labeling with dates of production & expiry.

1.g Frozen food must not be accepted if the temperature is above -18°C

1.h Check and move to storage within 10 minutes of unloading.

1.i Supplier who are not certified for HACCP/ ISO 9001or at least for SLS product standards are supplying potentially hazardous food (Meat) and are to be audited by the nominated members of the Food Safety audit team per year

1.j Segregated areas should be provided for the storage of rejected, recalled or returned materials or products. They should either be returned to the suppliers or, where appropriate, reprocessed or destroyed. Whatever action is taken should be approved and recorded by authorized personnel.

2. Storage

2.a Raw materials be used on a First-In/First-Out (FIFO) basis or according to a plant specified product rotation/inventory control schedule, such as the oldest bone date.

2.b The package/pallet integrity must be maintained throughout the storage period to maintain the condition of the material. Product identity in storage should allow for the internal tracking system.

2.c Procedures should be in place to maintain product and package integrity (i.e., prevent species contamination, drip contamination during storage, etc.)

2.d Place frozen product in a tempering room that is < -10°C and allow product to reach desired level of tempering state; actual time will vary depending on amount of product and type of packaging.

2.e The product should be monitored on a scheduled basis to prevent loss of package integrity and product drip, and to ensure that product drip does not contaminate other products.

2.f The product temperature should be monitored and documented on a scheduled basis to ensure that the desired end temperature is not exceeded.

3. Thawing

3.a It should be done in a time/temperature controlled manner, which is adequately monitored and documented.

3.b Under refrigeration - that maintains the food temperature at 5°C or below.

Completely submerged under potable running water for a period not to exceed two hours at a water temperature of 21°C or below, and with sufficient water velocity to agitate and flush off loose particles into the sink drain.

3.c The product's traceability should be maintained throughout the thawing process.

4. Seasoning

4.a Seasoning should be done under refrigeration that maintains the food temperature at 5°C or below

5. Processing

5.a Procedures for ensuring proper end product characteristics (i.e., weights, physical characteristics, quantity, etc.) should be in place.

5.b Physical barrier (preferably from floor to ceiling) for separating raw and cooked processing areas

5.c Where necessary, workers, equipment and hand tools are restricted to either raw or finished product areas so that the possibility of cross-contamination is minimized.

5.d The core temperature & the temperature of food must exceed 72°C while cooking.

6. Hot Holding

6.a Storing food in properly labeled containers.

6.b Store cooked food above raw food.

6.c Food should be stored in hermetically sealed container, or

from an intact package and shall be heated to a temperature of at least 65°C for hot holding

6.d Hot food must not be kept out for more than 2 hours.

6.e Food should not remain in hot cupboards for no longer than 4 hours

7. BBQ

7.a The open air barbeque should be separated from public access to prevent Food contamination.

7.b Separate utensils should be used to prepare fully cooked barbeques and rare barbeque products.

8. Serving

8.a Employees shall use utensils, including scoops, forks, tongs, ,paper wrappers, gloves, or other implements, to assemble barbequed meat or to place barbequed on plates.

8.b Separate utensils should be used to prepare fully cooked barbeques and rare barbeque products.

9. Equipment and Facility

9.a Manufacturing equipment should be designed so that it can be easily and thoroughly cleaned. It should be cleaned according to detailed and written procedures, and stored only in a clean and dry condition.

9.b Use of footbaths before entrance into a food processing area, including preparation of sanitizing agent, schedule for changing, etc.

9.c Drains should be of adequate size, and have trapped gullies. Open channels should be avoided where possible, but if necessary, they should be shallow to facilitate cleaning and disinfection.

9.d At all times during processing, all materials, bulk containers, major items of equipment and, where appropriate, rooms used should be labelled or otherwise identified with an indication of the product or material being processed, its strength (where applicable) and batch number. Where applicable, this indication should also mention the stage of production.

9.e Wall surfaces need to be made of materials that are impervious (i.e. do not allow fluid to pass through), non-absorbent, washable and non-toxic, and must be smooth up to a height appropriate for the work.

9.f All areas of a food facility shall have sufficient ventilation to facilitate proper food storage and to provide a reasonable condition of comfort for each employee, consistent with the job performed by the employee.

9.g An accurate, easily readable, metal probe thermometer suitable for measuring the temperature of food shall be readily available on the premises of each food facility.

9.h All refuse shall be removed and disposed of in a sanitary manner as frequently as may be necessary to prevent the creation of a nuisance.

9.i Insect control devices that are used to electrocute or stun flying insects shall be designed to retain the insect within the device.

9.j Employee traffic flow must be maintained to prevent cross-contamination. Flow should not allow employees to move from raw to cooked areas without following all of the procedures outlined for cooked products personnel.

9.k Employee traffic flow should be maintained during operational and non operational hours.

9.l. All individuals (management, maintenance, sanitation, inspectors, visitors, etc.) entering the cooked products processing area must follow the established protocol.

10. Maintenance and Sanitation

10.a The food contact surfaces of cooking equipment and pans shall be kept free of encrusted grease deposits and other soil accumulations.

10.b Non food contact surfaces of equipment shall be kept free of an accumulation of dust, dirt, food residue, and other debris.

10.c Non food contact surfaces of equipment that are exposed to splash, spillage, or other food soiling or that require frequent cleaning shall be constructed of a corrosion resistant, nonabsorbent, and smooth material that allows easy cleaning and to facilitate maintenance and free of unnecessary ledges, projections, and crevices to allow for easy cleaning and to facilitate maintenance.

10.d Hygiene inspections are carried out by the coordinator to identify the nonconformities.

10.e Nonconformities identified by operational staff are also directed to the coordinator.

10.f The appropriate corrective actions are taken immediately by coordinator in consultation with Director in kitchen or Executive chef.

10.g Kitchen waste are collected into peddle operated garbage bins which are located at operational floor.

10.h Colour code is used to collect different types of garbage separately.

Black colour bags – Wet garbage

Blue colour bags - Dry garbage

10.i Accumulated garbage are removed from operational floor as and when required by kitchen stewarding crew.

10.j Any water supply shall be sufficient for the operation intended and shall be derived from an adequate source. Any water that contacts food or food contact surfaces shall be safe and of adequate sanitary quality.

10.k Provide adequate floor drainage in all area where floor are subjected to flooding type cleaning or where normal operations release or drainage water or other liquid waste on the floor.

10.l Rubbish and offals shall be stored and disposed off as to minimize the development of odour and minimize the potential for the waste becoming an attractant and harborage or breeding place for pests and protected against contamination of food, food contact surfaces, water supplies and ground surfaces.

10.m All the windows and doors should seal tightly and open windows should have fine mesh screens , free from openings or entry points for pest.

11. Personnel hygiene

11.a Before starting each shift they should wear washed sanitized and pressed uniforms with chef hat and suitable shoes.

11.b Employees are required to wear hair nets, bands, barrettes or caps to keep hair from contamination of food.

11.c All food handlers who has direct contact with food or subjected to medical examination once year to make sure that they do not have communicable diseases.

11.a Gloves shall be worn when contacting food and food contact surfaces if the employee has any cuts, sores, rashes, artificial nails, nail polish, rings (other than a plain ring, such as a wedding band), uncleanable orthopedic support devices, or fingernails that are not clean, smooth, or neatly trimmed.

11.b Whenever gloves are worn, they shall be changed, replaced, or washed as often as hand washing is required by this part.

11.c If used, single-use gloves shall be used for only one task, such as working with ready to eat food or with raw food of animal origin, used for no other purpose, and shall be discarded

when damaged or soiled, or when interruptions in the food handling occur.

11.d Be free from infections or boils or dermatitis. Do not work until infections are cured. Personnel shall be instructed to report such health condition to their supervisors.

11.e Have nails well cleaned, preferably trimmed short and free from nail polish.

11.f Refrain from wearing jewellery.

11.g Hands should be washed at following occasions.

-Before and after commencing the work

-After using the toilets

-After blowing the nose

-After using handkerchief

-After handling raw food (Meat, etc.)

-After handling raw food

-After unconscious body habits

-Touching areas of body such as ears, mouth, nose and hair or scratching any where in the body.

-After touching infected/ otherwise unsanitary areas of the body

-Before and after handling different types of food (e.g. Cooked and uncooked)

-Touching unclean equipment & work surfaces, soiled clothing

-After handling money

-Smoking or chewing tobacco

-Clearing away and scraping used dishes and utensils, performing scalling operations

-Eating food or drinking beverages

11.h Pens, pencils etc. shall not be carried in pockets above the waistline. Preferably no garment shall have pockets above the waist line.

12. Control of Operations

12.a Cleaning and maintenance records of water distribution system, water test reports should be maintained.

12.b IR thermometers, digital stem thermometers, chillers, freezers, and ovens are calibrated once a year from independent calibration laboratory.

12.c Temperature of all non calibrated chillers, freezers, fridges and hot holding units are verified once a month by the HACCP coordinator.

12.d A person should be designated responsible for handling the complaints and deciding the measures to be taken, together with sufficient supporting staff to assist. If this person is not the authorized person, the latter should be made aware of any complaint, investigation or recall.

12.e Any complaint concerning a product defect should be recorded with all the original details and thoroughly investigated. The person responsible for Quality Control should normally be involved in the study of such problems.

APPENDIX IV

Supplier Quality Assurance Documentation

Date of Inspection:.....

Details of Non Conformity :.....

Receiving ..... **Slaughtering .....** **Storage .....** **Transportation .....** **Personnel Hygiene...** **Maintenance .....**
Short Description about Nonconfirmity:

Action to be taken;

Reject ..... **Return to Supplier .....** **Issue to production under instruction: .....** **Rework internally: .....** **Others:.....**
Short Description about Actions Taken:

.....
Date

.....
Authorized Signature

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