

E355 : Cold Chain Management

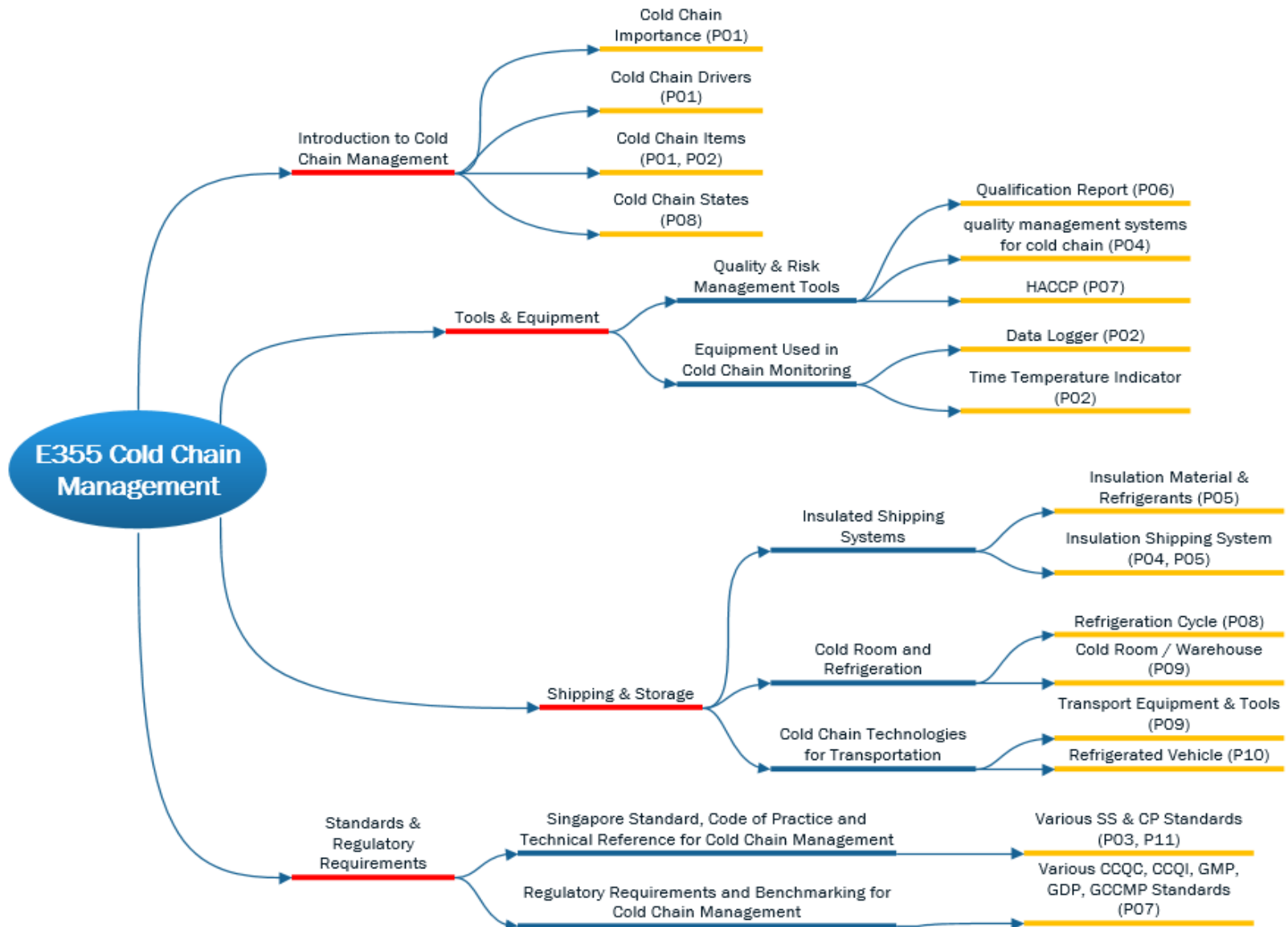
Problem 07

Compliance to regulations

- Recognize the consequences of a break in the cold chain
- Explain SS444:2010
- List and explain the 7 principles of HACCP
- Identify the critical control points (CCP)
- Implement HACCP System
- Explain SS 565:2011
- Derive a Quality Management System for Fish Ball Processing

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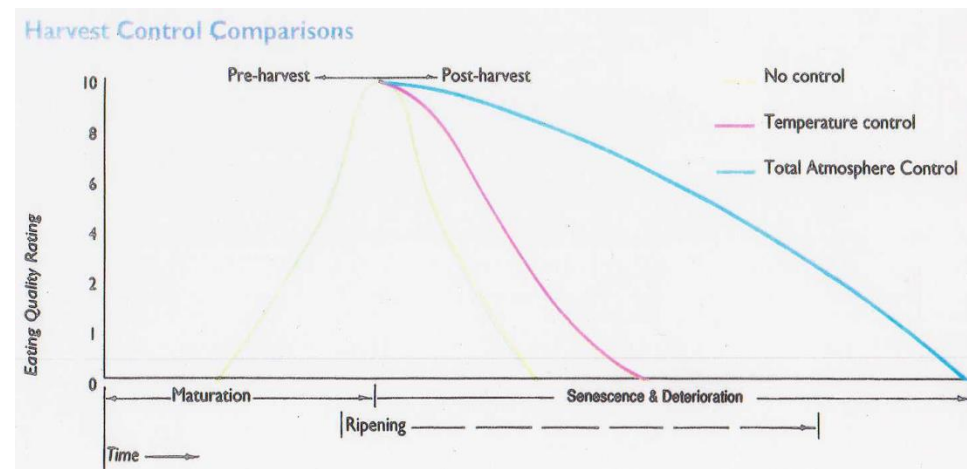
E355 Cold Chain Management - Topic Tree



Need for Cold Chain Quality Management



- Food poisoning bacteria grow best in the temperature range between 5°C and 60°C, without proper cold chain management, food will be unsafe for consumption
- The eating quality of fruits and vegetables drops tremendously if temperature conditions are not optimal
- With cold chain quality management in place, the consumers can be assured of the safety and quality of the food consumed



HACCP – Hazard Analysis and Critical Control Point System



- First developed in 1960s for National Aeronautics & Space Administration (NASA) in US to ensure food safety for the astronauts
- It is a management system in which food safety is addressed through the analysis and control of hazards throughout the food chain
- HACCP principles are increasingly being applied to other industries such as chemical and pharmaceutical
- Its goal is to **prevent** food safety issues from occurring by employing seven basic principles

HACCP



- Designed for use in all segments of the food industry from growing, harvesting, processing, manufacturing, distributing, and merchandising to preparing food for consumption
- The seven principles of HACCP have been universally accepted by government agencies, trade associations and the food industry around the world, in Singapore, AVA actively promotes companies to take up HACCP



HACCP and Other Food Safety Standards



- The seven HACCP principles are included in the international system **ISO 22000**. ISO 22000 standard is a complete food safety management system incorporating the elements of prerequisite programmes for food safety.
- SPRING Singapore has published **SS 444: 2010** Hazard analysis and critical control point (HACCP) system and guidelines for its application which sets out the principles of the HACCP system and provides general guidance for the application of the system adopted by Codes



Preliminary Tasks in the Development of the HACCP Plan



1. Form a HACCP team consisting of experts in food technology, production manager, HACCP expert etc.
2. Describe the food and its distribution process
3. Describe the intended use and consumers of the food (general, infant, elderly etc.)
4. Develop a flow diagram which describes the process
5. Verify the flow diagram





SS 444:2010

HACCP

An Overview of SS 444:2010



- This Singapore Standard is based substantially on the Codex Alimentarius Commission's "Hazard Analysis and Critical Control Point (HACCP) System and Guidelines for its Application, adapted and reproduced by permission of Codex.
- Successful application of HACCP requires:
 - Full commitment and involvement of management and the workforce
 - Requires multi-discipline approach – expertise in agronomy, veterinary health, production, microbiology, medicine, public health, food technology, environmental health, chemistry and engineering

HACCP Principle 1-

Hazard Analysis and Risk Assessment



- Hazard is defined as a biological, chemical or physical agent or condition with the potential to cause harm to health
- Conduct a hazard analysis and risk assessment of the production process
- Hazard includes:
 - a. **Biological**
 - **Bacteria**, Viral, Parasitic
 - b. **Chemical**
 - Naturally occurring e.g. shellfish toxins, mushroom toxins
 - Added chemicals e.g. heavy metal (mercury), pesticides
 - c. **Physical**
 - Foreign objects e.g. stones, glass, bone, insects, rodents

***Cold chain focuses
on preventing
Biological Hazards***

HACCP Principle 1-

Hazard Analysis and Risk Assessment



- **Risk** is the probability of the hazard occurring
- **Severity** is the consequence of the hazard when it occurs
- **Significant Hazard** is a hazard that is likely to occur and which could cause adverse health effects
- **Risk Matrix** (to determine the significance of a hazard)

<i>Significant Hazard</i>		Risk		
		Low	Med	High
Severity	Low	Low	Low	High
	Med	Med	Med	High
	High	Med	High	High

HACCP Principle 1-

Hazard Analysis and Risk Assessment



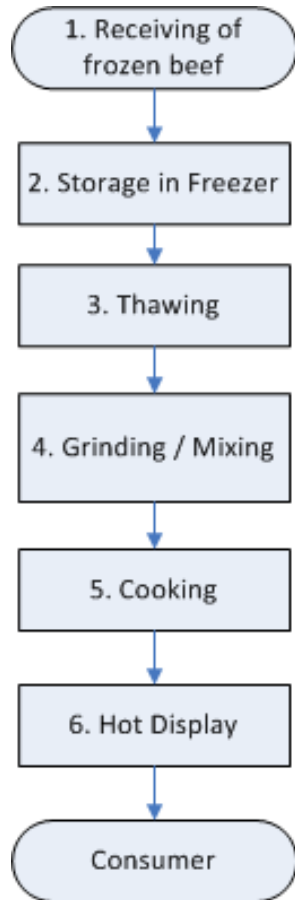
Sample Hazard Analysis Worksheet

HAACP Hazard Analysis Worksheet

Firm Name:		Product Description: (each product must have its own hazard analysis.)			
Firm Address:		Methods of Distribution and Storage:			
Date of Analysis:		Intended Use and Consumer:			
		Typical Consumer:			
Processing Step	Identify potential hazards introduced, controlled, or enhanced at this step.	Are any potential food safety hazards significant? (Yes or No)	Justify your determination of hazard significance.	What control measures can be applied for the significant hazard?	Is this step a Critical Control Point? (Yes or No)
Receiving	Biological:				
	Chemical:				
	Physical:				
Fumigation	Biological:				
	Chemical:				
	Physical:				
Hulling/Shelling	Biological:				
	Chemical:				
	Physical:				

HACCP Principle 1-

Hazard Analysis and Risk Assessment



For example, for the cooking process in the production of frozen cooked beef patties, the hazard analysis can be

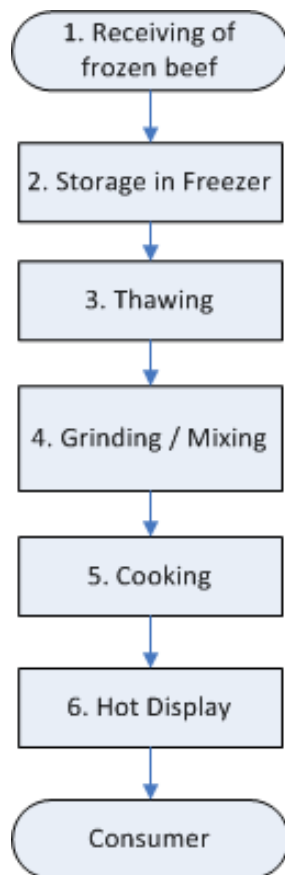
Step	Potential Hazard(s)	Justification	Control Measure(s)
5. Cooking	Enteric pathogens: e.g., Salmonella, verotoxigenic - E. coli	enteric pathogens have been associated with outbreaks of foodborne illness from undercooked ground beef	Cooking

HACCP - Principle 2

Determine the Critical Control Points (CCPs)



Example of CCPs in a process flow



Identified CCP

Receiving, CP – receiving does not reduce or eliminate hazards.

Storage, CP – for food stored in a confined freezer / fridge, there is no need for special control

Thawing, **CCP** – if thawing is not monitored, and temperature rises to unacceptable levels for long duration, bacteria will multiply quickly.

Grinding, CP – pre-package / packaging by equipment do not need special control

Cooking, **CCP** – Meat can be undercook, cooking can reduce or eliminate the hazard of pathogens

Hot display, **CCP** – Cook meat needs to be maintained above 60°C to deter bacteria growth.

HACCP - Principle 2

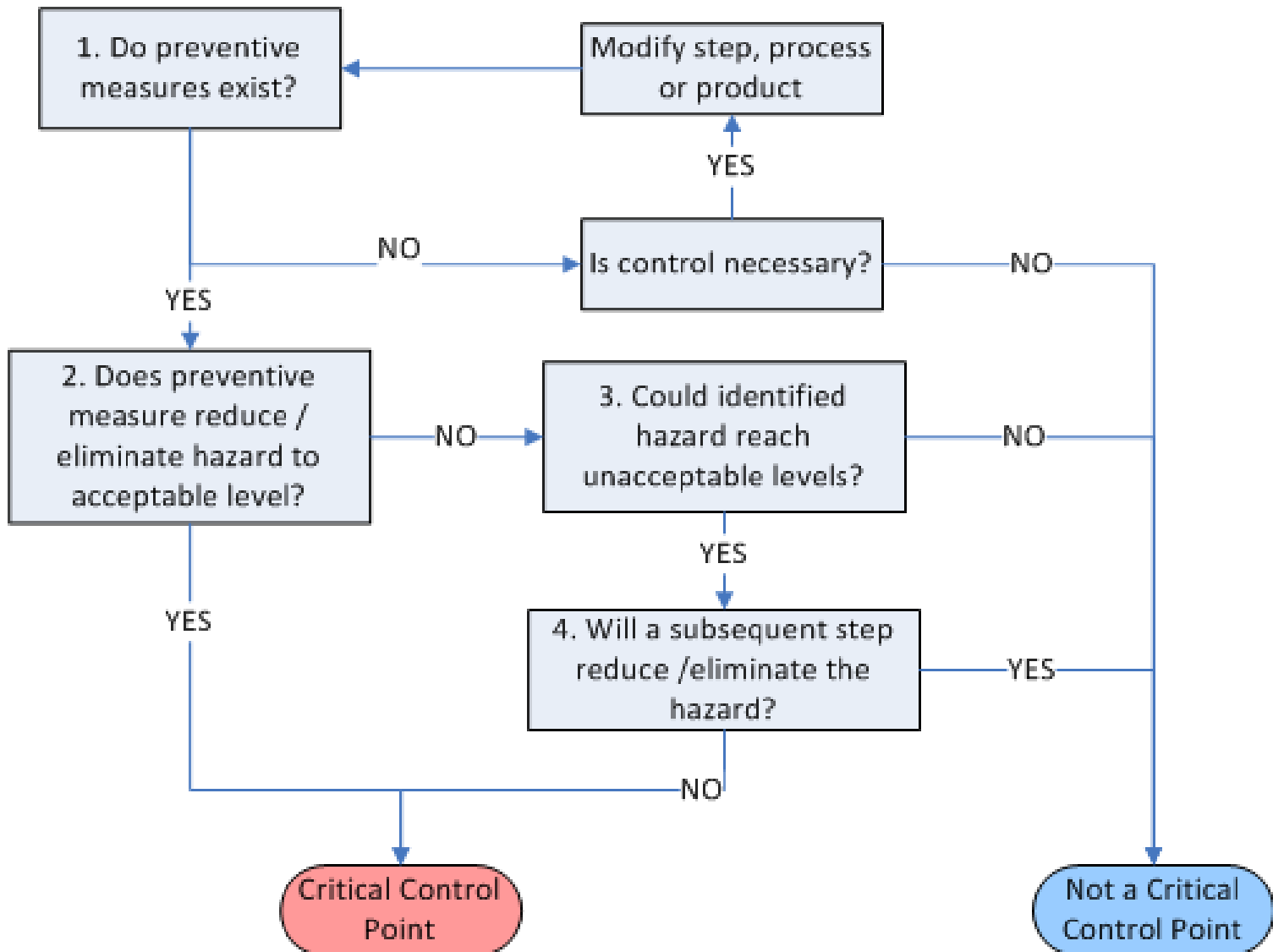
Determine the Critical Control Points (CCPs)



- All the steps / processes are considered as control points (**CP**), some of them should be further classified as critical control points (**CCP**) due to the potential hazard
- A **critical control point** is a step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level
- The potential hazards that are reasonably likely to cause illness or injury in the absence of their control must be addressed in determining CCPs
- Decision trees can be used to identify CCPs
- Examples of CCPs may include: thermal processing, chilling, testing ingredients for chemical residues, product formulation control, and testing product for metal contaminants

HACCP - Principle 2

Determine the Critical Control Points (CCPs)

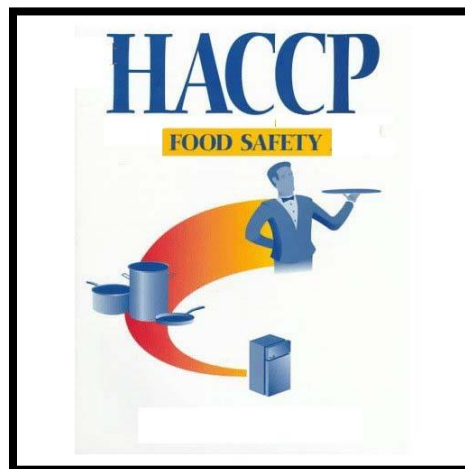


HACCP - Principle 3

Establish Critical Limits



- A **critical limit** is a maximum and/or minimum value to which a biological, chemical or physical parameter must be controlled at a CCP to prevent, eliminate or reduce to an acceptable level
- Critical limits may be based upon factors such as: temperature, time, humidity, moisture level, water activity (a_w), pH, salt concentration or viscosity



HACCP - Principle 3

Establish Critical Limits



- All critical limits should be based on information published by credible organizations or accepted industry practice.
E.g. <https://www.fsis.usda.gov/wps/portal/fsis/topics/food-safety-education/get-answers/food-safety-fact-sheets/safe-food-handling/safe-food-handling-fact-sheets>
- Example of critical limits for cooking

Process Step	CCP	Critical Limits
5. Cooking	YES	Oven temperature: ____ ° C Time; rate of heating and cooling (belt speed in ft/min): ____ ft/min Patty thickness: ____ in. Patty composition: e.g. all beef Oven humidity: ____ % RH

HACCP - Principle 4

Establish Monitoring System



- Monitoring is a planned sequence of observations or measurements to assess whether a CCP is under control and to produce an accurate record for future use in verification.
- Purpose of monitoring include
 1. Tracking of the operation, observing if there is a trend towards loss of control, allowing corrective actions to be taken
 2. To determine when there is loss of control and a deviation occurs at a CCP
 3. Providing written documentation for verification of HACCP plan
- Must state **WHAT** to act on, **WHO** is to act, **WHEN** to act, **HOW** to act
- E.g. What: temperature, How: Take temperature of product
Who: owner of process, When: every batch

HACCP - Principle 5

Establish Corrective Action



- When there is deviation from an established CCP limit, corrective actions must be taken to prevent a product that may be unsafe from reaching consumers.
- Corrective action must include
 - Correction of the process
 - Disposition of the non-compliant product
 - Documentation of the event

HACCP – Principle 6

Establish Verification Process



- Verification process is confirmation that HACCP plan is adhered to, effective and valid
- The verification process should specify the method involved and the frequency of verification

Sample Verification Process Plan

Activity	Frequency	Responsibility	Reviewer
Verification Activities Scheduling	Yearly or Upon HACCP System Change	HACCP Coordinator	Plant Manager
Verification of CCP Monitoring as Described in the Plan (e.g., monitoring of patty cooking temperature)	According to HACCP Plan (e.g., once per shift)	According to HACCP Plan (e.g., Line Supervisor)	According to HACCP Plan (e.g., Quality Control)
Review of Monitoring, Corrective Action Records to Show Compliance with the Plan	Monthly	Quality Assurance	HACCP Team

HACCP - Principle 7

Establish Record Keeping and Documentation Procedures



- Records maintained for HACCP should include
 - 1) Processing - Records of all monitored CCP's
 - 2) Deviation - Records of any deviations from the HACCP plan
 - 3) Ingredients - Supplier qualification, ingredient certification, audit records
 - 4) Product safety
 - 5) Storage and distribution - Traceability data
 - 6) Validation studies





Implementation/Application

HACCP

Guidelines for the Application of the HACCP System



- Prior to application of HACCP, prerequisite programs:
 - Good Hygienic Practices (GHP)
 - Good Manufacturing Practices (GMP)
According to Codex General Practices of Food Hygiene or
Singapore Standard CP3:1988 Food Hygiene General
 - Training
- Management awareness of HACCP and commitment
- Consideration shall be given to the impact of:
 - Raw materials
 - Ingredients
 - Food manufacturing practice
 - Role of manufacturing processes to control hazard
 - Likely end user of the product
 - Categories of consumers of concern
 - Epidemiological evidence relative to food safety

Guidelines for the Application of the HACCP System



- Redesign of operation should be considered if a hazard which needs to be controlled is identified but no CCP are found
- HACCP should be applied to each specific operation separately
- Individual business should be responsible for the application of the HACCP principles
- Efficacy of any HACCP system rely on:
 - Management
 - Employees
 - Knowledge and skills

Implementation Process of HACCP System



1. Assemble HACCP team

- Assemble a multi-disciplinary team
- Without in-house expertise, seek advise from other sources:
 - Trade and industry associations
 - Independent experts
 - Regulatory authorities
 - Reference from HACCP literature HACCP guides
- In-house well trained individual



2. Describe product

- Full description of the product
- Relevant safety information:
 - Composition
 - Physical/chemical characteristics
 - Microcidal or microstatic treatments
 - Packaging
 - Durability
 - Storage conditions and method of distribution

3. Identify intended use

- Expected uses by the end user or consumer
- Special consideration – food for vulnerable groups
 - **Infants / elderly / people with medical conditions**



4. Construct flow diagram

- Constructed by HACCP team
- Cover all steps of operation of production
- Consideration should be given to steps preceding and following the specified operation

5. On-site confirmation of flow diagram

- Confirm the processing operation against the flow diagram
- Amend the flow diagram where appropriate
- Performed by person or persons with sufficient knowledge of the processing operation



6. List all potential hazards in each steps (see Principle 1)

- In hazard analysis, should include:
 - Likely occurrence and severity of their adverse health effects
 - Qualitative and/or quantitative evaluation
 - Survival or multiplication of microorganism of concern
 - Production/presence of toxins, chemicals or physical agents in food
 - Conditions leading to the above
- More than one control measure may be required for a specific hazard
- More than one hazard may be controlled by a specific control measure



7. Determine critical control point

- See Principle 2 (P9)

8. Establish critical limit for each CCP

- See Principle 3 (P9)

9. Establish monitoring system for each CCP

- See Principle 4 (P9)

10. Establish corrective actions

- See Principle 5 (P9)

11. Establish verification procedure actions

- See Principle 6 (P9)

12. Establish documentation and record keeping

- See Principle 7 (P9)



SS 565:2011

SPECIFICATIONS FOR CHILLED AND FROZEN PARTIALLY COOKED FISH BALLS

An Overview of SS 565:2011 Specifications for chilled and frozen partially cooked fish balls



- Singapore fish processing industry now produces annually close to 30,000 tonnes of surimi based products (e.g. fish balls & fish cakes) valued at S\$80 million, for local consumption and export
- Purpose of SS 565:2011
 - Enhance competitive edge of Singapore fish ball industry
 - Improve Singapore's reputation as a trusted business hub for fish balls processing
 - Increase productivity for Singapore fish balls processing industry
 - Help to safeguard public health, ensure freshness and wholesomeness of fish balls supplied to consumers

Classifications of fish balls



- Chilled partially cooked fish balls
 - Fish balls chilled after cooking
 - Temperature maintained at $\leq 4^{\circ}\text{C}$, remaining in unfrozen state until ready for consumption
- Frozen partially cooked fish balls
 - Fish balls subjected to freezing process
 - Temperature maintained at $\leq -18^{\circ}\text{C}$, remaining in frozen state until ready for consumption
- Partially cooked fish balls
 - Made of surimi, and may contain salt, sugar, starch, flavor enhancer, water & other permitted ingredients
 - Do not contain substances like artificial coloring matter, preservatives and artificial sweetening agents
 - Subjected to a setting and cooking process



Main Requirements of SS 565:2011



- Three main requirements namely in terms of **raw materials**, **hygiene** as well as **chemical, physical and microbial characteristics**

a) Raw materials requirement

- Fish ball shall be prepared from a combination of:
 - Surimi
 - Starch
 - Salt
 - Water
 - Other permitted ingredients (e.g. flavor enhancers, antioxidants, gel strength enhancers.)

b) Hygiene requirement

- Domestic products prepared in accordance with Wholesome Meat and Fish Act (Chapter 349A, Section 42, 2001)
- Exported products prepared in accordance with the hygiene and safety requirement of the country of destination

Main Requirements of SS 565:2011



c) Chemical, physical and microbial characteristics

Characteristics	Requirements
Protein nitrogen	Min 7%
Starch	Max 5%
Expressible liquid	Max 30%
Gel Strength	Min 150 g.cm (Deformation = 1cm, Force =150 g)
Whiteness	Min 50
Moisture	Max 90%
Salt	Max 2.5%
Total plate count (48 h at 35°C)	$m = 5 \times 10^5$ cfu/g, $M = 1 \times 10^7$ cfu/g; $n=5$; $c= 3$ (ICMSF, 1986)
E Coli count	$m = 11$ MPN/g; $M=500$ MPN/g; $n=5$; $c= 3$ (ICMSF, 1986)

Other Requirements of SS 565:2011



- Tests

- As per test methods given in Annex of SS 565:2011 or other recognized equivalent international methods

- Sampling

- In accordance with appropriate sampling plan with an AQL (Acceptable Quality Level) of 6.5
- Pre-packed goods: sample unit shall be the entire container
- Products packed in bulk: sample shall be at least 1 kg of fish balls



- Packaging

- With packing materials that is fit for its intended use
- With material that is not likely to contaminate the food
- With care to prevent any contamination during the packaging process



- Labeling

- In accordance with the requirements of the country of destination

- Storage Instructions

- Chilled partially cooked fish balls: Shall be stored at $\leq 4^{\circ}\text{C}$ remaining in unfrozen state throughout
- Frozen partially cooked fish balls: Shall be stored at $\leq -18^{\circ}\text{C}$



Today's Problem



- Food quality and safety is becoming increasingly important to consumers
- Universally accepted HACCP certification assures the customers that the food is safe for consumption
- Follow the 12 implementation steps of HACCP
- Incorporating SS565:2011 requirements in the HACCP plan
- Ensure prerequisite programs are in place prior to the application of HACCP
- Getting full support from the management
- Training programs for task force team, workers and supervisor

Learning Objectives



- Recognize the consequences of a break in the cold chain
- Explain SS444:2010 Hazard Analysis and Critical Control Point (HACCP) System and Guidelines for its Application
 - List and explain the 7 principles of HACCP
 - Identify the critical control points (CCP) in a cold chain process
 - Implementation of HACCP System
- Explain SS 565:2011 Specifications for chilled and frozen partially cooked fish balls
- Derive a Quality Management System for Fish Ball Processing