UNIT 13 HACCP – A FOOD SAFETY ASSURANCE SYSTEM

Structure

13.1 INTRODUCTION

In the last unit we learnt about risk analysis, which you may have realized, is a proactive, preventive approach to food safety. Many animal and food-related industries are now using risk analysis in their decision-making and in the development of HACCP plans. In fact, risk analysis is becoming the new cornerstone in producing safe and acceptable foods when implemented in HACCP system.

Until recently, most systems for regulating food safety were based on end product testing and inspection. These systems cannot respond to existing and emerging challenges to food safety because they do not provide or stimulate a preventive approach. It is in this backdrop that HACCP, which stands for Hazard Analysis Critical Control Point offers a preventive and a cost effective approach to food safety. What is HACCP? What is its relevance in the context of food safety? We will focus on these and other important aspects of HACCP in this unit.

Objectives

After studying this unit, you will be able to:

- define HACCP,
- discuss the need, relevance of HACCP in the context of food safety,
- enumerate the principles of HACCP, and
- explain the guidelines for application of HACCP principles.

13.2 HACCP – AN EFFECTIVE FOOD SAFETY ASSURANCE SYSTEM

What is HACCP?

HACCP, as you may already know, is an acronym that stands for *Hazard Analysis Critical Control Point, a systematic, science-based approach used in food production as a means to assure food safety.*

The concepts for HACCP was developed in the 1960's by the Pillsbury Company in consultation with the US National Aeronautics and Space Administration (NASA) and the U.S. Army Laboratories at Natick. While it was originally developed to ensure microbiological safety of food stuffs, it has been further broadened to include chemical and physical hazards in foods. In 1993, the *Codex Alimentarius Commission* endorsed the HACCP system as the most cost-effective approach devised to date for ensuring the safety of food.

HACCP, therefore, is a preventive system of food control. It involves examining and analysing every stage of a food-related operation to identify and assess hazards, determining the 'critical control points' at which action is required to control the identified hazards, establishing the critical limits that must be met at, and procedures to monitor, each critical control point, establishing corrective procedures when a deviation is identified by monitoring, documenting the HACCP plan and verifying procedures to establish that it is working correctly.

From the definition above, the following points require consideration. HACCP is a food-related operation to:

- identify and assess hazard at every stage of operation, right from start to finish
- determine the critical control points
- establish the critical limit and procedures to monitor each critical control point, and
- establish corrective procedures.

It is obvious, therefore, that HACCP is not just based on end product testing and inspection. It is a *preventive* and a *continuous approach* to food safety *identifying/ examining, analyzing/evaluating* and *establishing correctives measures* and *controlling hazards* at every stage of a food-related operation. That is why it is effective and unique.

In the definition above, we came across terms like critical control points, critical limit etc. What do these terms mean? Let us first look up the meaning/definitions of these and various other terms used and you might come across during the study of HACCP.

Terms used in the context of HACCP:		
Control	:	a) To manage the conditions of an operation to maintain compliance with established criteria. b) The state where correct procedures are being followed and criteria are being met.
Control Measure	:	Any action or activity that can be used to prevent, eliminate or reduce a significant hazard.
Control Point	:	Any step at which biological, chemical or physical factors can be controlled.
Corrective Action	:	Procedures followed when a deviation occurs.
Criterion	:	A requirement on which a judgment or decision can be based.
Critical Control Point	:	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.

Critical Limit	:	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 the occurrence of a food safety hazard.
CCP Decision Tree	:	A sequence of questions to assist in determining whether a control point is a CCP.
Deviation	:	Failure to meet a critical limit.
HACCP	:	A systematic approach to the identification, evaluation and control of food safety hazards.
HACCP Plan	:	The written document which is based upon the principles of HACCP and which delineates the procedures to be followed.
HACCP System	:	The result of the implementation of the HACCP Plan.
HACCP Team	:	The group of people who are responsible for developing, implementing and maintaining the HACCP system.
Hazard	:	A biological, chemical or physical agent that is reasonably likely to cause illness or injury in the absence of its control.
Hazard Analysis	:	The process of collecting and evaluating information on hazards associated with the food under consideration to decide which are significant and must be addressed in the HACCP plan.
Monitor	:	To conduct 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.
Prerequisite Programs	:	Procedures, including good manufacturing practices that address operational conditions providing the foundation for the HACCP system.
Severity	:	The seriousness of the effect(s) of a hazard.
Step	:	A point, procedure, operation or stage in the food system from primary production to final consumption.
Validation	:	That element of verification focused on collecting and evaluating scientific and technical information to determine if the HACCP plan, when properly implemented, will effectively control the hazards.
Verification	:	Those activities, other than monitoring, that determine the validity of the HACCP plan and that the system is operating according to the plan.

With the knowledge about the different terms, let us now move on to learn about the need, relevance for HACCP in the context of food safety.

13.3 NEED FOR HACCP

Why the need for HACCP? What is the advantage of HACCP over the current systems being adopted for food safety? Let's find out.

While traditional safety assurance programmes focused on identifying problems in the finished product, HACCP, a recent proactive, preventive technique, focuses on identifying potential problems and controlling them during the design and the production process itself, as highlighted in Figure 13.1.

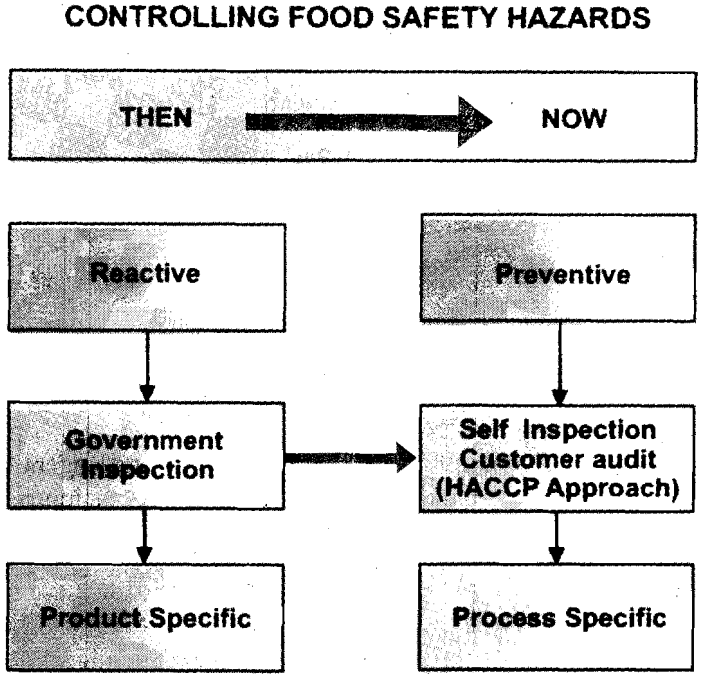

Figure 13.1: Controlling food safety hazards

HACCP offers a number of advantages over the current system. Most importantly, HACCP:

- focuses on identifying and preventing hazards from contaminating food
- is based on sound science
- permits more efficient and effective government oversight, primarily because the recordkeeping allows investigators to see how well a firm is complying with food safety laws over a period rather than how well it is doing on any given day
- places responsibility for ensuring food safety appropriately on the food manufacturer or distributor
- helps food companies compete more effectively in the world market, and
- reduces barriers to international trade.

Let us review some of these advantages in more details.

Preventing Food Borne Disease Outbreaks

Food safety has been of concern to mankind since the dawn of history, and many of the problems encountered in our food supply go back to the earliest recorded years. Despite progress in food science and technology, foodborne diseases remain one of the most widespread public health problems in the contemporary world.

As per WHO, up to one-third of populations of developed countries are affected by the foodborne illness each year and the problem is likely to be even more widespread in developing countries. Food and waterborne diarrhoeal diseases, for example, are

leading causes of illness and death in developing countries, killing an estimated 2.2 million people annually, most of whom are children. Epidemiological investigations have also indicated that a large proportion of food borne diseases result from poor hygienic handling of food in small businesses. One of the most important challenges is the increasing number of new food pathogens. For example, between 1973 and 1988, bacteria not previously recognized as important causes of food-borne illness– such as *Escherichia coli* O157:H7 and *Salmonella enteritidis*–became more widespread.

Worldwide it is now being recognized that the application of HACCP system mitigates the risks of food borne disease outbreaks.

Ensuring Food Safety

It is now well-known that the end product inspection and testing does not provide safety of food. It has inherent limitation of mapping the potential hazards that could be present in a lot of raw material or food product. It has been proved that a 100 percent inspection is not a reliable control technique for this purpose. Further, for inspection and testing, a sampling plan is used and it is imperative to note that no sampling plan can reflect the lot characteristics or ensure absence of a particular organism.

Accordingly, there is a need for development of a comprehensive and effective food system which functions in such a way that food safety considerations are built into the food chain from production to consumption and that is what HACCP, actually ensures.

International Obligations – Agreements on Sanitary and Phytosanitary Measures (SPS) and Technical Barriers to Trade (TBT)

The SPS Agreement, to which India is a signatory, makes it obligatory for us as a nation to maintain measures to ensure that food is safe for consumers and to prevent the spread of pests or diseases among animals and plants. *The TBT agreement* encourages the development of international standards and conformity assessment systems that facilitate trade and that the technical regulations do not form non-tariff barriers to trade.

Both these agreements have wider implications in the International Trade and in this background the various Codex Standards / Guidelines, including those on HACCP, Good Handling Practices (GHP) and Good Manufacturing Practices (GMP), take an unprecedented importance with respect to consumer protection and international food trade.

Other factors

- Increased worldwide tourism and international trade in foodstuffs, leading to a greater exposure to foodborne hazards from other areas.
- New food technologies and processing methods, causing concerns either about the safety of the products themselves or the eventual consequences due to inappropriate handling during preparation in households or food service / catering establishments.
- Increased contamination of the environment.
- Increasing consumer awareness of food safety.
- Lack of or decreasing resources for food safety.

It is this climate of increasing concern about food safety, the lack of sufficient resources and the recognition of the limitations of traditional approaches to food safety assurance which have accentuated the need for a cost-effective food safety assurance method. The HACCP system has proven to be such a system.

Next, let us study about the benefits of this system to consumers, food industry, government and other agencies.

13.4 BENEFITS OF HACCP

From our understanding of HACCP, so far, we can generalize that HACCP provides a systemic approach to food safety. It is a proactive strategy, aimed at continuous problem prevention and is cost effective.

However, the responsibility for safe and nutritious food needs to be shared by all players in the food chain, which includes those who produce, transform or handle the food from production to storage and to its ultimate consumption. Besides, it involves the interplay of scientific, legal/regulatory, social and economic agencies, both nationally and globally.

The challenge, therefore, for us as a nation is to build comprehensive HACCP food safety system that ensures the long term involvement and commitment of all concerned parties to ensure that the result is the provision of safe food and a nutritious diet for the common man. The benefits of HACCP can be summarized as under.

a) *Benefits to Consumers*

- Reduced risk of food borne diseases
- Increased confidence in food supply
- Increased awareness of basic hygiene
- Increased quality of life (health and socio-economic)

b) *Benefits to Industry*

- Increased market access
- Reduction in production costs through reduced wastage and recall of food
- Increased consumer and government confidence
- Mitigating the business risk

c) *Benefits to Governments*

- Improved public health
- Reduced public health costs
- Enhanced facilitation of International Trade
- Increased confidence of the community in the food supply

The additional benefits of the HACCP system include:

i) The HACCP system overcomes many of the limitations of the traditional approaches to food safety control (generally based on 'snap-shot' inspection and end product testing), including:

- the difficulty of collecting and examining sufficient samples to obtain meaningful, representative information, in a timely manner and without the high cost of end-product analysis
- reducing the potential for product recall
- identification of problems without understanding the causes, and
- limitations of 'snap-shot' inspection techniques in predicting potential food safety problems.

ii) The HACCP system allows for the identification of conceivable, reasonably expected hazards, even where failures have not previously been experienced. It is, therefore, particularly useful for new operations.

iii) The HACCP system is sufficiently flexible to accommodate changes introduced, such as progress in equipment design, improvements in processing procedures and technological developments related to the product.

iv) The HACCP system is applicable to the whole food chain, from the raw material to the end product, i.e. growing, harvesting, processing or manufacturing, transport, distribution, preparation, serving and consumption.

Before moving on to our next section on application of HACCP principles, let us now recapitulate what we have learnt till now.

Check Your Progress Exercise 1

1) What do you understand by the term 'HACCP'? Enlist the benefits of HACCP.

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2) Explain why HACCP is a better and effective method over traditional food safety assurance programmes?

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3) Why there is a need for HACCP in maintaining international standards in food trade?

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13.5 PRINCIPLES OF HACCP

HACCP, we now know, deals with continuous problem prevention. What does HACCP involve? The HACCP system involves the following seven principles:

Principle 1: Conduct a Hazard Analysis

Principle 1 describes where the HACCP team should start. A process flow diagram is put together, detailing all the steps in the process, from incoming raw materials to finished product. When complete, the HACCP team identifies all the hazards which could occur at each stage and describe preventative measures for their control. The hazard, as you may already recall studying earlier in Unit 2, could be biological, such as a microbe, chemical, such as a toxin, or physical, such as ground glass, metal fragments etc.

Principle 2: Determine the Critical Control Points (CCPs)

When all the hazards and preventative measures have been described, the HACCP team establishes the points where control is critical to managing the safety of the product. These are points in a food's production – from its raw state through processing and shipping to consumption by the consumer – at which the potential hazard can be controlled or eliminated. Examples are cooking, cooling, packaging, metal detection etc.

Principle 3: Establish Critical Limit(s)

The third step establishes preventive measures with critical limits for each control point. For a cooked food, for example, this might include setting the minimum cooking temperature and time required to ensure the elimination of any harmful microbes.

The critical limits describe the difference between safe and unsafe product at the CCPs. These must involve a measurable parameter and may also be known as the absolute tolerance for the CCP.

Principle 4: Establish a System to Monitor Control of the CCP

The HACCP team should specify monitoring requirements for management of the CCP within its critical limits. This will involve specifying monitoring actions along with frequency and responsibility. Such procedures might include determining how and by whom cooking time and temperature should be monitored.

Principle 5: Establish the Corrective Action to be taken when Monitoring Indicates that a Particular CCP is not Under Control

Corrective action procedures and responsibilities for their implementation need to be specified. This will include action to bring the process back under control and action to deal with product manufactured while the process was out of control. For example, reprocessing or disposing of food if the minimum cooking temperature is not met.

Principle 6: Establish Procedures for Verification to Confirm that the HACCP System is Working Effectively

Verification procedure must be developed to maintain the HACCP system and ensure that it continues to work effectively. For example, testing time-and-temperature recording devices to verify that a cooking unit is working properly.

Principle 7: Establish Documentation Concerning all Procedures and Records Appropriate to these Principles and their Application

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.

In this section, the HACCP principles were highlighted. In the next section, the guidelines for the application of these principles to a specific product and process has been explained. Read carefully.

13.6 GUIDELINES FOR APPLICATION OF HACCP PRINCIPLES

Before the application of the HACCP principles to a specific product and process, it is important to develop a HACCP Plan. What does this planning entail? The next sub-section orients us to this aspect.

13.6.1 Preliminary Tasks in Development of HACCP Plan

In the development of a HACCP plan, five preliminary tasks need to be accomplished. These five preliminary tasks are given in Figure 13.2.

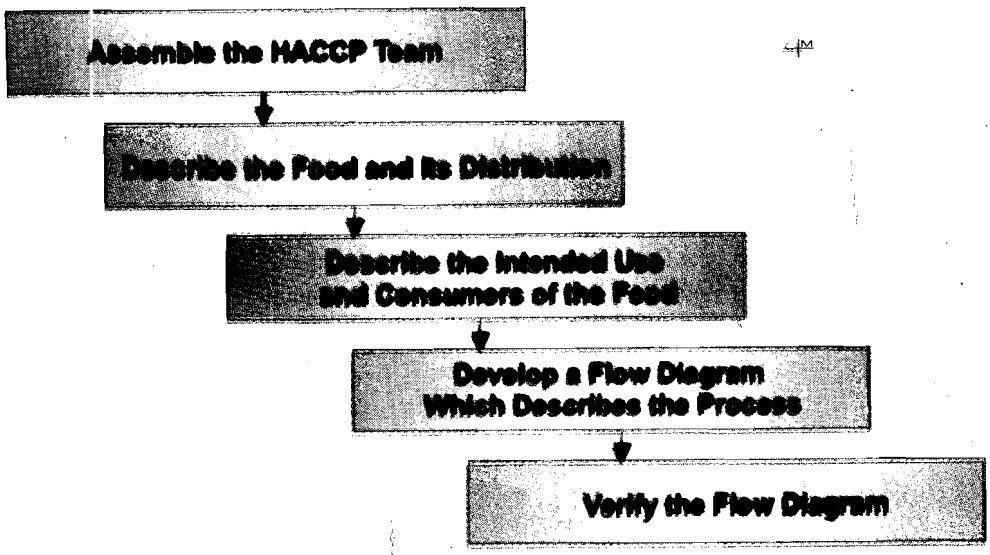

Figure 13.2: Preliminary tasks in the development of the HACCP plan

As highlighted in Figure 13.2, the first task in developing a HACCP plan is to assemble a HACCP team consisting of individuals who have specific knowledge and expertise appropriate to the product and process. Let us learn about each of these tasks in greater details next.

a) *Assemble HACCP team*

The food operation company should assure that the appropriate product specific knowledge and expertise is available for the development of an effective HACCP plan. Optimally, this may be accomplished by assembling a multidisciplinary team, including individuals from areas such as *engineering, production, sanitation, quality assurance and food microbiology*. Where such expertise is not available on site, expert advice should be obtained from other sources. It is recommended that experts should have the knowledge and experience to correctly (a) conduct a hazard analysis (b) identify potential hazards (c) identify hazards which must be controlled (d) recommend controls, critical limits and procedures for monitoring and verification (e) recommend appropriate corrective actions when a deviation occurs, (f) recommend research related to the HACCP plan if important information is not known and (g) validate the HACCP plan.

The scope of the HACCP plan should be identified. The scope should describe which segment of the food chain is involved and the general classes of hazards to be addressed.

b) *Describe product*

Once the HACCP team is in place, the first task for the team is *to describe the food.* This consists of a general description of the food, ingredients and processing methods. A full description of the product should be drawn up, including relevant safety information such as: composition, physical / chemical structure (including a_w pH, etc.), microbial / static treatments (e.g. heat-treatment, freezing, brining, smoking, etc.), packaging, durability, storage conditions and method of distribution i.e. whether the food is to be distributed frozen, refrigerated, or at ambient temperature.

c) *Identify intended use*

Next, the task involves *describing the normal expected use of the food.* The intended use should be based on the expected uses of the product by the end user or consumer. The intended consumers may be the general public or a particular segment of the population (e.g. infants, immuno-compromised individuals, the elderly, etc.). In specific cases, vulnerable groups of the population, e.g. institutional feeding, may have to be considered.

d) *Construct flow diagram*

As indicated in Figure 13.2, the fourth task is to develop a *flow diagram which describes the process.* The flow diagram should be constructed by the HACCP team. The purpose of a flow diagram is to *provide a clear, simple outline of the steps involved in the process.* The flow diagram should cover all steps in the operation. When applying HACCP to a given operation, consideration should be given to steps preceding and following the specified operation. Example of a flow diagram for the liquid milk process is presented in Figure 13.3.

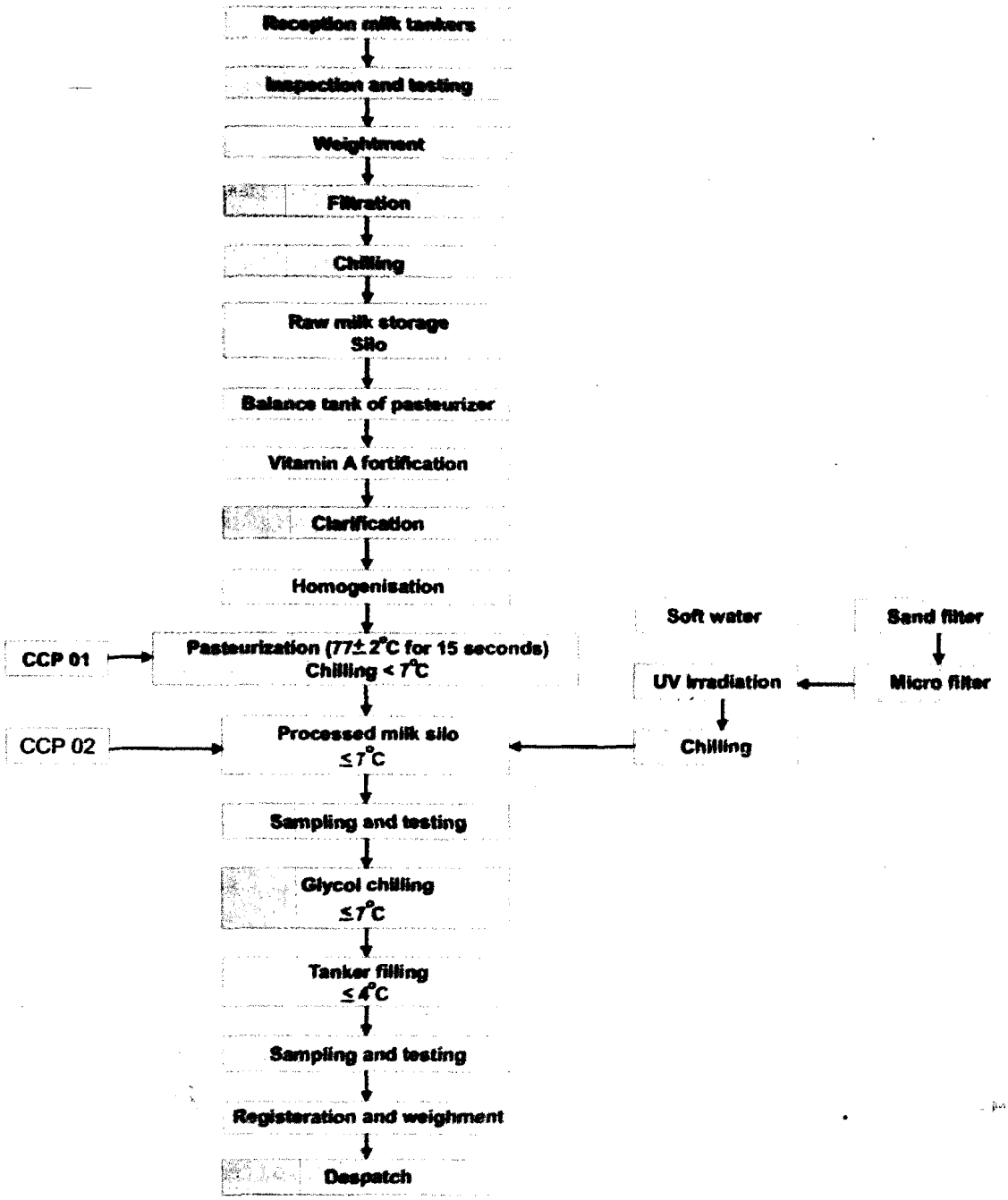

Figure 13.3: Process flow diagram for liquid milk

Finally, the last task is to verify the flow diagram, as discussed next.

e) *On-site confirmation of flow diagram*

The HACCP team should perform an on-site review of the operation to verify the accuracy and completeness of the flow diagram. Modifications/amendments should be made to the flow diagram as necessary and documented.

Before we proceed further, let us take a break and recapitulate the HACCP principles and tasks involved HACCP paln.

Check Your Progress Exercise 2

1) List the seven principles of HACCP.

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2) What steps should be followed to develop a HACCP plan?

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Now that the HACCP plan is ready and the five preliminary tasks have been completed, next, the seven principles of HACCP are applied to ensure safe food. Let us learn about these principles.

13.6.2 Applying the HACCP Principles

In section 13.5 we have already listed the seven HACCP principles. Now, let us apply these principles in the liquid milk process example we have taken earlier and see how HACCP works to provide safe milk to customers. We start with the first principle.

List all potential hazards associated with each step, conduct a hazard analysis, and consider any measures to control identified hazards (Principle 1)

After addressing the preliminary tasks discussed above, the HACCP team conducts a hazard analysis and identifies appropriate control measures.

The HACCP team should conduct a hazard analysis to identify for the HACCP plan which hazards are of such a nature that their elimination or reduction to acceptable levels is essential to the production of a safe food.

In conducting the hazard analysis, wherever possible, the following should be included:

- the likely occurrence of hazards and severity of their adverse health effects
- the qualitative and/or quantitative evaluation of the presence of hazards
- survival or multiplication of microorganisms of concern
- production or persistence in foods of toxins, chemicals or physical agents, and
- conditions leading to the above.

The team must then consider what control measures, if any, exist which can be applied for each hazard. More than one control measure may be required to control a specific hazard(s) and more than one hazard may be controlled by a specified control measure.

For example, if a HACCP team were to conduct a hazard analysis for the liquid milk process, pathogens (e.g. *Streptococcus, Pseudomonas, Lactobacillus*) in the raw milk would be identified as hazards. Random milk sampling, time/temperature control etc. are the control measures which can be used to eliminate these hazards. This hazard analysis summary/information could be presented in the format presented in Table 13.1 or alternatively it could be a narrative summary of the HACCP team's hazard analysis considerations and a summary table listing only the hazards and associated control measures.

Table 13.1: Liquid milk – hazard analysis

Step	Potential Hazard(s)	Justification	Hazard to be addressed in plan? Y/N	Control Measure(s)
1. Receipt/Delivery of milk	• Microbiological hazard • Physical – hay, grass, hair or any other foreign matter • Chemical – urea etc. • Dirty equipments	Pathogens have been associated with outbreaks of foodborne illness from raw milk	Y	• Specification compliance –random milk sampling • Time, temperature control • Usage of clean equipment • Proper covering

Next principle to be applied in the HACCP plan is to determine the CCP(s) as discussed in the next step.

Determine Critical Control Points (Principle 2)

As you already know, a critical control point is defined as a step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level. The information developed during the hazard analysis is essential for the HACCP team in identifying which steps in the process are CCPs. There may be more than one CCP at which control is applied to address the same hazard. The determination of a CCP in the HACCP system can be facilitated by the application of a decision tree. A CCP decision tree, as you may recall reading earlier in section 13.2, is a sequence of questions to assist in determining whether a control point is a CCP. A decision tree to identify CCP in liquid milk process is illustrated in Figure 13.4 which indicates a logic reasoning approach.

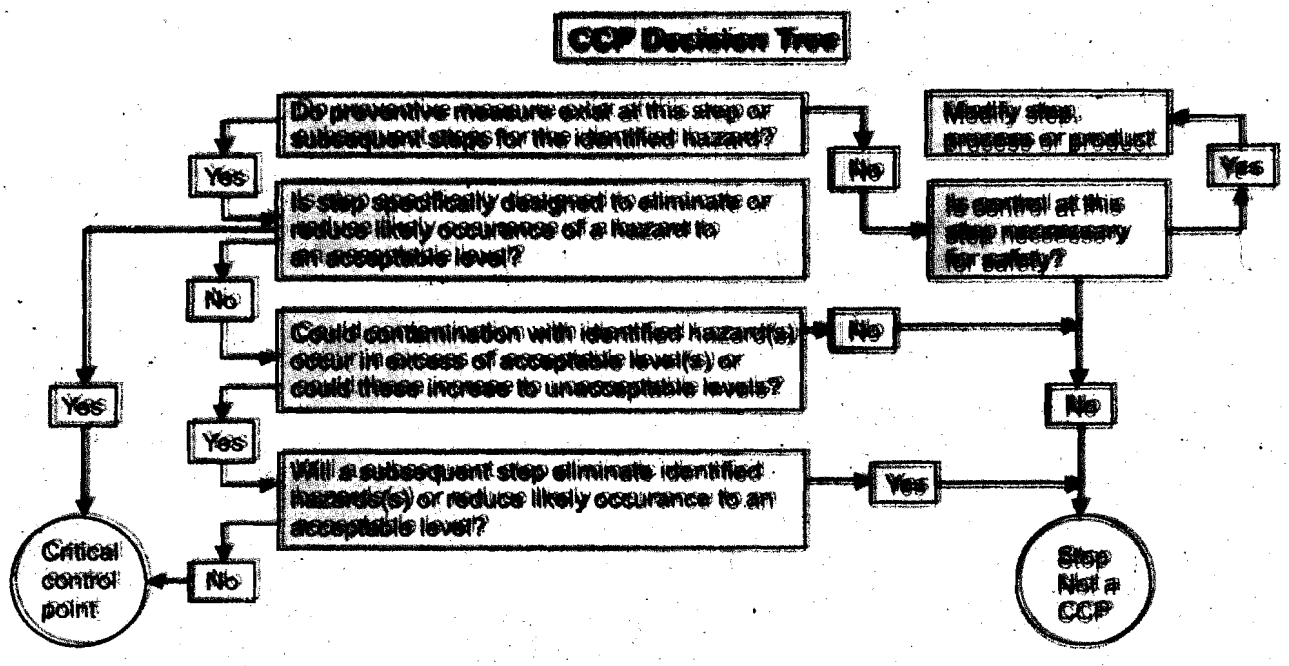

Figure: 13.4: Decision tree to identify CCPs in liquid milk process

As you may have noticed in Figure 13.4, if a hazard has been identified at a step where control is necessary for safety, and no control measure exists at that step, or any other, then the product or process should be modified at that step, or at any earlier or later stage, to include a control measure.

Examples of CCPs may include: thermal processing, chilling, testing ingredients for chemical residues, product formulation control and testing product for metal contaminants. For example, a specified heat process, at a given time and temperature designed to destroy a specific microbiological pathogen, could be a CCP. Likewise, refrigeration of a precooked food to prevent hazardous microorganisms from multiplying, or the adjustment of a food to a pH necessary to prevent toxin formation could also be CCPs. *Pasteurization* and *storage of processed milk* (processed milk silo) are the two CCPs in the liquid milk process example we have taken above and these CCPs are also highlighted in the process flow diagram in Figure 13.3.

Having identified the CCP, the next step is to establish the critical limits. Let us learn how.

Establish Critical Limits for each CCP (Principle 3)

A critical limit, as you already know, 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 the occurrence of a food safety hazard. Criteria often used include measurements of temperature, time, moisture level, pH, water activity(a_w), and sensory parameters such as visual appearance and texture.

Taking the example of liquid milk, the process should be designed to ensure the production of a safe product. The hazard analysis, conducted earlier, identified pathogens (e.g., *Streptococcus, Pseudomonas, Lactobacillus*) as significant biological hazards. Furthermore, it identified *pasteurization* and *storage* of processed milk as the step in the process at which control can be applied to eliminate the pathogens (i.e.CCP). To ensure that an acceptable level is consistently achieved, accurate information is needed on the probable number of the pathogens in the raw milk, their heat resistance, the factors that influence the heating of milk etc. Collectively, this information forms the scientific basis for the critical limits that are established. Table 13.2 illustrates the critical limits for each CCP in the liquid milk process.

Table 13.2: Critical limits for CCP

Process Step	CCP	Critical Limits
1. Pasteurization	YES	Temperature: 77 ± 2°C
2. Storage of processed milk	YES	Temperature < 7°C

Once the critical limits have been established, the next principle indicates setting up of monitoring systems as discussed next.

Establish a Monitoring System for each CCP (Principle 4)

Monitoring, we learnt, 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. Monitoring serves three main purposes. These are:

- First, monitoring is essential to food safety management in that it facilitates tracking of the operation. If monitoring indicates that there is a trend towards loss of control, then action can be taken to bring the process back into control before a deviation from a critical limit occurs.
- Second, monitoring is used to determine when there is a loss of control and a deviation occurs at a CCP, i.e. exceeding or not meeting a critical limit. When a deviation occurs, an appropriate corrective action must be taken.

- Third, it provides written documentation for use in verification.

Examples of monitoring activities include: visual observations and measurement of temperature, time, pH and moisture level. 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. For example, the safety of pasteurized milk is based upon measurements of time and temperature of heating rather than testing the heated milk to assure the absence of surviving pathogens.

There are many ways to monitor critical limits on a continuous or batch basis and record the data on charts. Continuous monitoring is always preferred when feasible. During monitoring wherever deviations are observed, it is important to establish corrective action, as described in the next step.

Establish Corrective Actions (Principle 5)

An important purpose of corrective actions is to prevent foods which may be hazardous from reaching consumers. Where there is a deviation from established critical limits, corrective actions are necessary. Specific corrective actions must be developed for each CCP in the HACCP system in order to deal with deviations when they occur.

The actions must ensure that the CCP has been brought under control. Actions taken must also include proper disposition of the affected product. Deviation and product disposition procedures must be documented in the HACCP record keeping. As a minimum, the HACCP plan should specify what is done when a deviation occurs, who is responsible for implementing the corrective actions and that a record will be developed and maintained of the actions taken.

Next, establish procedures for verification. Let us see how.

Establish a Verification Procedures (Principle 6)

Verification is defined as *those activities, other than monitoring, that determine the validity of the HACCP plan and that the system is operating according to the plan.* Verification and auditing methods, procedures and tests, including random sampling and analysis, can be used to determine if the HACCP system is working correctly. The frequency of verification should be sufficient to confirm that the HACCP system is working effectively. Examples of verification activities include:

- review of HACCP system and its records
- review of deviations and product dispositions, and
- confirmations that CCPs are kept under control.

An example of a HACCP verification schedule is given in Table 13.3 for your reference.

Table 13.3: Example of a HACCP verification schedule

Activity	Frequency	Responsibility	Reviewer
Verification activities scheduling	Yearly or upon HACCP system change	HACCP Coordinator	Plant Manager
Initial validation of HACCP Plan	Prior to and during initial implementation of plan	Independent Expert(s)[a]	HACCP Team
Subsequent validation of HACCP Plan	When critical limits changed, significant changes in process, equipment changed, after system failure, etc.	Independent Expert(s)[a]	HACCP Team
Verification of CCP monitoring as described in the Plan	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)

Activity	Frequency	Responsibility	Reviewer
Review of monitoring, corrective action records to show compliance with the Plan	Monthly	Quality assurance	HACCP team
Comprehensive HACCP system verification	Yearly	Independent expert(s)[a]	Plant manager

[a] Done by others than the team writing and implementing the plan. May require additional technical expertise, as well as, laboratory and plant test studies.

The last principle of the HACCP system is documentation and record keeping.

Establish a Documentation and Record Keeping (Principle 7)

Remember, an efficient and accurate record keeping is essential to the application of a HACCP system. HACCP procedures should be documented. Documentation and record keeping should be appropriate to the nature and size of the operation. Examples of records are:

- CCP monitoring activities
- deviations and associated corrective actions
- modifications to the HACCP system, and
- HACCP worksheet. A format of a HACCP worksheet is presented in Figure 13.4.

With this, we come to an end on the study of the principles of HACCP and their application in ensuring food safety. To help you understand this concept better, we have included a complete HACCP plan for liquid milk in Table 13.5.

Two additional case studies – Manufacture of Vegetable Biryani and Manufacture of Sausage Products – where the HACCP system has been used to ensure quality and safe products have been included. These case studies will help you understand the seven principles and their application in producing safe food. Go ahead and read section 13.8. But first just let us see what is the HACCP status in India .

13.7 THE HACCP STATUS IN INDIA

The HACCP situation in the overall food industry in India is still very dismissal. What ever small efforts that have been made have been limited to the organized sector which, as such, has a small share in the overall industry. For example, the organized dairy sector, which apply HACCP principles in providing safe milk to consumers, just constitutes 15-16 percent of the entire dairy industry. Nevertheless, it is heartening to see the progress made in HACCP implementation by dairy, marine and biscuit making industries.

In the Indian context, where the food safety management systems is not fully developed and the resources are scarce, there is a need to develop a strategy for implementing the HACCP system in a phased manner across all pertinent sectors and scales of the industry, particularly the unorganized sector. The various barriers being faced to the implementation of HACCP include:

- lack of concerted efforts by stakeholders

- lack of customer and business demand
- financial constraints
- human resource constraints, and
- inadequate infrastructure and facilities.

Describe Product

Process Flow Diagram

HACCP Plan

Step	Hazard(s)	Control measures	CCPs	Critical limit(s)	Monitoring procedures	Corrective action (s)	Records

Verification

Figure 13.4: HACCP worksheet format example

Table 13.5: HACCP plan for liquid milk

Sl. No.	Process step	CCP	Critical limit	Monitoring				Corrective action	Record	Verification			
				What	How	when	Who			What	How	When	Who
1.	Pasteurization	Temp	77±2°C	Past Temp	Computerized automatic control system	Conti nuously during processing	Plant Shift Operator I/C Lab once in a shift	Stop processing/ re-process In case Phosphatase test is positive	Computer stored records maintained for 30 days	Temp Record *calibra-tion status	*Scrutiny *Check temp *Phos. Test *Cal. Status	Fort-nightly	Section I/C QAQS
2.	Storage of Processed Mil	Temp	≤7°C	Temp	Computerized automatic control system	Conti-nuously during processing	Plant Shift Operator I/C lab	Silo with higher temp Prioritized for despatch/ deep chilled through glycol	Computer stored records maintained for 30 days	*Record of Temp *MBR time	*Scrutiny *Record Checking at site	Fort-Nightly	Section I/C QAQS

Check Your Progress Exercise 3

1) List the three common hazards encountered in liquid milk process.

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2) What do you understand by a decision tree?

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3) What are the critical control points and the critical limits in the liquid milk process?

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4) Why should we establish a monitoring system in a HACCP plan?

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13.8 HACCP CASE STUDIES

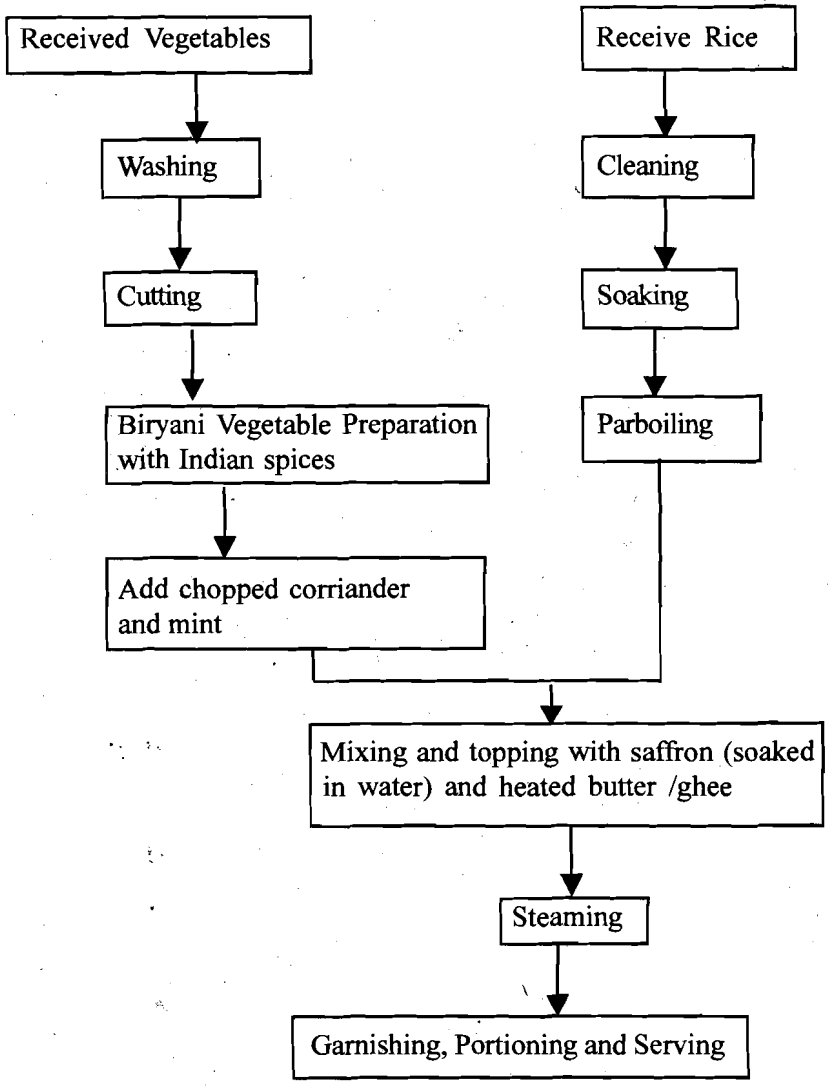
In this section we shall get to know about the application of HACCP principles through the study of two case studies (1) Manufacture of Vegetable Biryani, and (2) Manufacture of Sausage Product.

Vegetable biryani, as you may already know, is a tasty dish prepared from rice and seasonal vegetables, eaten all across the country. Sausage too is a food consisting of finely chopped meat mixed with seasonings and, often, other ingredients, all encased in a thin membrane, Manufacturing of these food items following HACCP principles is described in this section. Let us begin with the Case Study on 'Vegetable Biryani'.

Case Study 1: Manufacture of Vegetable Biryani

Within this case study the flow chart and the HACCP Plan for the vegetable biryani is included.

A: Vegetable Biryani Flow Chart



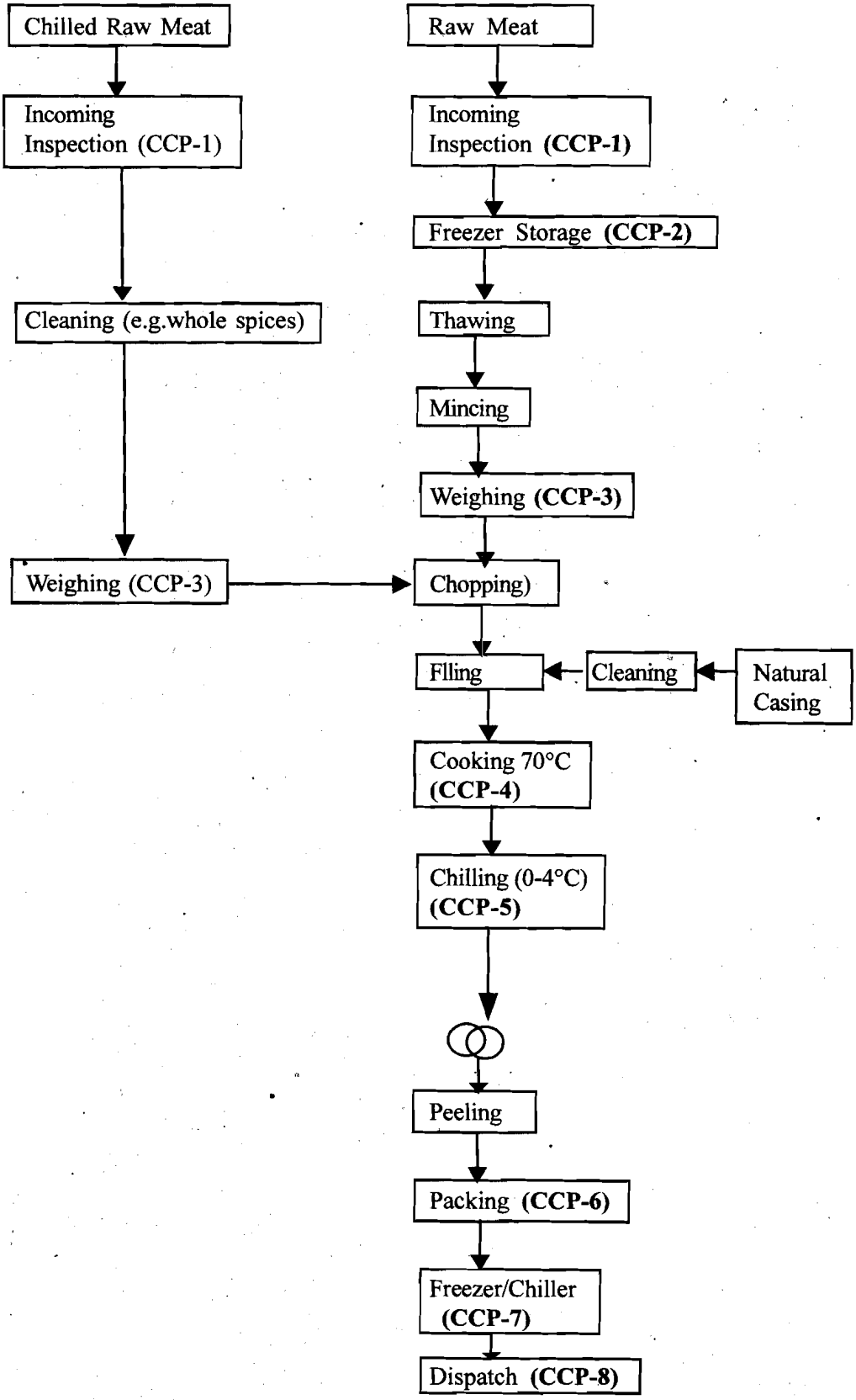
B. Vegetable Biryani – HACCP Plan

Process Step	Hazards	Preventative measures	CCP	Critical limits	Monitoring	Corrective actions
1. Receiving	*Pathogens *Foreign Objects worms, insects etc.	*Visual inspection *Specification complaince *Product labeling and expiry check	Yes	*No visible insect infestation *No Foreign objects in material	*Visual Daily Inspection/ Sampling	*Reject, if insect infestation dirt/ foreign objects found *Vendor Quality Assurance
2. Washing & Cleaning	*Pesticide *Foreign Objects worms, insects etc.	*wash and disinfect with chlorine *Cleaning physically to avoid foreign objects	Yes	*Disinfect with 100 ppm chlorine *Foreign object within tolerable limits	*Chlorine strips test *Records of foreign objects	*If chlorine dosage is not as per limits rectify as required *Vendor Quality Assurance
3. Cutting & Soaking	*Microbial cross contamination *Foreign objects *Un-potable water	*Right type of knives and cutting boards *Potable water supply *Random water testing	No	*Microbiological standards	Random microbiological tests	*Personnel Hygiene and Training *Cleaning of water storage tank regularly
4. Vegetable & Rice Prep.	*Microbial growth/cross contamination *Foreign objects *Dirty Equipment	*Temp. control *Adherence to SOP's *Usage of clean Equip *Proper Covering during the preparation	Yes	*Temperature (> 75°C)	*Temp checks *Visual inspection	*Personnel Hygiene & Training
5. Mixing & Topping	*Microbial growth/corss contaimination *Foreign objects *Dirty Equipment	*Time & Temp. Cotrol *Adherence to SOP's *Usage of clean equip. *Proper covering during the preparation	Yes	*Temperature & time (>60°C within 30 minutes) *Microbiological standards	*Random microbiological tests *Temp checks *Visual inspection	*Personnel Hygiene & Training *Discard if in doubt.
6. Garnishing Portioning & Serving	*Microbial growth/cross contaimination *Foreign objects *Dirty portioning service ware	*Time & Temp control *Usage of clean portioning & service ware *Proper covering during the service	No	*Serving temperature and exposure within tolerable limits	*Visual inspection	*Personnel Hygiene and Training *Discard if in doubt.

Case Study II: Manufature of Sausage Products

Here we will first look at the flow chart for manufacture of sausage product, followed by the HACCP Plan for sausages and finally present the Hazard Analysis Worksheet for sausages. So lets's get started.

A: Flow Chart for Sausage Products



B: Haccp Plan (Sausage)

CCP No. & Location	Hazards	Preventive Measures	Critical Limits	Monitoring				Corrective Action	Records	Verification Procedure & Frequency
				What	How	Freq.	Who			
CCP 1 (BCP) Receiving of raw meat	**B :** Pathogens **C :** Veterinary Drug Residue **P :** Feathers, bones, insects etc.	▪ Temperature control of incoming meat & meat cuts. ▪ Supplier's certificate conforming to specifications. ▪ Physical inspection	Maximum temperature of incoming a) fresh chilled meat: 5 °C b) frozen meat : - 18°C Micro. & other specifications	Core temperature of raw meat Micro. count of raw meat.	Food probes Sampling & micro. analysis of raw meat	Every lot received Every lot received	Receiving in-charge QA Staff	Supplier to be warned in case of temp. requirement being not met. QC to de-list the supplier in case of temp abuse after three consecutive warnings. If the micro. lab results indicate failure of three consecutive raw meat samples, de-list the supplier.	Receiving Record Micro. lab analysis	QA Executive to verify receiving records daily / weekly.
CCP 1 (BCP) Receiving of non meat ingredients	**B :** Pathogens, moulds **C :** Pesticide Residue **P :** Foreign objects	Branded / *ISI; FPO; Agmark* ingredients; Supplier's certificate conforming to agreed specifications. Physical inspection	Contractual specifications	Conformance of ingredients to laid down specifications	Visual inspection & supplier certificate	Every lot received	Receiving in-charge	Material to be returned to supplier if not found as per specifications. De-list the supplier in case of three consecutive rejections.	Receiving Record	QA Executive to verify receiving records daily / weekly.

CCP No. & Location	Hazards	Preventive Measures	Critical Limits	Monitoring				Corrective Action	Records	Verification Procedure & Frequency
				What	How	Freq.	Who			
CCP 2 (B) Storage of raw meat	**B:** Microbial proliferation	Monitoring of freezer/ chiller temperatures	Storage temp. norms	Chiller freezer temp	Temp. gauges	Every three hours in work shift	Chilled Store In-charge	Inform maintenance department in case of deviation	Raw Meat Storage Temperature records	Verification every day / week by QA Executive
CCP 3 (BCP) Weighing & mixing of ingredients & additives	**B:** Pathogens may proliferate due to cross contamination	Cleaning and sanitization of plant, equipment and personal hygiene	Company Hygiene Standards	Plant, equipment & personal hygiene	Visual inspection, equipment & hand swabs	Weekly	Prod. Executive & QA staff	In case of adverse swab reports the cleaning and sanitization schedule to be reviewed	Swab reports	Verification by QA Executive daily / weekly
	C : Additives may be added in excess	Physical cleaning & pre weighment of ingredients and additives in requisite batch quantities	As per recipe	Additives being weighed	Weighing balance	Every batch	Prod. in-charge	Reject the remaining lot of any ingredient / additives in which foreign object was detected & follow up with respective supplier.	Requisition slip	Production Executive to verify daily.
	P : Foreign objects		Absence of any foreign object	Presence of any foreign object in ingredients & additives	Visual inspection	Every batch			Foreign object incident report	Random verification by QA Executive
CCP 4 (B) Cooking	**B :** Pathogens may proliferate if norms are not maintained.	Monitoring of cooking time & temp of all lots.	Company Process Standards	Cooking temperature & time	Food probes & gauges	Every cooking lot	Operator/ Prod. Executive	Reprocessing in case of deviation / other use / discard	Cooking records	QA Executive to verify every day / week.
CCP 5 (B) Chilling	**B :** Pathogens may remain if chilling is not done rapidly and temp norms are not maintained.	Monitoring of chilling time & temperature.	Company Process Standards	Chilling temperature & time	Food probes & gauges	Every cooked lot	Operator	Chilling with blast chiller / potable ice to be carried out in event of desired chilling temp. not attained	Chilling records	QA Executive to verify every day / week.

CCP No. & Location	Hazards	Preventive Measures	Critical Limits	Monitoring				Corrective Action	Records	Verification Procedure & Frequency
				What	How	Freq.	Who			
CCP 6 (BP) Packaging	**B:** Pathogens may proliferate if temperature abuse takes place or due to improper personal hygiene **P:** Foreign objects, casing material fragments.	▪ Avoid exposure of product to ambient temperatures ▪ Hands to be cleaned and sanitized before start up & at regular intervals during packaging ▪ Inspection of packaging material, product during packing and visual inspection of packed products for seal integrity & foreign objects.	Company process & product standards	Product exposure to ambient temperatures Personal Hygiene	Packaging time Hand swabs Visual inspection	Every cooked lot Every alternate day Every packing operation	Packaging In-charge QA staff Packaging In-charge	Chill the packaged product in deep / chiller if temperature abuse takes place. In case of adverse swab reports the personal hygiene, training & monitoring to be reviewed	Packaging records Swab reports	QA Executive to verify daily / weekly.
CCP 7 (B) Prod. Storage Freezers & Chillers	B: Microbial proliferation	Monitoring of freezers / chillers temperature	Storage temp. norms	Chiller freezer temp	Temp. gauges	Every three hours in work shift	Chilled Store In-charge	Inform maintenance department in case of deviation	Product Storage Temperature records	Every day/ week by QA Executive
CCP 8 (B) Dispatch	B: Microbial proliferation	Monitoring of Dispatch temperatures.	Dispatch temp norms	Dispatch temp	Food probe	Every dispatch	Dispatch In-charge / Security personnel	Inform QA of noncompliance and chill the products	Dispatch temperature records	Every day / week by QA Executive

C: Hazard Analysis Worksheet (Sausage)

(1)	(2)	(3)	(4)	(5)	(6)
Ingredient/processing step	**Identify potential hazards introduced, controlled or enhanced at this step (1)**	**Are any potential food-safety hazards significant? (Yes/No)**	**Justify your decisions for column 3.**	**What preventative measures can be applied to prevent the significant hazards?**	**Is this step a critical control point? (Yes/No)**
Receiving raw boneless meat	B: Pathogens C: Veterinary drug residues P: Feathers, bones, insects	Yes	Receiving of non-conforming raw meat, particularly with high pathogenic counts.	▪ Temperature control of incoming meat & meat cuts. ▪ Supplier's certificate conforming to agreed specifications. Physical inspection	Yes (CCP1)
Receiving of non meat ingredients a) Spices	B: Microbial/ Mycotoxins contamination C: Pesticide Residues P: Foreign objects	Yes	While the microbial load can be reasonably controlled in subsequent processes, the mycotoxin and pesticide residues cannot be eliminated if contaminating the raw material.	Branded / *ISI / Agmark / FPO* marked ingredients; Supplier's certificate conforming to agreed specifications on random basis.	Yes (CCP1)
b) Sugar	B: Moulds C: None P: Foreign objects	Yes	Beyond the microbiological and chemical hazards, the risks of foreign matter contributing as physical hazard in the raw material needs to be controlled.	Physical inspection; vendor audits	
c) Salt	B: None C: None P: Foreign objects	Yes			
Storage of meat ingredients	B: Microbial proliferation C: None P: None	Yes	Pathogens may proliferate if temperatures are not maintained.	Monitoring of freezers / chillers temperature	Yes (CCP2)
Storage of non meat ingredients	B: None C: None P: None				No

(1)	(2)	(3)	(4)	(5)	(6)
Ingredient/processing step	**Identify potential hazards introduced, controlled or enhanced at this step (1)**	**Are any potential food-safety hazards significant? (Yes/No)**	**Justify your decisions for column 3.**	**What preventative measures can be applied to prevent the significant hazards?**	**Is this step a critical control point? (Yes/No)**
Mincing	B: Microbial contamination & proliferation if equipment is not sanitized properly. C: None P: None	No	Microbial load can be reasonably controlled in subsequent process step of cooking / sterilization.	-	No
Mixing and weighing of ingredients and additives	B: Pathogens may proliferate due to cross contamination C : Additives may be added in excess P : Foreign objects	Yes	This process step accounts for considerable manual handling and the possibilities of contamination, foreign objects are high.	▪ Cleaning and sanitization of plant, equipment and personal hygiene ▪ Physical cleaning & pre weighment of ingredients and additives in requisite batch quantities	Yes (CCP3)
Chopping	B: Microbial contamination. C: None P: None	No	Microbial load can be reasonably controlled in subsequent process step of cooking / sterilization.		No
Preparation of natural casing	B: Pathogens C: None P: None	No	Microbial load can be reasonably controlled by proper storage, handling and subsequent process step of cleaning, cooking / sterilization.		No
Filling	B: None C: None P: None				No
Cooking	B: Pathogens proliferation C: None P: None	Yes	Pathogens may proliferate if time and temperature norms are not maintained.	Monitoring of time and temperature of all lots.	Yes (CCP4)

(1)	(2)	(3)	(4)	(5)	(6)
Ingredient/processing step	**Identify potential hazards introduced, controlled or enhanced at this step (1)**	**Are any potential food-safety hazards significant? (Yes/No)**	**Justify your decisions for column 3.**	**What preventative measures can be applied to prevent the significant hazards?**	**Is this step a critical control point? (Yes/No)**
Chilling	B: Pathogens proliferation C: None P: None	Yes	Pathogens may proliferate if chilling is not done rapidly and temperature norms are not maintained.	Monitoring of chilling time and temperature.	Yes (CCP5)
Peeling	B: Microbial contamination & proliferation C: None P: None	No	Microbial load can be reasonably controlled by proper handling.		No
Packaging	B: Microbial contamination & proliferation P: Foreign objects	Yes	Bacteria may proliferate if temperature abuse takes place or due to improper sealing and personal hygiene. Casing material fragments may be carried with the product	▪ Avoid exposure of product to ambient temperatures. ▪ Hands to be cleaned and sanitized before start up & at regular intervals during packing ▪ Inspection of packing material, product during packing and visual inspection of packed products for seal integrity & foreign objects.	Yes (CCP 6)
Product Storage (Freezers & Chillers)	B: Microbial proliferation C: None P: None	Yes	Pathogens may proliferate if temperatures are not maintained.	Monitoring of freezers / chillers temperature	Yes (CCP 7)
Dispatch	B: Microbial proliferation C: None P: None	Yes	Pathogens may proliferate if temperature norms are not maintained.	Monitoring of product dispatch temperatures.	Yes (CCP 8)

13.9 LET US SUM UP

This unit introduced us to the concept of HACCP, which stands for Hazard Analysis Critical Control Point. We learnt that HACCP offers a preventive and a cost effective approach to food safety.

It is now well known that the end product inspection and testing and even 100 percent inspection does not provide safety of food. It has inherent limitation of mapping the potential hazards that could be present in a lot of raw material or food product. Further, with the rampant rise in contaminants in the environment and the food chain, there are increasing concerns today among the consumers about the food they have to eat. It is in this context that, we learnt HACCP offers greater confidence in the food chain through evolving of a preventive food safety assurance system. Besides enhancing food safety, HACCP implementation is today vital for us as a nation on account of International obligations like Agreements on Sanitary and Phytosanitary Measures (SPS) and Technical Barriers to Trade (TBT).

Among the benefits, the Unit highlihgted that the HACCP system overcomes many of the limitations of the traditional approaches to food safety control (generally based on 'snap-shot' inspection and end product testing). In addition, it offers several benefits to the consumers, industry and government.

Finally the Unit focussed on the preliminary task and the principles involved in applying HACCP in a food industry.

13.9 GLOSSARY

Aspect : an element of the food business operation (products, processes, PRP, services) that can interact with the food safety.

Certification : action by a third party demonstrating that adequate confidence is given that a duly identified product, process or service conforms with a specific standard or other normative document.

Control measure : any action and activity that can be used to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

Corrective action : any action to be taken when the results of monitoring at the CCP indicate a loss of control.

Flow diagram : a systematic representation of the sequence of steps or operations used in the preparation, processing, manufacturing, packaging, storage, transportation, distribution, handling or offering for sale of a particular food item.

Food business operator : the person or persons responsible for ensuring that the requirements of the food legislation are met within the food business under his/their control.

Food handler : any person who directly handles packaged or unpacked food, food equipment and utensils, or food contact surfaces and is therefore expected to comply with food hygiene requirements.

Food hygiene : all conditions and measures necessary to ensure the safety arid suitability of food at all stages of the food chain.

(1)	(2)	(3)	(4)	(5)	(6)
Ingredient/processing step	**Identify potential hazards introduced, controlled or enhanced at this step (1)**	**Are any potential food-safety hazards significant? (Yes/No)**	**Justify your decisions for column 3.**	**What preventative measures can be applied to prevent the significant hazards?**	**Is this step a critical control point? (Yes/No)**
Chilling	B: Pathogens proliferation C: None P: None	Yes	Pathogens may proliferate if chilling is not done rapidly and temperature norms are not maintained.	Monitoring of chilling time and temperature.	Yes (CCP5)
Peeling	B: Microbial contamination & proliferation C: None P: None	No	Microbial load can be reasonably controlled by proper handling.		No
Packaging	B: Microbial contamination & proliferation P: Foreign objects	Yes	Bacteria may proliferate if temperature abuse takes place or due to improper sealing and personal hygiene. Casing material fragments may be carried with the product	▪ Avoid exposure of product to ambient temperatures. ▪ Hands to be cleaned and sanitized before start up & at regular intervals during packing ▪ Inspection of packing material, product during packing and visual inspection of packed products for seal integrity & foreign objects.	Yes (CCP 6)
Product Storage (Freezers & Chillers)	B: Microbial proliferation C: None P: None	Yes	Pathogens may proliferate if temperatures are not maintained.	Monitoring of freezers / chillers temperature	Yes (CCP 7)
Dispatch	B: Microbial proliferation C: None P: None	Yes	Pathogens may proliferate if temperature norms are not maintained.	Monitoring of product dispatch temperatures.	Yes (CCP 8)

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Food hygiene : all conditions and measures necessary to ensure the safety arid suitability of food at all stages of the food chain

Food safety	:	assurance that food will not cause harm to the customer when it is prepared and/or eaten according to its intended use.
Food suitability	:	assurance that food is acceptable for human consumption according to its intended use,
General Control Measure:		see: Control measure, general
Good manufacturing practices (GMPs)	:	standards published in the Code of Federal Regulations and used by the Food and Drug Administration to ensure the quality of marketed products and that products are produced under sanitary conditions.
HACCP audit	:	a systematic and independent examination to determine whether the HACCP system, including the I-IACCP plan and related results, comply with planned arrangements, are implemented effectively and are suitable for the achievement of its objectives.
HACCP based Food Safety System	:	a HACCP system; the organizational structure, procedures, processes and resources needed to execute the HACCP plan(s) and meet its objectives.
Monitoring	:	the act of conducting a planned sequence of observations or measurement of control parameters to assess whether a CCP is under control.
Pre-requisite Programme (PRP)	:	any specified and documented activity or facility implemented in accordance with the Codex General Principles of food hygiene, good manufacturing practice and appropriate food legislation, in order to establish basic conditions that are suitable for the production and handling of safe food at all stages of the food chain.
Preventive action	:	any measure or activity that will be used to prevent, to eliminate or to reduce the recurrence of causes for existing deviations, defects or any other undesired situation with respect to food safety.
Primary production	:	those steps in the food chain up to and including harvesting, hunting, fishing, milking and all stages of animal production prior to slaughter.
Products, unprocessed	:	foodstuffs which have not undergone a treatment, including products which have been, for example, divided, parted, severed, boned, minced, skinned, ground, cut, cleaned, trimmed, husked or milled, chilled, frozen or deep-frozen.
Products, processed	:	foodstuffs resulting from the application to unprocessed products of a treatment such as heating, smoking, curing, maturing, pickling, drying, marinating, extraction, extrusion, etc. or a combination of these processes and/or products; substances necessary for their manufacture or for giving specific characteristics to the products may be added
Risk	:	the probability of causing an adverse health effect caused by the occurrence and the severity of a particular hazard in food when prepared and consumed according to its intended use.

Validation : obtaining evidence (in advance) that the specific and general control measures of the HACCP plan are effective.

Verification : the application of methods, procedures, tests and other evaluations, in addition to monitoring, to determine compliance with the specifications laid down in the HACCP plan and the effectiveness of the HACCP-based Food Safety System.

13.10 ANSWERS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress Exercise 1

1) The term HACCP means a systematic, science-based preventive approach used in food production as a means to assure food safety. The benefits of HACCP include: reduced risk of food borne diseases, increased awareness of basic hygiene for consumers, increased market access, reduction in production costs and increased consumer and government confidence.

2) HACCP is a better and effective method over traditional food safety assurance programmes because traditional food safety assurance programmes focused only on identifying problems in the finished product while HACCP being a recent proactive, preventive technique focuses on identifying potential problems and controlling them during the design, production and every stage of food operation.

3) There is a need for HACCP in maintaining international standards in food trade as it reduces the risks of food borne disease outbreaks, ensures food safety for consumers.

Check Your Progress Exercise 2

1) The seven principles of HACCP are:

   Principle 1: Conduct a hazard analysis.

   Principle 2: Determine the Critical Control Points (CCPs).

   Principle 3: Establish critical limit(s)

   Principle 4: Establish a system to monitor control of the CCP.

   Principle 5: Establish the corrective action to be taken when monitoring indicates that a particular CCP is not under control.

   Principle 6 Establish procedures for verification to confirm that the HACCP system is working effectively.

   Principle 7 Establish documentation concerning all procedures and records appropriate to these principles and their application.

2) Assemble the HACCP Team

   Describe the Food and its Distribution

   Describe the Intended Use and Consumers of the food

   Develop a Flow Diagram which Describes the process

   Verify the Flow Diagram

Check Your Progress Exercise 3

1) The three common hazards encountered in liquid milk process are microbiological hazards, physical hazard– hay, grass, hair or any other foreign matter and chemical hazards – urea etc.

2) A decision tree is a process which helps in the determination of CCP in a HACCP system. A sequence of questions are formulated to assist in determining whether a control point is a CCP.

3) The critical control point for liquid milk are pasteurization and storage of processed milk. The critical limit for pasteurization, which is a CCP, is 77 $\pm$ 2°C. The critical limit for storage of processed milk is storage at temprature less than 7°C.

4) Monitoring is essential as it facilitates the tracking of the operation. It helps determine where there is a loss of control and if any deviation occurs at the CCP. When and if a deviation occurs, a corrective action can be taken. Finally, monitoring provides written documentation for use in verification.