

Implementing Hazard Analysis Critical Control Points (HACCP) in a Food Plant

by Marcia Nathai-Balkissoon¹ and Nagamuttu S. Arumugadasan²

Abstract: Food safety is a significant quality aspect of any food product. A food safety management system using Hazard Analysis Critical Control Points (HACCP) is to identify 1) preventive steps to reduce hazards at each critical control point (CCP), 2) corrective responses if control limits are not met, and 3) documentation and verification requirements. This paper presents the implementation of a HACCP system for of a food manufacturer of flaked, ready-to-eat breakfast cereals in Trinidad. The company has implemented HACCP for its own benefit, and has not sought HACCP certification. The implementation has improved personal hygiene and sanitation practices, attained encouraging results of microbiological spot checks, and reduced customer complaints caused by internal infestation and extraneous matter by 71% and 83%, respectively. Improvements in good manufacturing practices were achieved in the areas of plant and equipment, operating procedures and policies. HACCP documents also assisted in training and contributed to the consistency of practices. The paper concludes by underlining the importance of maintaining an effective HACCP system that would require continual review and revamping, as changes to plant, equipment, or manufacturing procedures would introduce new hazards.

Keywords: Hazards, Critical Control Point, HACCP

¹ Maintenance Manager and Deputy Management Representative at Universal Foods Limited Universal Foods Limited, Pt. Lisas, Trinidad and Tobago; E-mail: mnathai@tstt.net.tt

² Lecturer, Department of Mechanical and Manufacturing Engineering, The University of the West Indies, St. Augustine, Trinidad and Tobago; E-mail: nsaru@eng.uwi.tt

Introduction

In order to cope with trade barriers and new regulatory and statutory trends, many companies are recognising the need to keep their systems and technologies up-to-date. Much of the world has been measuring supplier worth against conformance to the ISO 9000 series of quality standards. Where ISO guidelines can contribute to implementation of overall quality systems, there have been similar systems to deal with the environment, total productivity, and food safety to name a few. According to Hui *et al.* (2001), almost every country around the world has begun focussing on food safety in “intense and multifaceted” ways. The use of Hazard Analysis Critical Control Points (HACCP) is widely accepted as a food safety management system. An analysis of potentially hazardous areas within the plant is performed, and critical control points (CCPs), which must be monitored to ensure consumer safety, are identified. According to FAO (1998), a hazard is “a biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect”. A CCP may be considered as a location, procedure, or process in a food production operation where a chemical, microbiological or physical hazard can be minimised if proper control is maintained at that point (IAMFES, 1991). Control measures are implemented at each critical point. HACCP is therefore a proactive approach to building food safety into one’s food production or preparation process that depends on the common-sense application of both scientific and technical methods in the plant.

In Europe, companies use HACCP to escape public newspapers’ “naming and shaming” practice, which leads to loss of goodwill and sales. Adopting HACCP practice is also becoming a requirement by law in the USA and Canada. Wilm (1998) argues that

HACCP documentation may sometimes be the deciding factor in some “due diligence” lawsuits brought against food manufacturers by consumers. Like the certification of a company’s Quality Management System (QMS) that can assist in crossing trade barriers, so can implementation of a HACCP system. In addition to improving the quality of product by reducing inherent food safety hazards, HACCP may be a ticket to additional export markets while helping companies to maintain existing ones.

Comment: Should be Wilm, 1998 (copyright date), not wilm, 2001 (cited date)

This paper presents the implementation of a HACCP plan at a cereal plant, where the work was limited to traditional flaked products manufactured by the company in Trinidad. Hazards would constitute significant threats to consumers because they could be passed on through the company’s operations from receipt of raw materials and ingredients to the distribution of packaged products. In an attempt to improve safety management and operations, the company has designed a HACCP plan and defined five objectives of its implementation below:

- To understand and address the hygienic insufficiencies existing at the plant level;
- To review the flow of materials within the production areas;
- To identify potential hazards to consumer safety;
- To manage major hazards and determine preventive and corrective actions at each CCP; and
- To reduce customer complaints and improve satisfaction.

The Implementation of the HACCP Plan

Prior to beginning the development of a HACCP plan, the company has undertaken a thorough gap analysis of its existing prerequisite programmes and good manufacturing

practices (GMPs). This audit of premises, storage and materials handling, equipment performance and maintenance, personnel training, sanitation and personal hygiene, and health and safety recall procedures was used to compile a list of areas for improvement, complete with action plan and deadlines. The company has assigned the priorities and responsibilities, so that several tasks could be completed concurrently with the development and implementation of the HACCP system (Stevenson and Bernard, 1995; Bernard *et al.*, 1997; FAO, 1998). As shown in Table 1, five preliminary steps were then taken to facilitate the smooth and quick application of the seven basic HACCP principles.

(Insert Table 1 about here)

Table 1. The 12-step HACCP programme used by the company

A multidisciplinary team was selected to ensure that the widest possible range of expertise was available in conducting the exercise. The team consisted of all departmental managers, as this ensured company-wide participation in the study and implementation of initiatives. According to FAO (1998), an understanding of the product was essential to the success of the undertaking, so the next step was to describe the product and its ingredients and to consider its intended use. Templates modelled after those provided by CFIA (1993) and FAO (1998) were thus used in detailing the many factors pertinent to each item in the range of flaked products that fell under the scope of the study. Each product's characteristics (e.g. nutritional, organoleptic, moisture, etc.), raw materials, other inputs (e.g. water, steam, etc.), packaging, shelf life, labelling,

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distribution, and storage were considered, with special attention to the identification of “at-risk” consumers like very young or very old people.

In order to get an appreciation of the food manufacturing process, plant layout schematics were prepared and verified through audits conducted alongside the steering committee and involved staff. These considered building, facility, and equipment locations, material flow paths, and the areas where spillage and dead spots were most prevalent. A flow diagram was also generated to map out the steps in the manufacturing process, and to assist in identifying food carriers that could contribute to contamination of the food (Stevenson and Bernard, 1995; Bernard *et al.*, 1997).

The most detailed part of the HACCP project involved evaluation of the integral hazards of the operations (FAO, 1998). Flow charts and schematics, coupled with intensive physical reviews of personnel and processing methods, raw materials, design of facility, plant and equipment, extrinsic parameters, packaging, storage and distribution, were used to develop a comprehensive “gate to plate” list of potential hazards (Mortimore and Wallace, 1998; Unnevehr and Hirschhorn, 2000). Hazards were of three types: physical, chemical and biological, and their evaluation was largely qualitative in nature, due to the lack of numerical data and limited time available to complete the work.

Figure 1 shows the CCP decision tree that helped whittle the list down so continuous, stringent focus could be concentrated on the most significant hazards at CCPs. Since only crucial hazards were identified as CCPs, a simple serial numbering method was used instead of a hierarchical one. Monitoring of each CCP was necessary so safe product would exit that stage of production. This was achieved by stating what the safe and unsafe control limits were for some measurable parameters (e.g. temperature,

moisture, and time) at that CCP (Mortimore and Wallace, 1998). These parameters had to be quick and easy to measure and control, so that a problem would be readily identified (FAO, 1998). After identification of controlled parameters, proper documentation should be done, including who was responsible for monitoring those parameters and how often the checks had to be done.

(Insert Figure 1 about here)

Figure 1. A CCP decision tree

Using HACCP aims to control the CCPs and monitor process parameters regularly to keep them in line. The HACCP plan was documented including identification of the records that had to be maintained for each CCP in the process. These records were vital since they would prove that when products were made, operating and other named parameters were under control and any deviations were properly addressed (Forsythe and Hayes, 1998). In some circumstances, the eventuality of an out-of-control situation still had to be catered for. A corrective action plan was developed, to state what responses were necessary if a critical limit was not met, and who was expected to take such actions, to regain control of the process and/or prevent unsafe product from reaching the consumer (Mortimore and Wallace, 1998). Record keeping was a requisite whenever HACCP verification work was done (CFIA, 1993; FAO, 1998). Simple verification exercises were built into the HACCP plan, with the intention of continuously reviewing the effectiveness of the HACCP system even as future changes are effected throughout the company and its processes.

Results of HACCP Implementation

Based on the results of the gap analysis, improvement was needed in several areas including the defining of responsibilities and training, condition of premises, improvement of supervision and improvement of storage facilities. Improving sanitation was the major area of concern. Figure 2 shows a cause-and-effect diagram of poor sanitation that was identified during a brainstorming session. The ranking of causes to the problem was achieved using the nominal group method. A Pareto chart was then constructed based on these ratings, directly addressing the weakest areas: training, accountability, and thoroughness of the sanitation procedure.

(Insert Figure 2 about here)

Figure 2. A cause-and-effect diagram for sanitation problems in the plant

Several schematics were developed to identify key CCPs. These include the plant and equipment layout, the raw, packaging, and finished goods flow paths, and the dead spot and high spillage locations. The HACCP plan eventually considered only nine key CCPs. This was intentional in order that attention would be centred on a few key areas, instead of diluting it by focusing on too many less-important ones (Forsythe and Hayes, 1998). For example, the first CCP, called “CCP1”, controlled the hazard of “Insufficient pathogen destruction” by taking the preventive measure “Cooking at over 60°C and 20psi for over 65 minutes”. The process operator would monitor these critical limits for temperature, pressure and time every 30 minutes using temperature and pressure gauges, recorder charts, and a watch. Low readings would prompt the operator to report his

findings to the supervisor who would then advise on adjustments to the process settings. The Production and Technical Managers would make ultimate decisions on the acceptance or rejection of a batch. Batch cooking parameter and test records would be maintained by technicians and operators, and reviewed by the Plant Superintendent and Laboratory Supervisor. Besides, calibration records would be maintained for each gauge used in the monitoring of CCP1. Other hazards, while significant, were addressed at normal control points (CPs), where inspection procedures and other good manufacturing practices were considered sufficient for control (Sperber *et al.*, 1998; Notermans *et al.*, 1995).

The HACCP system was incorporated into the existing ISO 9001:2000 QMS in the company. Training, enforcement, verification, product safety checks, and audits of the HACCP system were all conducted under the umbrella of the QMS. This allows changes to be made via a familiar medium. When the gap analysis was being conducted, certain weaknesses concerning the company's GMPs were identified. Communication with department heads and supervisors who were expected to oversee the burn-in period of the programme was especially stringent and detailed, to ensure understanding and buy-in and to share some approaches that would be valuable for mentoring and enforcement at the operational level. Copies of the HACCP plan, schematics, flow charts and amended operating procedures were issued to every supervisor and department head. Next, employees were trained at discussion-oriented sessions, prompting employee feedback and responding to their concerns even as the subject matter was covered. Topics included personal hygiene and sanitation.

Throughout the project, the company communicated well with employees about the importance and necessity of HACCP imperatives. Company-wide awareness was promoted by eye-catching fliers and posters, which explained the basics of HACCP. Changes were effected within weeks of making corrective action decisions for any particular CCPs. In-depth training was done to ensure that staff knew which requirements had changed and which stayed constant. This step-by-step approach to HACCP implementation reduced employee stress. Changes were intermittent and fairly small, so an entire plan was not foisted on the staff all in one day. This also meant that supervisors and managers could gauge the effectiveness of each new procedure separately, based on its own merit and how closely employees adhered to it. Hence, fine-tuning was possible through continuous intervention and monitoring.

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Evaluation and Discussion

Several documents were developed, including product and process description sheets, plant schematics showing layouts and material flow paths, hazard listings, a HACCP master plan and a company policy handbook including hygiene requirements and health and safety mandates. Also, revised sanitation schedules include a focus on sanitation by zone. All documents contribute to the effectiveness of the HACCP programme as they are used in daily operations, audits, and training.

A gap analysis of company processes and systems targeted improvement of facility construction and design, and GMPs in sanitation, maintenance, storage, and training. A schematic of the plant layout and material flow paths was developed. Understanding material flow patterns has enabled company employees to understand the

inherent weaknesses of the system, including cross-contamination risks and dead spot areas. The schematic has become a tool used in induction of new employees, touring of visitors to the plant, and retraining of veteran employees.

A thorough listing of potential hazards, which could put a consumer at risk, was developed. This considered the physical, chemical, and microbiological threats that could have conceivably existed in the company. Hazard severity was then evaluated using the CCP decision tree, and a shortlist of the most critical hazards was generated. The major potential hazards that could occur at each process step were identified, the process step was identified as a CCP or just a CP, and a HACCP plan was developed to state those actions necessary to prevent hazards from bypassing each CCP. The plan also advises on corrective actions to be effected should critical limits be missed, so that a hazard gets past the CCP. The HACCP plan specifies what actions are needed, who holds responsibility, what records must be kept, and what must be done to verify that the plan is functioning effectively.

The HACCP plan has helped to significantly reduce risks that are passed to the consumer through the company's products, and this has been made clear from a review of customer complaints lodged in the year prior to HACCP, and the year in which the work was done. The number of complaints caused by internal infestation and extraneous matter have declined by 71% and 83%, respectively, and the root causes of complaints point less and less to contamination or infestation problems. Besides, there have been no microbiological problems noted in routine lab testing of packaged product or swabs taken around the plant. Additionally, as a further measure of the effectiveness of GMPs in the plant, a run chart was constructed for the number of cartons of finished product rejected

at the metal detector during the year of the HACCP works. The numbers of metal rejects decreased over 80% from 10.8 units per month before the implementation to 2.1 units per month during and after the implementation.

Conclusions

The company has implemented HACCP for its own benefits rather than for HACCP certification. The company's quest for continuous quality improvement was significantly enhanced with improving product safety under the HACCP system. As yet, acquiring a HACCP certification is not a condition of sale in Trinidad. However, achievements from HACCP implementation would promote the product in the eyes of customers.

In order to strengthen its HACCP implementation, the company should broaden qualitative hazard assessments to quantify consumer risk and potential hazard reduction (Notermans *et al.*, 1995). Necessary data should be collected and used to evaluate and adapt the HACCP plan. The HACCP system must also be revised to reflect ongoing changes to operating systems, plant, facilities, workforce and environment, as these will impact on the safety of the consumer's end product. As changes occur, each employee must be retrained, kept aware of his role, and held accountable for a clean workspace and safe product at his stage of the process. Moreover, consideration should be given to the value and application of control charts in maintaining process control in the Production and Laboratory areas, as this will allow continuous tracking of process parameters at CCPs.

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Table 1. The 12-step HACCP programme used by the company

Features	Descriptions
Preliminary Steps	1) Assemble HACCP team 2) Describe product 3) Identify intended use 4) Construct flow diagram 5) Verify flow diagram on-site
Principles of HACCP	1) Conduct hazard analysis 2) Determine CCPs 3) Establish critical limits for each CCP 4) Establish monitoring system for each CCP 5) Establish corrective actions 6) Establish verification procedures 7) Establish documentation and record-keeping

Source: Adapted from FAO (1998)

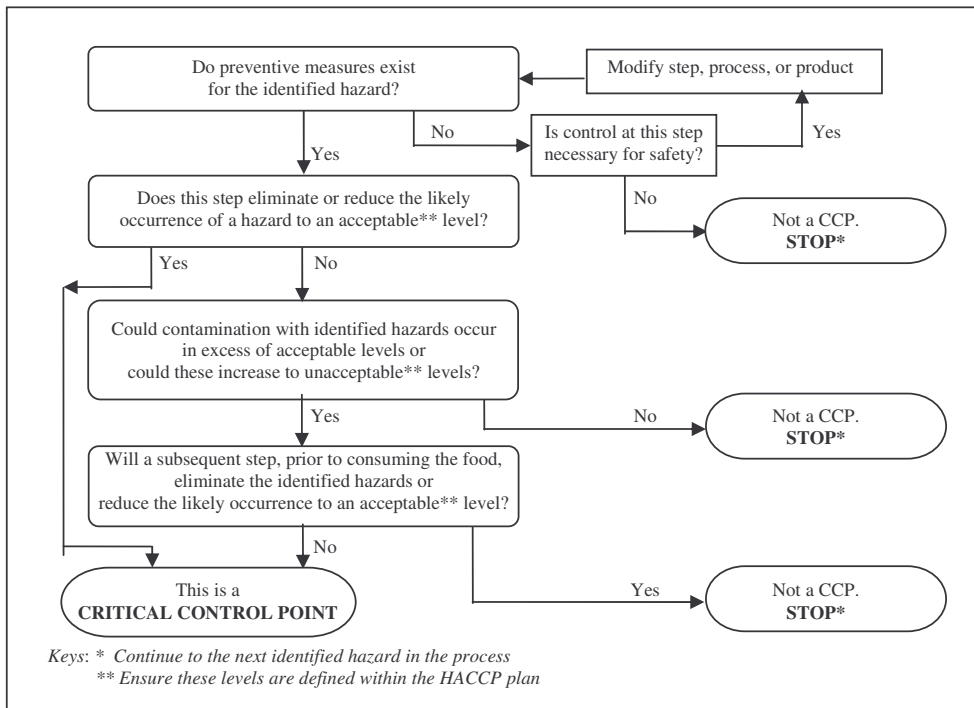


Figure 1. A CCP decision tree

Sources: Adapted from Stevenson and Bernard (1995); FAO (1998)

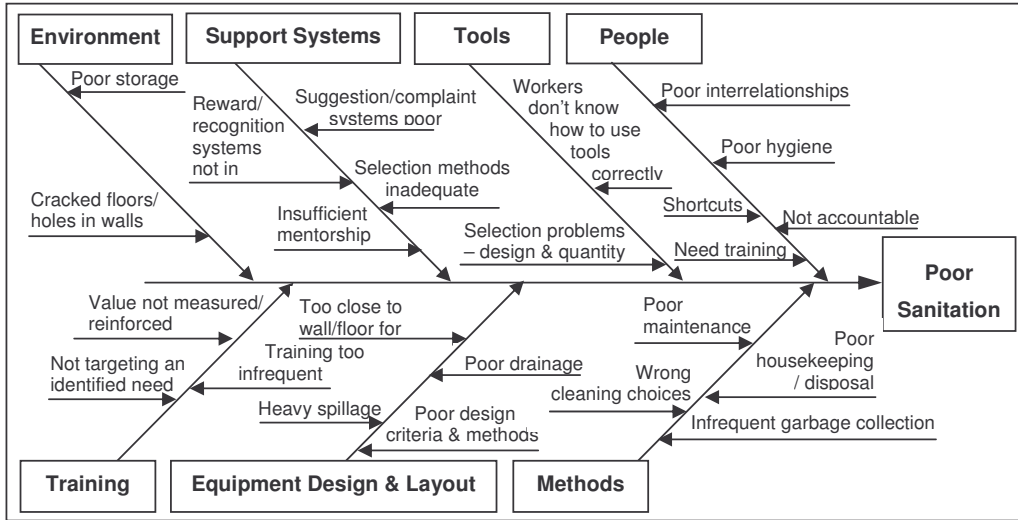


Figure 2. A cause-and-effect diagram of sanitation problems in the plant