IMPLEMENTING A HAZARD ANALYSIS CRITICAL CONTROL POINTS PLAN (HACCP) FOR A PACKAGING COMPANY

By

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A Research Paper

Submitted in Partial Fulfillment of the

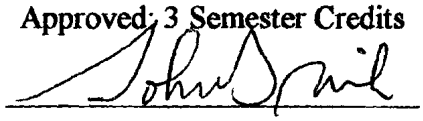
Requirements for the

Master of Science Degree

In

Management Technology

Approved: 3 Semester Credits



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Title:	***Implementing a Hazard Analysis Critical Control Points plan for a Packaging Company***
Graduate Degree/ Major:	**MS Management Technology**
Research Adviser:	**Dr. John Dzissah**
Month/Year:	**August, 2005**
Number of Pages:	**37**
Style Manual Used:	**American Psychological Association, 5th edition**

ABSTRACT

Hazard Analysis Critical Control Points (HACCP) is a systematic methodology to control hazards in a process by applying a two-part technique: first, an analysis that identifies hazards and their severity and likelihood of occurrence; and second, identification of critical points where the hazards may be controlled, and the monitoring criteria to ensure that controls are working effectively. HACCP is in essence a management system in which food safety is addressed through the analysis and control of biological, chemical and physical

hazards from raw material production, procurement and handling, to manufacturing, distribution and consumption of the finished product. HACCP is designed for use in all segments of the food industry from growing, harvesting, processing, manufacturing, distributing and merchandising to preparing food for consumption.

The purpose of this study is to extend this generic HACCP model in the packaging industry for water bottle labels. The aim is to increase the safety and quality of packaging labels used on water bottle retailers. Traditionally HACCP has been deemed as not applicable outside the food industry and there are no guidelines for implementing HACCP within a food packaging context. However water bottle labels are inherently part of the finished product for a consumer. Therefore potential health concerns need to be addressed through a HACCP program on the water, the bottle and the label on the bottle as well.

Acknowledgments

I would like to thank my research advisor Dr. John Dzissah for his invaluable guidance, encouragement and support that he provided throughout this research work. Also a special thanks to the HACCP team; Kimberly Ulman, Mike Omtvedt, Jesse Kraft, Brenda Lundberg for supporting me directly and indirectly in completing this research work.

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CHAPTER I

Introduction

A Hazard Analysis and Critical Control Point (HACCP) system is a preventative approach to controlling food safety. HACCP moves away from reliance on end product testing to a more proactive, preventative approach of controlling potential hazards. Although HACCP is a relatively new concept to the food packaging industry, it has its roots way back in the sixties. The first incarnation of HACCP was developed by the Pillsbury Corporation and the National Aeronautics and Space Administration (NASA), to ensure food safety for the first manned space missions. Since then, it has been widely adopted by national and international organizations, and the modern HACCP system and guidelines for its application were defined by the Codex Alimentarius Commission in the Codex Alimentarius Code of Practice

The Hazard Analysis and Critical Control Point system has been around since the late 1960's. Originally HACCP was designed for NASA and the space program to ensure a safe product by attempting to eliminate or reduce the need for end point testing after processing. End point testing was very costly and could damage much of the final product because some testing is destructive. As an alternative, HACCP is composed of several checks within the process to ensure a safe final product. The ascent of HACCP has been rapid, mainly because of the increase in the reported cases of serious food poisoning and the introduction of The Food Safety Act 1990 and The Food Safety (General Food Hygiene) Regulations 1995 (EU Food Safety Directive 93/43/EEC), which requires a food business to carry out a hazard analysis.

HACCP is composed of a number of necessary components. Each part of the HACCP plan must be completed before the HACCP system can run efficiently. A good HACCP system also requires teamwork and good communication within the plant.

Commitment from upper management is essential for a system to function. Without commitment there will be no support for the program to work effectively. Also, a HACCP team must be formed to handle all of the HACCP related information. This team should be trained properly to understand the HACCP principles. HACCP training courses can be taken to educate those who might not be familiar with HACCP.

Although in the Food Packaging Industry there is no legal requirement for packaging manufacturers to carry out a hazard analysis, in recent years it has been a strong customer requirement. The adoption of a formal Hazard Analysis System is now an explicit requirement of BRC Global Standard - Food Packaging. Audit systems designed for the Food industry like NFPA-Safe and AIBI (American Institute of Baking International) also require that suppliers to food manufacturing companies have implemented HACCP models within their facilities. However HACCP was developed for the food industry and there are no guidelines for implementing HACCP within a food packaging context. The puzzle for packaging therefore has been trying to apply the Codex Alimentarius principles to food packaging and this has been the cause of frustration for the packaging quality professional. During implementation many guidelines may seem wholly irrelevant to packaging.

In general it is recognized that Critical Control Points (CCP's) as encountered in food companies, do not exist in food packaging. It is in fact generally found quite difficult to identify CCP's in their true form in packaging scenarios creating room for debate with food safety auditors during technical audits. Most of the hazards that can be

identified in a food packaging operation are of a generic nature and could occur at any stage of the process e.g. blades, glass, pests, poor personnel hygiene etc. These types of hazards are controlled by what are commonly referred to as 'prerequisite programs' e.g. the standard operating procedures and basic environmental conditions that are necessary for safe food packaging production, and one would expect to find these in any comprehensive food packaging Good Manufacturing Practice (GMP) / Good Hygiene Practice (GHP) system.

Statement of Study

The purpose of this study is to design a HACCP plan for a packaging company that manufactures non food contact water bottle labels. The model is identified from several generic HACCP models. The researcher worked in the plant in the capacity of a quality engineer and as part of the HACCP team and worked with the production manager, Safety and Compliance Officer and Process Development Manager in order to develop the HACCP model.

Need for the Study

The company underwent an annual customer mandated audit by AIBI. While the company felt that a HACCP model may not be applicable to the nature of product being manufactured, AIBI required that the program be in place as part of the Quality Management System (QMS). The company decided to conduct a comprehensive HACCP program to determine the extent of Critical Control Points if any in their manufacturing process. Apart from satisfying the audit requirement, this would also bring together various safety programs already in place under the overall umbrella of HACCP including the GMP program, Pest Control, Chemical Storage and Customer Complaint Program

Objectives:

1. To determine existence and severity of Critical Control Points in the printing process of water bottle labels.
2. To bring varied safety programs under a single umbrella to increase focus on end consumer safety
3. To set up a specific HACCP model for a non food contact packaging company

Significance of the Study

A specific model of HACCP will be developed for a non food contact packaging company. Very little information is available on HACCP implementation in this industry. The model will serve as a comprehensive quality control program with the overall objective of consumer safety. It will also provide a basis of comparison of severity of CCPs in a non food contact packaging label to Food contact packaging label and the food product itself. Finally, the model can be taken forward to other packaging divisions of the mother company; Taylor Corporation as well as other players in the industry.

Limitations of the Study

1. The study is subject to time and budget constraints of the research team
2. While the team had functional experts in the areas of production, quality and safety issues, it did not have formal training on conducting a HACCP program.

FDA Definitions (2005):

Acceptable level: Acceptable level means the presence of a hazard which does not pose the likelihood of causing an unacceptable health risk.

Control point: This means any point in a specific food system at which loss of control does not lead to an unacceptable health risk.

Critical control point: As defined in the Food Code, means a point at which loss of control may result in an unacceptable health risk.

Critical limit" As defined in the Food Code, means the maximum or minimum value to which a physical, biological, or chemical parameter must be controlled at a critical control point to minimize the risk that the identified food safety hazard may occur.

Deviation: This means failure to meet a required critical limit for a critical control point.

HACCP plan: As defined in the Food Code, this means a written document that delineates the formal procedures for following the HACCP principles developed by The National Advisory Committee on Microbiological Criteria for Foods.

Hazard: This as defined in the Food Code, means a biological, chemical, or physical property that may cause an unacceptable consumer health risk.

Monitoring: Monitoring means a planned sequence of observations or measurements of critical limits designed to produce an accurate record and intended to ensure that the critical limit maintains product safety. Continuous monitoring means an uninterrupted record of data.

Preventive measures. These mean an action to exclude, destroy, eliminate, or reduce a hazard and prevent recontamination through effective means.

Risk: Risk means an estimate of the likely occurrence of a hazard.

Sensitive ingredient: Sensitive ingredient means any ingredient historically associated with a known microbiological hazard that causes or contributes to production of a potentially hazardous food as defined in the Food Code.

Verification: Verification means methods, procedures, and tests used to determine if the HACCP system in use is in compliance with the HACCP plan.

Other Definitions:

Good Manufacturing Practices (GMPs): quality standards required of companies producing regulated products, such as pharmaceuticals, and administered and monitored by the FDA

Lithographic Printing: This is a manual process is based on the repulsion of oil and water. The image is placed on the surface with an oil-based medium; acid is then used to 'burn' the oil into the surface. When printing, the surface is covered in water, which remains on the non-oily surface and avoids the oily parts; a roller can then apply an oil-based ink that adheres only to the oily portion of the surface

Offset Lithography Printing is a widely used printing technique where the inked image is transferred (or "offset") first to a rubber blanket, then to the printing surface. When used in combination with the lithographic process, the offset technique employs a flat planographic image carrier on which the image to be printed obtains ink from ink rollers, while the non-printing area attracts a film of water, keeping the nonprinting areas ink-free

CHAPTER II: LITERATURE REVIEW

History

The Pillsbury Company first developed the concept of HACCP in the early 1960s. The firm worked cooperatively with NASA to develop this new system to ensure safety of the food consumed by the astronauts. At that time, most safety systems were based on end product testing. For this concept to be fully effective, companies must test 100% of their product. Since most testing is destructive, this approach would no be feasible because the entire product would be required (Mortimore and Wallace, 2000).

At the 1971 National Conference on Food Protection, the HACCP system was first presented. This new approach to food safety gained interest among food processors and was used as the basis for regulations regarding low-acid and acidified foods. Furthermore, the FDA even began using HACCP for investigation activities. However, after the initial excitement of the new system, interest in HACCP began to fade.

According to Stevenson (1990), only a few large companies continued to apply HACCP. During the 1980s, some of the government protection agencies asked NAS/NRC (National Academy of Sciences/National Research Council) to form a committee that would generate some general principles for the application of microbial criteria in foods. This committee proposed the implementation of HACCP in food protection programs. In addition, they suggested that the food industry receive the proper training with regard to the HACCP concept (Stevenson, 1990).

Many food industries have implemented HACCP since its inception. Some have done so voluntarily, whereas others have been mandated. Industries currently mandated are Seafood (since 1997) and Juices (effective in 2002). The meat and poultry industry

fell under the HACCP mandate in 1998(large plants). Small and very small plants followed in 1999 and 2000, respectively. The smaller plants were given more time to develop their HACCP plans due to fewer resources and personnel compared to larger plants (Bowers, 1998). The canned food industries do not have a mandatory HACCP requirement, but one is highly recommended. The major reason that some canning companies have implemented HACCP is to control Clostridium botulinum (Food Safety and Inspection Service, 2000).

Purpose of a HACCP Program

The HACCP program serves several purposes. The main objective of HACCP is to produce a safe product. HACCP is a safety program, not a quality program. Meta-fragments, microorganisms that cause illness and harmful chemicals are examples of some of the hazards that HACCP will attempt to reduce or eliminate (Swanson and Anderson, 2000). There will never be a process that is absolutely safe, but there must always be a constant effort to achieve zero defects (Snyder, 1991).

Another function of HACCP is to reduce or even eliminate the need for endpoint testing. Before the HACCP concept was developed, many processors depended on endpoint testing to determine if their product was satisfactory. This testing can be very tedious and time consuming. Also, testing can lead to a loss of a portion of the product since some types of testing are destructive (Bauman, 1990). HACCP attempts to reduce endpoint testing by conducting a series of checks throughout the process. At each step in the process, all possible hazards are considered in regards to how to prevent them and what actions will be taken if a significant hazard occurs (Mortimore and Wallace, 2000). By the time the product reaches the end of the process, HACCP attempts to reduce hazards to an acceptable level.

A third purpose of HACCP is to provide documentation to prove that the process is being conducted as written. Without documentation and records, there is no verification that anything has actually taken place.

Advantages

According to the FDA (1999), the advantages of HACCP over other safety systems are that this preventative program:

- Focuses on identifying and preventing hazards from contaminating food
- Is based on sound science
- Permits more effective government oversight because record keeping allows investigators to determine how well a firm is complying with food safety laws over a period of time rather then how well it is doing on any given day
- Places responsibility for ensuring food safety appropriately on the food manufacturer or distributor

According to Mayes (1994), "Implementation of HACCP is not a quick 'back to the envelope' job done on a quiet afternoon, but it is instead a detailed technical evaluation of a product and process requiring time, commitment, scientific and technical expertise to carry out hazard analyses and establish control and monitoring procedures, and the requisite knowledge, skills and attitude for successful implementation".

HACCP Components

Prerequisite Programs: Before HACCP implementation within the food industry, certain programs were already in place to provide for food safety. For the HACCP system to produce safe products, it must be built on a solid foundation of prerequisite programs.

These programs provide the basic conditions that are necessary for the production of safe food. Some examples of common prerequisite programs are GMPs, SSOPs, letter of guarantee and pest control (NACMCF, 1999). Prerequisite programs ensure that HACCP plan(s) are functioning effectively (Stier, 1998). Consistent maintenance of these programs is important to the success of the HACCP plan (Bernard et al., 1997). Understanding the difference between HACCP and prerequisite programs is accomplished through the recognition of two main points. First, prerequisite programs deal indirectly with food safety, whereas, HACCP focuses solely on food safety. Second, prerequisites tend to be more general and applicable across a processing plant. HACCP plans are only based on hazard analyses that are product or line specific. (Bernard and Parkinson, 1999). Also, there is often the misconception that HACCP replaces the need for prerequisite program. HACCP does not replace any prerequisites. It combines with the prerequisites to form a food safety system (Motarjemi, 1999).

Two of the most common prerequisite programs for HACCP are the Good Manufacturing Practices (GMPs) and the Sanitation Standard Operating Procedures (SSOPs). GMPs emphasize sanitary effectiveness and hygienic practices during food processing. Many companies require that their supplier conduct regularly scheduled audits to assure that they are adhering to their GMPs (Stier 1998). SSOPs are a widely used program to maintain proper sanitation within food processing plants even before HACCP was mandated (Gombas, 1998). SSOPs describe all daily procedures that will be conducted to maintain sanitation, specify the frequency of the procedures, and identify those responsible for implementing and monitoring the SSOP (Stier 1998). Both GMPs and SSOPs are signed and dated by a qualified official and kept with all HACCP related documents (Adams, 1998).

HACCP Team: A HACCP Team has to be developed to champion the operation. However commitment from upper management should be obtained first. Without commitment from the entire plant, HACCP will not function properly. The HACCP team is established of individuals who will execute the duties of implementing and maintaining the HACCP plan. It is important to avoid too much work delegated to one person, but not have too many members so that communication between them becomes difficult. A team consisting of four to six members is ideal, with one of them acting as team leader (Mortimore and Wallace, 2000).

It is recommended that the team consist of at least one expert from Quality Assurance, Operations or Production, and Engineering. The Quality Assurance experience will provide knowledge in what types of hazards can occur and the risks associated with these hazards. The expert from operations or production will have detailed knowledge of the day-to-day operational activity. The engineering representative will be capable of providing expertise on the processing equipment with respect to process capability.

Additional expertise will be needed and can be selected from within the company or from outside consultants. It may be easier to keep the HACCP team internal for communication and availability purposes. These additional experts can be selected based on which will be more beneficial to that particular plant. Someone from research and development can be selected if new products and processes are being developed. Other experts such as purchasing agents, microbiologists and statisticians can be beneficial to the team. Also, a HACCP expert might also be considered. One who is knowledgeable in setting up HACCP plans will help keep the team focused (Mortimore and Wallace, 2000).

Product Description: Another requirement of a HACCP plan is to develop a product description and intended use of this product. According to Mortimore and Wallace (2000), the product description should contain a brief description of the product with regards to storage temperature and shelf life. The description should also describe any hazards associated with the production of the product and how to control these hazards. Furthermore, it should give a description of target groups that may consume this product (Ababouch, 2000). The purpose of the product description is to help familiarize the HACCP team with the products and technologies being utilized.

Process Flow Diagram: Prior to conducting the hazard analysis, a process flow diagram must be created. This is a flow chart that represents the process starting with receiving of materials to shipping of the end product. All of those stages on the flow chart that are critical control points must be labeled. The diagram should include time and temperature profiles for each stage of production. The flow diagram does not necessarily have to be an extensive drawing of the facility. A block type flow diagram is used most frequently (FDA, 2000).

Once the flow diagram is completed it should be verified by the HACCP team to ensure completeness and thoroughness. The team should meet and review the diagram to ensure that all stages are included and all other criteria are present. Modifications should be made as necessary (FDA, 2000).

HACCP Principles:

After these preliminary steps, the HACCP team should develop the seven HACCP principles. Originally the HACCP protocol consisted of only three principles 1) Hazard analysis and risk assessment, 2) Determine the Critical Control Points (CCPs), and 3) Monitor the CCPs. In 1989 the National Advisory Committee on Microbiological Criteria

for Foods (NACMCF) included four more principles to the HACCP system (Sperber, 1991). According to Snyder (1991), the seven principles that now make up a HACCP plan are:

1. Conduct a Hazard Analysis and Risk Assessment
2. Determine CCPs
3. Establish Critical Limits (CL) for each CCP
4. Establish Monitoring procedures for each CCP/CL
5. Establish Corrective Actions
6. Establish Verification Procedures
7. Establish a Record keeping System

Principle 1

The first principle involves conducting a hazard analysis, which involves assessing certain risks involved in production of a product. "Hazard Analysis is defined as 'the process of collecting and evaluating information on hazards and conditions leading to their presence to decide which are significant for food safety and therefore should be addressed in the HACCP plan'" (Mayes, 1999). The first part of conducting a hazard analysis involves identifying all possible hazards that could occur within the food product. The HACCP team should hold a brainstorming session to identify every possible hazard. During this session, the team should not consider the significance of a particular hazard. That will be dealt with during the risk assessment. Mayes (1999) states that "the Hazard Analysis is probably the key principle in the whole HACCP system and the one people find to be the most difficult." The three types of hazards that must be considered during a hazard analysis are biological, chemical and physical (Tompkin, 1994). Biological hazards are normally those that involve microorganisms. Another type of hazard is a chemieal hazard. These hazards involve specific chemicals that may be added

to the product or chemicals that contaminate the food during processing. Cleaning compounds and pesticides are two examples of chemicals that could contaminate the product. Other chemical hazards include several added which may be an allergen to the consumer (e.g. Peanuts, eggs or shellfish) (Mortimore and Wallace, 2000). Other hazards are the physical hazards. As the previous two types, these also can occur during any stage in the process. Physical hazards are those that are sharp or hard that could cause injury or choking. Fragments of glass, metal or wood could all be considered physical hazards (Mortimore and Wallace, 2000).

After all potential hazards are identified the HACCP team must now conduct risk assessment. According to Sohrab (1999), "Risk assessment is a scientific evaluation of known or potential adverse health effects resulting from human exposure to food borne hazards". An example is where the team determines which identified hazards are significant. A significant hazard is one in which the likelihood of occurrence and severity of illness are high.

When determining the likelihood of a hazard, the HACCP team must research each hazard and identify any trends. If the literature indicates that this hazard does no occur often, the team can indicate that the likelihood of occurrence is low. The team must also research a hazard to understand it's severity if it is not properly controlled. Some hazards may be more severe then others. For example, microorganisms that can lead to chronic illnesses or death are considered very severe. Other microorganisms may only cause small side effects. These are not very severe (Sohrab, 1999).

Principle 2

When the hazard analysis is complete, the HACCP team must go over the flow diagram and decide which steps are critical control points (CCPs). A CCP can be a point

in the process where a significant hazard can be eliminated or reduced to an acceptable level. A CCP is also a point where loss of control will lead to a significant hazard. It differs from a control point (CP) in that a loss of control at a CP will not lead to a significant hazard. CCPs require a lot of careful development and extra documentation and that is why they should be limited to only those that are truly critical (Weddig, 1999). When determining which steps are critical control points, some companies use what is called the shotgun approach. This is a method that is not based on any true reasoning; rather CCPs are chosen based on the opinions of the team. This may lead to an excessive number of CCPs resulting in problems for the plant. A more accurate and feasible method that can reduce the number of CCPs is use of the decision tree. This approach asks several questions about each processing step where a hazard is significant (Tompkin, 1994). The questions are in "yes or no" format, and will eventually determine whether that step is a CCP.

Principle 3

Once the CCPs are determined, critical limits are required for each step that is a CCP. A critical limit is a maximum or minimum value to which a specific parameter must be controlled at each CCP. Common critical limits are temperature, time, moisture, pH and salt concentration. Critical limits are rarely a range of values. Each limit should have some sort of basis whether that is FSIS regulations, FDA action levels, or any other scientific literature (Food Safety and Inspection Service, 1996). An example is the temperature within a freezer. If the critical limit is set at 0° C or below, the temperature must always remain at or below that temperature. The temperature must be watched very closely and monitored to ensure that the limit is not exceeded (King, 1992). Critical limits

can be slightly stricter than the regulations set by FSIS. This requirement will ensure that regulatory requirements are still met in the event of a slight deviation from the limit (Food Safety and Inspection Service, 1996).

Principle 4

The next step is to monitor each CCP and critical limit. Monitoring of each critical limit is very important because it helps to ensure that the CCPs are in compliance and the critical limits are not exceeded (Sohrab, 1999). Critical limits can be monitored continuously or non-continuously. If a critical limit were monitored continuously, a temperature monitoring system would be a good investment. A computer system will be devised for measurements at regular increments. Continuous monitoring is ideal when a particular parameter tends to have more variation then normal. This system will also need to be monitored by an individual to ensure the computer system is functioning properly (Tompkin, 1995). If non-continuous monitoring is utilized, a member of the HACCP team must conduct checks at regular increments (i.e. every 30 minutes or every hour). That individual is responsible for keeping an accurate record of each CCP and notifying the proper authority if a critical limit is exceeded. Because non -continuous monitoring is being used, it is important that the frequency of monitoring be adequate to ensure control of the CCP (Sohrab, 1999).

Principle 5

If there is a deviation from the set standards of a critical limit, corrective actions must be taken (Snyder, 1991). Corrective actions are procedures carried out when a loss of control has occurred at a particular CCP. Sperber (1991) suggested that all corrective actions as well as responsibilities should be clearly outlined before HACCP is

implemented. All records and corrective actions should be documented to prove that corrective actions are being conducted (Sohrab, 1999).

The first step of a corrective action is to stop the processing line and isolate a possibly adulterated product (King, 1992). Once the non-compliant product is segregated, microbial testing will help assess the safety of the product (Kvenberg and Schwalm, 2000). If the product is deemed as unsafe, it will be discarded. However, if testing reveals minimal adulteration, the product can then be reprocessed (Food Safety and Inspection Service, 2000).

Before the processing continues, control must be reached at that CCP. Once the process is stopped, it is up to the individuals responsible to identify why a deviation has occurred and what can be done to bring the process back to conformance. Once this reason is determined, measures will be implemented to prevent the deviation from occurring again (King, 1992). If a deviation occurs too often at one CCP, the HACCP team will have to evaluate whether the HACCP plan is sufficient to control this hazard (Kvenberg and Schwalm, 2000). Corrective actions might even be considered if monitoring indicates a trend towards loss of control at that CCP (Sohrab, 1999).

Principle 6

The next principle that must be addressed is verification. Verification is the application of methods, procedures and tests to determine the company's compliance with the HACCP plan (Mayes, 1999). Verification covers all internal daily activities with regards to HACCP (Lupin, 2000). A few verification procedures include a review of the HACCP system and records, any deviations and product dispositions, and confirmation that the CCPs are kept under control (Mayes, 1999). The only way to be confident that a safe product is being produced is to verify that the personnel have control at each step

(Snyder, 1991). Verification can be performed by plant audits with the use of microbial, physical and chemical tests. Government agencies will sometimes review HACCP plans to ensure compliance with standards (Snyder, 1991). The frequency of such audits should be sufficient to verify that the HACCP program is functioning properly (Mayes, 1999). There is often some confusion about how validation differs from verification. Verification determines compliance with the HACCP plan, where validation merely determines that the end results can be achieved (Sperber, 1999).

Principle 7

The seventh principle of HACCP is to establish adequate record keeping procedures. Without records, there is no proof that a plant is doing what their HACCP plan indicates. According to Sohrab (1999), the purpose of recording keeping is to show that the HACCP plan is compliant with the documented system. Records are useful in providing a basis for trends and for systematic improvement of the process over time (Snyder, 1991). All forms pertaining to monitoring results, corrective action logs, or training records must be kept on file for at least 1 year. Any modifications to, or audits of, the HACCP plan must be documented as well (Ababouch, 2000). USDA requires that the HACCP plan and records be filed together and be readily available when requested (King, 1992).

HACCP Assessment

Although HACCP assessment (auditing) can fall under verification, it is not one of the seven principles. Even though both regulators and processors have the same goal of producing safe products, their views differ on how effectiveness should be measured. The goals of a regulatory agency in terms of HACCP are to:

- Make the food supply safer through the prevention of food safety problems
- Enable regulatory agencies to more efficiently utilize their existing resources devoted to ensuring food safety
- Enhance the ability of the regulatory agency to provide consumers with the assurance that the food supply is safe
- Underscore the industry's role in continuous problem prevention and problem solving (Kvenberg et. al., 2000).

The main purpose of HACCP assessment is to establish whether a processor is capable of producing or distributing safe products consistently, i.e. ensuring that the HACCP program is effective in maintaining product safety (Anon, 2000). Assessment should include review of the HACCP manual and an on -site verification to establish whether the HACCP plan is properly implemented (Ababouch, 2000). According to Mortimore (2000), the outcome of any assessment should show that the manufacturer has:

1. Implemented a sound HACCP system
2. The knowledge and experience needed to maintain it
3. The necessary support (prerequisite) programs in place

Check sheets can be used to make the assessment more effective. Check sheets have been proven to be an effective tool in assessing HACCP plans. However, check sheets alone will not suffice. It is important for the auditor to have adequate knowledge to identify any deficiencies and address them properly (Ababouch, 2000). It will be up to the discretion of the assessor on how to form their check sheets. Some may use a check sheet as an aide-memoiré, but many separate questions must supplement the check sheet,

since they are only a broad outline of criteria. There is no set formula for a HACCP plan; therefore check sheets will differ from plant to plant (Mortimore, 2000).

Assessments can be conducted either with an internal assessment team, or with outside consultants. An internal assessment should not be conducted by those individuals involved with the daily activities of the HACCP plan(s) (Lupin, 2000). One type of HACCP assessment is through the establishment of the effectiveness of in-house HACCP systems. Another assessment would include visiting the suppliers and ensuring their HACCP plan supplies safe incoming ingredients. Occasionally a third type of HACCP assessment may include customers' systems. This assessment will occur when the consumer is partly responsible for distribution of a product (Mortimore, 2000). The frequency at which HACCP assessments are conducted depends on the risk category of the food and the level of commitment from the management. The frequency will also depend on the reputation of the food processor (Ababouch, 2000). An assessment should be conducted any time there are changes to products or processes within a plant. It is a good idea to have audits scheduled throughout the year regardless of other factors that may arise (i.e. recalls, HACCP changes) (Anon, 2000). The current regulation requires at least a yearly audit, but this is a minimum requirement (Lupin, 2000).

CHAPTER III: METHODOLOGY

Introduction

This study was conducted in a medium scale water bottle label producing factory. The plant has more than 300 employees across different lines of business and different quality and process control procedures and audit systems in place catering to the needs of different customers across varied industries. The water bottle label line of business serves the bottled water industry where a paper label is applied on top of a plastic bottle. The customer requirements include annual AIBI certification of the Quality Management System (QMS) of the plant. This yearly audit includes an evaluation of whether a HACCP model is in place and its effectiveness. The company decided to implement HACCP both as a method of satisfying customer requirements and ensuring a robust quality system that did not allow for health and safety issues with its products.

This chapter will cover a description of the research method and process that was used in this study and how the study was approached by introducing the HACCP record keeping forms.

Research Method:

This study does not utilize a quantitative approach because no data is available on adverse consumer health concerns with water bottle labels. Moreover the objective was to implement a HACCP model in anticipation of potential consumer safety concerns.

Hence it was felt that a qualitative approach that is exploratory and open minded would be more applicable to the research objective. This would allow for an analysis of

processes, raw material ingredients, interactions, estimation and projection of potential safety issues. The record keeping forms were designed as follows:

1. Prerequisite Programs
2. Product Description
3. List of Incoming ingredients
4. Process Flow Diagram
5. Process Hazard Analysis
6. HACCP Master Plan
7. HACCP Deviation Report

Prerequisite Programs: Prerequisite programs encompass varied subsystems of process checks, control limits and standardized procedures in place that focuses on different aspects of quality, sanitation, health, security and safety. Each program addresses a specific or group of issues and acre critical in identifying and monitoring critical control points and minimizing risk of failure at a CCP. Without these prerequisite programs the multiplicative effect of failures make them much more difficult to identify and remove from good finished product. The prerequisite programs bring quality closer to the source and reduce the need for costly sampling and monitoring of final product.

Product Description: The product description builds a profile of the product and includes descriptions of the intended use, form and proper storage of the product. This helps the researcher to determine critical control points. The product description includes the following aspects of the label (Canadian Food Inspection Agency, 2001):

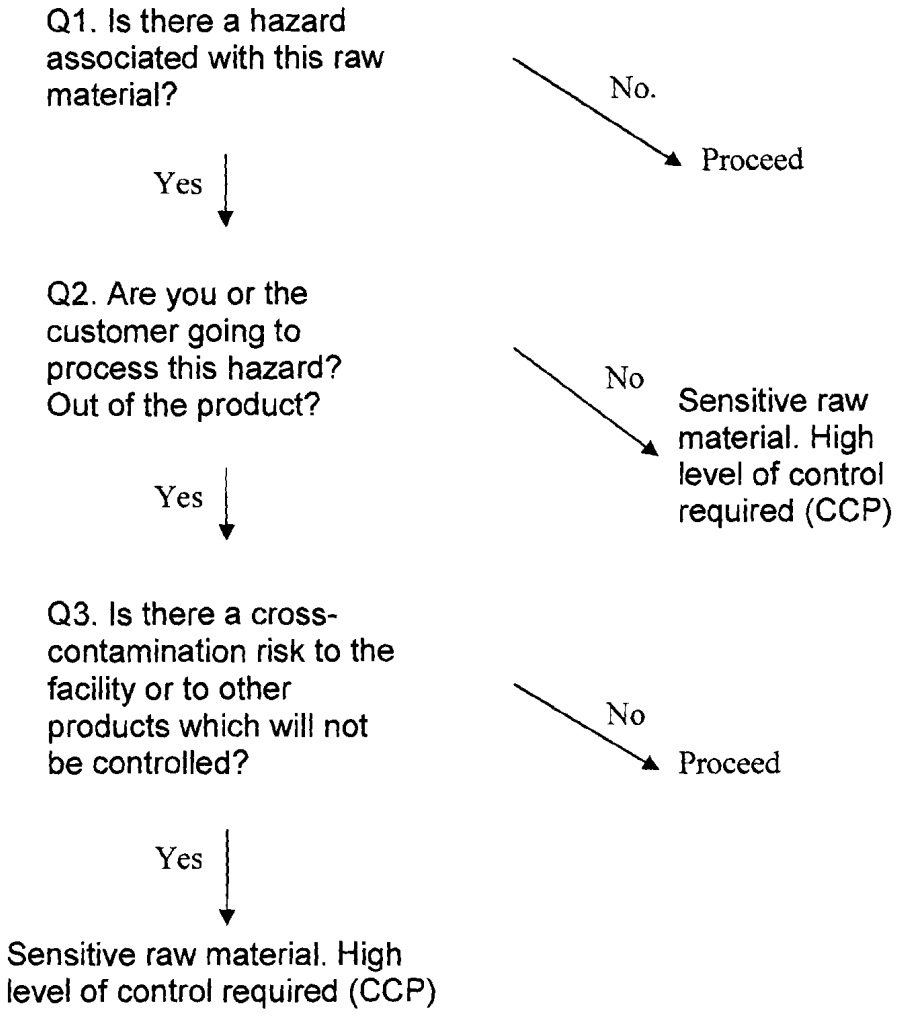
1. Product Name
2. Important product characteristics (Moisture, pH, salt, preservatives…)
3. How it is to be used

4. Packaging
5. Shelf life
6. Where it will be sold
7. Labeling instruction
8. Distribution condition

List of Incoming ingredients: CCPS within the process is only part of the picture. Very often ingredients and raw materials used in the creation of the product have a large contribution in increasing the risk of health repercussions. There can be contamination within a raw material from a supplier. Alternatively a desired product characteristic of a raw material might not be within specification limits. In either case, there is a possibility of a health hazard to the end user depending on the nature of the failure and the form in which the product is used.

The decision whether an ingredient represents a critical control point is determined through the decision tree in Figure 1. (Mortimore and Wallace, 1997).

Figure 1: CCP Raw Material Decision Tree



Process Flow Diagram: The Process Flow Diagram is a visual representation of the entire sequence of steps to manufacture and distribute the product. This visual schematic of the process helps the researcher and the HACCP team to easily focus on every step and analyze for the possibility of hazards and CCPs. See Figure 2 for example of process flow.

Process Hazard Analysis: The Process Hazard Analysis focuses on identifying microbiological, chemical and physical hazards that may occur at each step of the process. Microbiological hazards are pathogens or harmful bacteria that introduced from raw material contamination or during production. In a food production environment

inadequate personal hygiene can result in microbiological contamination. Chemical contaminants include plant toxins and chemicals added during production or from contamination of incoming ingredients. Incorrect handling of product or environmental conditions can cause physical contamination or damage the product in a manner that could cause a hazard to the end user.

In the hazard analysis chart, each step of the process flow is linked to the type of hazard associated with it and to the preventive steps necessary to minimize or eliminate the possibility of occurrence.

HACCP Master Plan: The HACCP Master Plan lays out a control chart (Table 1) based on the CCPs in the processing. For each CCP, the identified hazards and preventative measures will be listed in this chart. In addition, the critical limits, monitoring, corrective action and responsibility will be summarized in this chart. All the information is well organized and documented for a HACCP plan. It helps the company easily manage all the information.

Table 1: HACCP Master Plan

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Significant	Critical	Monitoring				Corrective	
CCP	Hazard	Limits	What	How	Frequency	Who	Action(s)	Verification

The critical limits in Table 1 refer to the absolute tolerance levels before the CCP will be considered to have to have breached acceptable safety levels. Critical limits may have upper and/or lower control limits. These limits have to be accompanied by a measurable factor. All personnel involved in the manufacturing process that affect the

CCP need to understand the critical aspect of staying within the control limits and be trained in how to monitor the response factor.

The monitoring procedure is important to ensure that the process is under safety control. Monitoring is more effective with repeated inspection and testing. The data should be recorded continuously too. Some discontinuous systems are also used in monitoring. The frequency of monitoring shows how often monitoring needs to be provided. It depends on the type of CCP and monitoring procedure (Mortimore and Wallace, 1997).

When a deviation from a critical limit occurs at a CCP, a corrective action needs to take place, according to HACCP principle 5. The researcher should also incorporate corrective actions that will prevent deviation at the CCP. The corrective actions should be specified on the HACCP plan. Those actions should focus on both the CCP and the specific circumstances and environment of the processing (Mortimore and Wallace, 1997).

The responsibility should be considered both in monitoring and corrective action. The most important issue with responsibility is ensuring it is properly assigned. An operator in processing needs to know the necessary procedures and the correct way to follow them. It is also important to define which individuals are responsible for documenting and certifying the corrective action procedures. This information will be crucial in verifying that the required action has been taken. This is particularly important for legal issues (Mortimore and Wallace, 1997).

CHAPTER IV: REPORT OF FINDINGS

Introduction

The principles of HACCP of and several generic models were used to design the HACCP model for the plant. This section discusses the design of the actual HACCP model utilized for Precision Press as a label printing supplier for the food industry.

Prerequisite Programs

This first step in the study was bringing in all existing prerequisite programs under the umbrella of HACCP and giving them a common direction of attaining zero defects with the final product so as to ensure that are no health concerns with the final product. Several prerequisite programs formed the basis of the model for ensuring a robust system of checks against possible failures of critical control points.

Sanitation Program: The goal of our Sanitation Program is to maintain a sanitary environment, necessary for the production of Cut and Stack labels of the highest quality and safety. The program is maintained by the General Maintenance Supervisor. The program includes daily Cleaning Schedules/sign-offs across all shifts plantwide.

Good Manufacturing Program: The goal of our Good Manufacturing Program is to successfully organize, maintain and operate a sanitary process and environment in our facility. These individual programs are contained in a Master Index located in Document and Data Control, maintained by the Quality Assurance Coordinator, and includes the following:

1. Receiving Inspections

2. Storage Procedures
3. Shipping Program
4. Glass and Brittle Plastics Policy
5. Bloodborne Pathogens Program
6. Plant GMP policies
7. Approved Supplier Program
8. Self-Inspection Program
9. Preventive Maintenance Program
    a. Equipment Maintenance
        i. Technical
        ii. Operator
    b. Building and Sanitary Maintenance
10. Regulatory Inspections Procedures
11. Employee Training Program

Pest Control Program: The Pest Control Program is designed to allow no pests in the plant. This includes rodents, insects and birds. The Pest Control Program is carried out through a licensed pest control company, which meets all Federal and State regulatory requirements. The pest control program is maintained by a Compliance Officer. The pest control practices that assist in maintaining a pest free environment in the plant include:

1. Licensed and insured Outside Pest Control Service
2. Weekly and monthly monitoring of interior and exterior pest control devices
3. Utilization of approved chemicals and baits
4. MSDS ands Sample Labels available
5. No Pesticides stored on premises

Chemical Control Program: The goal of the Chemical Control Program is to eliminate the possibility of chemical contamination of ingredients, contact surfaces and finished products, as well as protecting the work area and the employees from exposure to hazardous chemicals. The program is maintained by the Compliance Officer. This goal is accomplished through the Chemical Control Program which manages the purchase, receiving, storage, mixing, labeling and use of all chemicals used in the plant, including:

1. Chemical Control
2. Approved chemical program
3. Segregated and controlled access storage
4. MSDS on file and available to all personnel
5. Training Program
6. Emergency Procedures
7. HazCom program
8. Chemical Inventory

Customer Complaint Program: The goal of our Customer Complaint Program is to resolve all customer complaints as soon as possible to theirs and our own satisfaction. The program is maintained by the Quality Assurance Coordinator and is located in Document Control. It consists of the following procedures:

1. Action Plan/follow-up
2. Response to Customer
3. Product disposition documentation

Product Recall Program: The goal of the Product Recall Program is to protect our customer from the possible event of a product safety failure by removing all suspect products from the distribution channels in the least amount of time, once a product recall

or withdrawal is warranted and initiated. The program is maintained by the Quality Assurance Coordinator and is located in Document Control. The program consists of the following:

1. Lot information tracked from receipt to delivery (including packaging materials)
2. Computerized inventory/shipment records
3. FIFO policy
4. Recall Standard Operating Procedure (SOP)
5. Contact Points for Product Recall
6. Notification Procedures
7. Action Plan
8. Documentation
9. FDA contact information
10. Mock Recalls, twice a year

List of ingredient and incoming material (Included in Table 3)

Table 2 details a product profile and in Table 3 is listed all ingredients and raw materials in the product makeup. The table also provides for preventative measures for the hazards in each raw material if any. However in the case of packaging Labels all ingredients are listed as low for likely risk and hence do not form a critical ingredient. Hence no specific prerequisite Programs or process steps are identified for hazard reduction. See detail in Table 4.

Table 2: Product Description Form

HACCP FINISHED PRODUCT PROFILE

Product Description:	Cut and Stack Labels
Method of Storage and Distribution:	Labels are banded, wrapped and boxed in line. Once pallet or order is complete, product is taken to shipping. The labels are then transported in non-refrigerated trucks.
Intended Use and Consumer:	Applied to plastic water bottles, NWNA
Preservative tolerance/DAL	N/A
Water activity (a_w)	N/A
pH / Titratable acidity	N/A
Storage requirements	Extreme temperature changes to be avoided
Shelf-life/Manufacture code	Production date
Potential for customer misuse	N/A
Can this product cause illness or injury?	No
Comment: (Explain any product or ingredient parameter essential to preventing, controlling, or eliminating hazards)	N/A

Signature of Company Official: _____

Title: _____

Date: _____

Table 3: Ingredient Hazard Analysis

PRODUCT OR PROCESS NAME: CUT AND STACK LABELS

List all ingredients used in the product, process, or plant	Identify known hazards	Likely Risk (likelihood & severity) H = High, M = Medium, L = Low		Is this a Critical Ingredient (1) (Yes/No)	Identify Prerequisite Programs or process steps to reduce or eliminate known hazards
		Likelihood	*Severity*		
WET-STRENGTH 51# ANTI-MOLD PAPER	None	L	L	No	N/A
WET-STRENGTH 54# PAPER	None	L	L	No	N/A
WET-STRENGTH 70g NON ANTI-MOLD PAPER	None	L	L	No	N/A
COBBLEPRINT	None	L	L	No	N/A
Ink, UV	None	L	L	No	N/A
UV TOPCOAT #51292 Varnish	None	L	L	No	N/A
INKJET RESERVOIR #IR-236BK	None	L	L	No	N/A
INKJET CARTRIDGE #IC-236BK	None	L	L	No	N/A
MC-236BK MAKEUP	None	L	L	No	N/A
MAGNETIC DIES	None	L	L	No	N/A
VIDEOJET INK	None	L	L	No	N/A
VIDEOJET MAKE UP	None	L	L	No	N/A
VIDEOJET WASH	None	L	L	No	N/A
VIDEOJET INK – 16-8200Q	None	L	L	No	N/A
VIDEOJET MAKE UP – 16-8205F	None	L	L	No	N/A
ISOPROPYL ALCOHOL	None	L	L	No	N/A

DOWNY	None	L	L	No	N/A
2" 120g. BANDUM FILM	None	L	L	No	N/A
FILM	None	L	L	No	N/A
10.75 120g. FILM	None	L	L	No	N/A
SELF-ADHESIVE POLYPROPYLEN E – red tear tape	None	L	L	No	N/A
Nestle Cartons	None	L	L	No	N/A
2" BOXING TAPE	None	L	L	No	N/A
20" 80G PALLET WRAP	None	L	L	No	N/A

B = Biological, C = Chemical, P = Physical

Instructions: Identify any likely potential hazards associated with incoming material (ingredients or packaging material), rework, and preservatives, then assess to the best of your knowledge the likely risk associated with these materials and identify any specific preventive programs or corrective steps that eliminate or reduce to an acceptable level those risks in the finished product.

Process Flow Diagram

The flow diagram is specific for the label production in this plant. This is composed of four overall processes: receiving, processing, shipping and quality control. The flow was used to analyze the possibility of any critical control point in the overall process flow for production of labels. See detail in Figure 1.

Hazards identification

The Process Hazard Analysis table is designed to detail out preventative measures for the hazards in each processing step. All the control situations are set up under the requirements in the plant to make safe labels that do not allow for health concerns. As no CCPs are identified in the process, there are no hazard prevention measures noted in the table. See details in the table 4.

HACCP Deviation Report

The HACCP Deviation report forms an important part of the control process for keeping hazards in check. It provides a tool for ensuring that the level of deviation and historical responses are noted, a current response is decided upon and a future plan of action for responses is deliberated and documented. Finally the disposition of the affected stock is documented whether they are to be disposed off or reworked and the manner of rework to be conducted. This control and documentation is important both as a process check and to ensure backward traceability in the event of a product recall. See Table 5 for details

Figure 2: Process flow Chart

Product: Nestle cut & stack labels

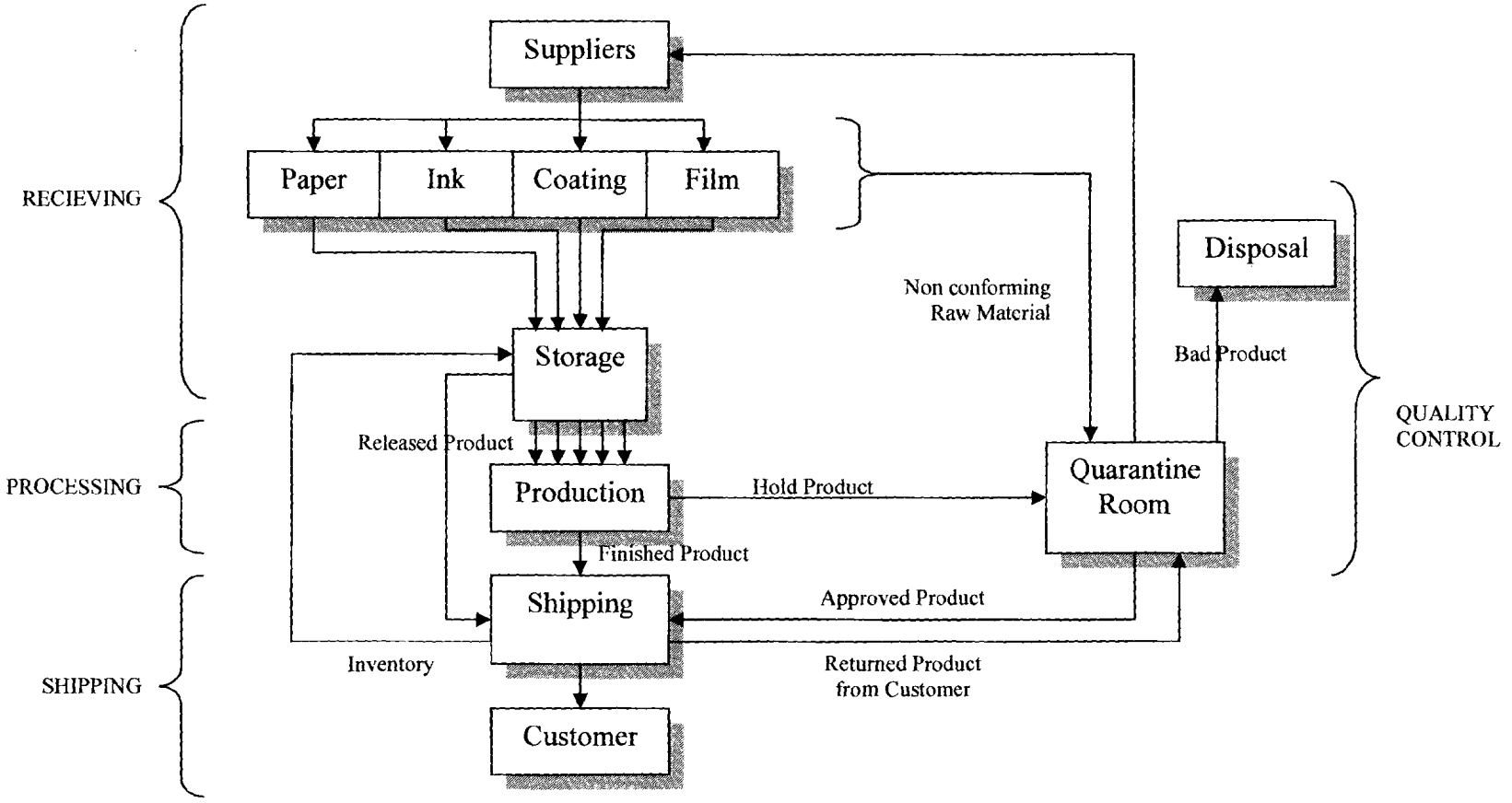


Table 4: Process Hazard Analysis

PROCESS HAZARD ANALYSIS

(1)	(2)	(3)	(4)	(5)	(6)
List each process step from the Process Flow Diagram. (For Receiving only, bring forward each ingredient from the Ingredient Hazard Analysis that was determined to be a Critical Ingredient.)	Does this ingredient or process step INTRODUCE a potential safety hazard? Identify here. (Be as specific as possible when listing the hazard.)	Is this hazard CONTROLLED by a Prerequisite Program or process step? If YES, identify the Program or process. If a Prerequisite Program or process is identified, ignore Columns 4-6 and go to next process step. If NO, go to Column 4.	Is this hazard ELIMINATED by a subsequent process step? If YES, this step is NOT a CCP. Identify the subsequent process step in Column 5 and proceed. If the hazard is eliminated at this step enter NO and go to Column 6 and assign a CCP number.	Identify the last process step that will eliminate the potential hazard. (Example: metal detector, filter, cooking, pasteurizing, etc.).	Assign a CCP number when the answer in Column 4 is NO. Otherwise leave blank.
Receiving	B ----------				
	C----------				
	P----------				
Storage	B ----------				
	C----------				
	P----------				
Production	B ----------				
	C----------				
	P----------				
Quarantine Room	B ----------				
	C----------				
	P----------				

Disposal	B ----------				
	C----------				
	P----------				
Shipping	B ----------				
	C----------				
	P----------				

Table 5: HACCP Master Plan

HACCP MASTER PLAN

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
CCP	Significant Hazard	Critical Limits	Monitoring				Corrective Action(s)	Verification	Records
			What	How	Frequency	Who			
No Critical Control Points Identified									

Signature of Company Official: _____ Title: _____ Date: _____

Table 6: HACCP Deviation Report

HACCP DEVIATION REPORT

Date: _____ Critical Control Point:_____

Location: _____ Equipment:_____

Specified Range: _____ Actual Reading: _____

Past History: _____

_____

_____

Current Corrective Action:_____

_____

_____

_____

Future Corrective Action Needed: _____

_____

_____

_____

Production Disposition: _____

_____

_____

_____

Attach a copy of all records of the critical control point deviation.

CHAPTER V: CONCLUSIONS AND RECOMENDATIONS

Statement of the problem

The study was conducted to design the HACCP model for Water Bottle Label printing plant in order to satisfy customer requirements and to improve safety and quality of the final product.

Method and procedures

Several generic HACCP models were used as a basis for the generation of the model used in this study. The forms designed in the study were used as process steps to ensure that all aspects of a comprehensive HACCP model were incorporated. The process steps as indicated in the forms were then performed as best applicable to a packaging product which is not part of food production. The interpretation of the steps originally designed for food products in the generic HACCP models were based on the knowledge and opinions of the HACCP Team.

Findings and conclusions

The seven principles of HACCP were utilized in developing a model for the company. Various prerequisite programs operating independently were brought under the umbrella and common direction of the HACCP model. The product description illustrated the form and intended use of the product. This demonstrated that the nature of the product (a water bottle label) is not intended for contact with the food product (bottled water). The bottle forms a barrier between the label and the food product. Based on this product

profile, the list of incoming ingredients and process steps were analyzed. No Critical Control Points were found wherein there was a possible hazard to the end user on consumption of the bottled water through label attached to the bottle. Finally a HACCP Master Plan and Deviation Report Tool were developed to ensure a closed loop system. However, as there were no Critical Control Points identified, therefore no action items or prevention and response methods were noted in the HACCP Master Plan.

The HACCP Team felt that nature of the product and industry indicated a low level of applicability of the HACCP model. However the team noted that there were benefits in incorporating HACCP into the company's overall Quality System:

1. The model brought together various independent prerequisite programs operating independently onto common platform and gave them a common direction. This brought about a better sense of clarity and unified vision in the operation of these programs
2. The HACCP model is part of auditing systems such as AIBI (American Institute of Baking International) and NFPA-Safe. These auditing bodies are geared towards the food industry and hence award points for successful implementation of the HACCP model. The company is currently evaluated annually by AIBI and could NFPA-Safe evaluation was also a future possibility depending on the customer.
3. The company was also planning to make all its Lines of Business including the Water Bottle Label printing line ISO 9000 compliant. While ISO 9000 does not require a HACCP implementation, it does require a system for evaluation of business and process risk. HACCP in essence fulfills this requirement while focusing strongly on consumer safety.

4. Finally the dynamics of the market are constantly changing the nature of the business. There is a strong customer interest in In-Mold Labels which is currently a stronghold of European suppliers. If American suppliers wish to embrace In-Mold Label technology, the nature of production could drastically change to include several new Critical Control Points from both label ingredients and process variables. This is because a failure in the molding process can possibly bring the label in direct contact with the food product inside the container. Hence a strong HACCP implementation would now be essential to ensure consumer safety.

Recommendations

The HACCP plan in study was implemented in the plant and evaluated by a customer mandated AIBI audit. The auditor recognized the difficulty in applying Critical Control Points to a product that is not intended for contact with a food product. However the auditor saw value in continuing the program to ensure that there were periodic evaluations that none of the ingredients in making the product could penetrate the barrier of the bottle between the label and the water.

HACCP should become part of the culture of the plant. It provides a strong tool for continuous improvement. Some pillars of a robust HACCP program are Supply Quality Assurance. GMPs (Good manufacturing Practices) and Statistical Process Control (SPC). The direct application of HACCP is difficult in industries that do not produce food. But for industries that are associated with the food production industry (packaging, warehousing, transportation), the implementation of HACCP provides recognizable value. This is because the functioning of these industries can also impact the

final experience of the end consumer and hence have a role to play in ensuring the safety of food products for consumption.

The argument for universal implementation of HACCP can be summarized in that HACCP delivers security to the end user and a quality system to the producer that is both cost effective and robust.

REFERENCES

Dillon, M. and Griffith, C. (1995). *How to HACCP.* South Humberside, DN: M.D. Associates.

FDA. (2001). *NCIMS HACCP Pilot Program Phase II Expansion.* Retrieved September 20, 2006, from http://www.cfsan.fda.gov/~comm/daipilo2.html

Bennet, William L, Steed, Leonard L. (1999). *An integrated approach to food safety. Quality Progress* 32 (2): 37-42.

Canadian Food Inspection Agency. (2001). *Food Safety Enhancement Program.* Retrieved April 02, 2006, from http://www.inspection.gc.ca/english/ppc/psps/haccp/haccpe.shtml

Macrae, R., Robinson, R.K., Sadler, M.J., (1993). *Encyclopedia of food science food technology and nutrition.* CA: Academic press limited.

Patton, M. (1987). *How to use qualitative methods in evaluation.* Beverly Hills, CA: SAGE Publication, Inc.

Riswadkar, A.V. (2000), *An Introduction to HACCP the Hazard Analysis & Critical Control Point System for Food Processors.* Professional safety 45 (6). P33-36.

Mortimore, Sara, Wallace, Carol. (1997). HACCP. New York, NY: Chapman & Hall