

# **HACCP AND MICROBREWERIES**

**PRACTICAL GUIDELINES OF FOOD SAFETY FOR  
MICROBREWERIES, BREWPUBS AND THE  
BEER INDUSTRY**



**CLEMSON**  
E X T E N S I O N

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# HACCP AND MICROBREWERIES

## I. PURPOSE OF THIS PUBLICATION

The purpose of this publication is to assist microbrewers, inspectors and interested persons in understanding the food safety aspects related to the microbrewing process to make beer. A major issue related to any food or beverage is the control of potential hazards to reduce the risks of food-borne illnesses in consumers. The Hazard Analysis Critical Control Points (HACCP) approach is applied for the analysis of potential hazards during the microbrewing process. Many food safety aspects remain to be presented and understood. This publication may be considered as the basis to build future knowledge in the food safety aspect of the increasingly growing industry of brew pubs and microbreweries.

## II. INTRODUCTION

Beer is considered a safe beverage; however, its degree of safety may be comparable to many other food products. Many hazardous situations may arise during the production of beer. It is uncommon to hear about a beer contaminated with a pathogen such as *E. Coli*, or the presence of glass fragments in bottled beer, or contaminating mycotoxins in a freshly brewed beer. Although unusual, these hazards may occur and the processor should be ready to prevent these situations.

Beer is a fermented beverage made in several steps from cereal grains such as malted barley. Other

grains such as corn and rice are being used to aid in the final texture and flavor of the product. The primary ingredients in making beer are: malted barley, water, hops, and yeast. Water generally constitutes more than 90% of the finished product. The final alcohol content may vary from 0.5% to 15% and the pH is typically 4.5 or less. These two factors, along with the low nutritional value, make beer a fairly safe product without considering the toxicity of alcohol consumption and abuse.

Each ingredient has its own function. Barley provides the starch which is converted to maltose and other sugars, and finally to alcohol and carbon dioxide. Color, flavor and body are other important functions of barley and are dependent on its roasting method. Different degrees of roasting result in a range of colored beers from very light to very dark.

- Hops are flowers used as such or processed to obtain an extract to provide flavor, aroma and preservative effects to beer.
- Yeast are microscopic fungi used to convert sugars into alcohol and carbon dioxide.
- Minor ingredients may include herbs, spices, fruit, adjuncts and additives.
- Adjuncts are unmalted grain such as corn or rice added to enhance the flavor and body of beers.
- Additives are chemicals that may be added to enhance the quality of beers, such as clarifiers, sulfur dioxide and salts.

The major steps in producing beer include: malting, roasting, milling, mashing, boiling, fermenting, maturing, and keging or bottling.<sup>1</sup>

These steps, presented in a flow diagram, have to be analyzed to effectively apply the HACCP method to control food safety. It is in the public interest that beer producers, especially at brewing pubs and microbreweries, develop and implement HACCP plans to ensure the safety of beer. This is particularly true in brew pubs and microbreweries where beer is not commonly pasteurized.

A brew pub has been described as an establishment which brews and sells beer for consumption on the premises such as in a restaurant.<sup>2</sup> A microbrewery has been identified as a brewery producing no more than 15,000 barrels of beer annually. It is also critically important that federal, state, and local inspectors perform a HACCP-based auditing in cooperation with the beer producer. This will help to verify the safety of the process and the finished product before it is consumed. Beer can be contaminated with pathogenic microorganisms, chemicals, or physical particulates that are hazardous to the health of consumers.

### III. BEER SAFETY AND HACCP

The safety of any food and beverage, including beer can be managed and controlled by the HACCP concept. This concept is already being used across the food industry, especially in large food companies where it may be a part of their quality management program. HACCP is not difficult to adopt for small processors which includes the microbrewing industry. It is very important to remember that HACCP is an analytical approach to food safety, focusing on critical points or areas of a food process which may present a hazardous situation in need of control.

### IV. THE BASICS OF HACCP

HACCP can be considered as a management tool. It is a simple but specialized method designed to prevent health hazards resulting from the consumption of contaminated food and beverages.

Health hazards may originate at any point in a production process, including receipt of raw materials, food handling, storage, packaging and transportation. The knowledge of the product formula and the details of the process are basic tools necessary to begin to apply the HACCP method.

A beer producer must also know certain facts including:

- The primary microorganisms and their sources that may cause food-borne illness.
- The influence of temperature on microorganisms (referred as pathogens from now on).
- Other types of contaminants from chemical or physical sources.

HACCP simplifies the hazard analysis by focusing on 3 types of contaminants: microbiological (pathogens), chemical (such as pesticides or antibiotics), and physical (such as metal fragments).

Once the details of a process are known, a flow diagram is necessary. This initiates an analysis to determine the critical areas presenting hazardous situations that need to be controlled. The HACCP approach applies the following seven principles at every step in the selected process:

**Principle 1:** Assess the potential hazards (microbiological, chemical, or physical) at every step in the beer making process.

**Principle 2:** Determine the critical control points (CCPs) necessary to control the hazards. The definition of a CCP will be provided later in this publication.

**Principle 3:** Establish the critical limits (CLs) for each CCP.

**Principle 4:** Establish procedures to monitor each CCP and their critical limits.

**Principle 5:** Establish corrective actions that need to be taken any time a deviation from critical limits occurs.

**Principle 6:** Establish an effective record keeping system to document the HACCP plan.

**Principle 7:** Establish procedures to verify that the HACCP system is working effectively.

## V. HACCP TERMINOLOGY AND DEFINITIONS

- 1. Critical control point:** Any point or procedure in a food process where loss of control may result in an unacceptable health risk.
- 2. Critical limit:** Prescribed tolerances established to control potential or actual hazards identified in a critical control point.
- 3. HACCP:** Hazard Analysis Critical Control Points
- 4. HACCP plan:** The written document describing the procedures to control food safety to be followed based on the HACCP principles.

**5. HACCP system:** The result of implementation of a HACCP plan.

**6. Hazard:** Any biological, chemical, or physical contaminant in the food that may cause an unacceptable health risk to the consumer.

**7. Monitoring:** A planned sequence of observations or measurements of critical limits to generate accurate records and to maintain food safety.

**8. Verification:** Methods, procedures, and tests used to determine if the HACCP system is in compliance with the HACCP plan.

## VI. STEPS TO DEVELOP A HACCP PLAN

The following are essential steps recommended to build a HACCP plan from scratch:

- 1. Select the product and the process to be analyzed.**
- 2. Describe the product.**

This part is important for two main reasons. The first is to obtain a general idea about potential hazards that one has to be aware to be considered for the hazard analysis. The second reason is for documentation purposes. A well-described product will convey the right information to interested customers about the safety of the product.

- 3. Write a flow diagram as indicated in Figure 1.**

This is a flow diagram representing a food process in a block format. Important information such as processing times and temperatures, storage temperatures, and critical direct handling operations should be indicated on either side of the blocks.

Every step should be identified with the name of the unit operation such as pasteurization, cooling, cooking, freezing. These names should be used throughout the whole HACCP plan and HACCP system for proper reference.

#### 4. Validate the flow diagram.

This means to actually confirm that every step in the diagram is accurately representing the desired process. A walk through the facility and visual examination of every step in the process is essential to validate the diagram. The seven principles of HACCP can be applied more effectively when the flow diagram has been validated.

#### 5. Application of the Seven Principles of HACCP.

An example of a HACCP plan is shown in Table 1, representing a model HACCP plan for one step in a beer making process. Notice that the heading in every column accommodates each one of the seven HACCP principles. You will need to work on each column one at a time until completing the whole chart or HACCP plan as follows:

##### a) Apply Principle 1 at every step in the process.

To do this, you will need the flow diagram to perform the hazard analysis at every step in the process that has been identified. You begin with listing ALL potential hazards (microbiological, chemical, and physical) for every step. This is best done with a HACCP team formed by a group of people within the company coming from representative areas such as quality control, production, sanitation, maintenance, management, distribution, etc.

At this point, ALL potential hazards should be listed, regardless of how important they may be. The next thing to do is to select those potential

hazards that the team considers significant. These will be subjected to further analysis to determine how critical they might be in the HACCP plan to become CCPs. The remaining hazards should be kept as records and part of the HACCP plan.

You also need to indicate any preventive measures already implemented to prevent the occurrence of the hazard.

At this point, use Form 1 in the Appendix to list the identified hazards with the corresponding processing steps and preventive measures.

##### b) Apply Principle 2.

You need to determine what steps in the process are critical control points (CCP). This means that all significant potential hazards have to be controlled at some point in the process. **You can determine which point is a CCP as follows:**

- By using the preventive measures already implemented to prevent hazardous situations.
- Common sense.
- Your own experience and knowledge.
- The assistance of the CCP Decision Tree (Figure 2).
- The definition of a CCP.

One important thing to remember is that it is essential to exercise control over a point to be considered as a CCP. If you cannot control a point or step, you can not call it a CCP.

At this point, use Form 1 in the Appendix to identify the CCPs by number in the first column, under the processing step. In column 4, describe the control parameter such as temperature, concentration of a chemical, size of a screen, time, etc.

### **c) Apply Principle 3.**

For each CCP that has been identified, you need to establish its critical limits (CL) also. The purpose of CLs is to provide allowed tolerances to effectively control the identified hazards. These limits should be flexible enough to insure food safety, taking into consideration factors such as equipment variability and other commercial limitations.

Examples of CLs are: temperature, pH, water activity, relative humidity, concentration of preservatives, etc. It is important to remember that these limits have to be respected at all times and that effective records are to be generated as evidence for auditing and compliance purposes.

At this point, use Form 2 in the appendix to record your critical limits in the second column.

### **d) Apply Principle 4.**

Establish monitoring procedures at this time. Chemical and physical monitoring is preferred to microbiological monitoring due to rapidity in obtaining results. At this point, microbiological monitoring is very much limited for monitoring purposes. However, microbiological testing can be used for verification procedures.

All monitoring procedures are to be recorded and signed. Examples of monitoring include temperature done with thermometers, time with clocks, water activity with hygrometers, pH with pH-meters, etc. The frequency of monitoring is determined by experience, laws and regulations, and common sense to control food safety. “As often as necessary” should be the rule.

At this point, continue to use Form 2 to record monitoring procedures in the third column.

### **e) Apply Principle 5.**

The purpose of establishing corrective actions for every deviation of critical limits is to eliminate the actual or potential hazard created by each deviation. Each action must be written. Demonstrate that the CCP has been brought under control. Some actions may be as drastic as stopping the process if necessary, or placing the product on hold for further investigation.

At this point, continue to use Form 2 to write corrective actions in the fifth column. Also, you may want to include the name of the person responsible for the monitoring.

### **f) Apply Principle 6.**

Developing an effective record keeping system is essential for the implementation of HACCP in any food processing facility, including beer making. Examples of record keeping are: the HACCP plan itself; forms to show monitoring and corrective actions activities; documents indicating chemical and microbiological reports; time-temperature logs; and charts, etc. Record maintenance is fundamental to a HACCP system and it would be critical to regulators, who may have the right to ask for copies of any records related to HACCP. Also depending on laws and regulations, HACCP records may have to be kept on site for at least one year, and for 2 additional years on site or at another known location.

At this point, use Form 3 in the Appendix to indicate ways for record keeping in the second column.

### **g) Apply Principle 7.**

Verification procedures are an important part of the HACCP plan to verify that the HACCP system is effectively working and fulfilling its purpose in controlling food safety. Verification may include several activities such as microbiological, chemical,

and physical testing, usually performed on a sporadic or distanced time basis. Auditing and inspection activities every 3 or 6 months, reviewing of all HACCP related records, sampling of finished products, etc. are also verification procedures.

At this point, continue to use Form 3 in the Appendix to write verification procedures in the third column. You may want to use the fourth column to identify the number of the SOP (Standard Operating Procedures) related to the control of the corresponding CCP in this row of the chart.

By applying all seven principles at every step, your HACCP plan should be ready for implementation.<sup>3</sup> Even if your plan is not perfect at this time, it is recommended that you use it in this form and to modify the plan as necessary while implementing it.

A HACCP plan should include the names of persons responsible for any HACCP-related activities such as monitoring and taking corrective actions as necessary. Also the development and use of standard operating procedures (SOPs) to take total control of every CCP is strongly recommended.

## VII. HACCP AND SOPs

Proper sanitation procedures are important in the production of safe food and beverages. Pathogens can grow and reach contamination levels in a food processing facility because of improper sanitation, poor handling procedures, and inadequate equipment.

Standard operating procedures are detailed procedures indicating step by step how to do a job. These procedures should be written in such a way as to assist in the training of new employees so they know what is expected of them. Standard operating procedures can be written to perform any job, including sanitation and HACCP related jobs. In the first case they are called sanitation SOPs and in the latter HACCP SOPs.

The purpose of sanitation and HACCP SOPs is to prevent direct contamination of food products before and during operations. Written SOPs are evidence reflecting the commitment by an establishment to control food safety and the consumer's health.

Examples of activities that can be written in SOP format are: cleaning procedures and tests to verify their efficacy; hand washing sanitation and disinfection of equipment prior to start up; calibration of thermometers; and preparation of preservative solutions, etc.

<sup>1</sup> M. J. Lewis and T. W. Young. 1995. *Brewing*. Chapman and Hall, London, UK.

<sup>2</sup> S. Johnson, 1994. *On Tap New England, The beer connoisseur's guide to brewpubs, restaurant breweries, craft breweries, cottage breweries, and brewery inns*. WBR Publications, Clemson, South Carolina.

<sup>3</sup> F. H. Barron, 1994. *Food Safety and Hazard Analysis and Critical Control Points (HACCP). Practical Guidelines for Food Processors*. Extension Circular 685. Food Science Department, Clemson University, Clemson, South Carolina.



**TABLE 1 - EXPLANATION OF A TYPICAL CRITICAL CONTROL POINT**

This is the description of the hazard itself or a factor related to the control of the hazard.
These are instructions on what to do and how often monitoring of CCPs occurs. It could be batch or continuous monitoring.
Specific records for each potential hazard in a CCP. Records may be legal evidence.

Process	Potential	Description	Critical	Monitoring	Person	Corrective	Records	Verification
Conditioning	Chemical	Concentration of sulfur dioxide	Less or equal to 50 ppm	Weight of sulfur dioxide per batch	Preparation operator	Dilute batch to correct concentration	Batch records for amount used	<ul style="list-style-type: none"> <li>Review records</li> <li>Collect 3 samples per year for external testing</li> <li>Collect 3 samples every 6 months for in house testing</li> </ul>
	Undeclared food allergen	Labels indicating presence of sulfur dioxide	All labels declaring sulfur dioxide	Check all labels for declaration	Labeler	Reject unlabelled containers	Batch production of all containers	<ul style="list-style-type: none"> <li>Collect 25 containers/week</li> <li>Persons responsible for doing the monitoring</li> </ul>

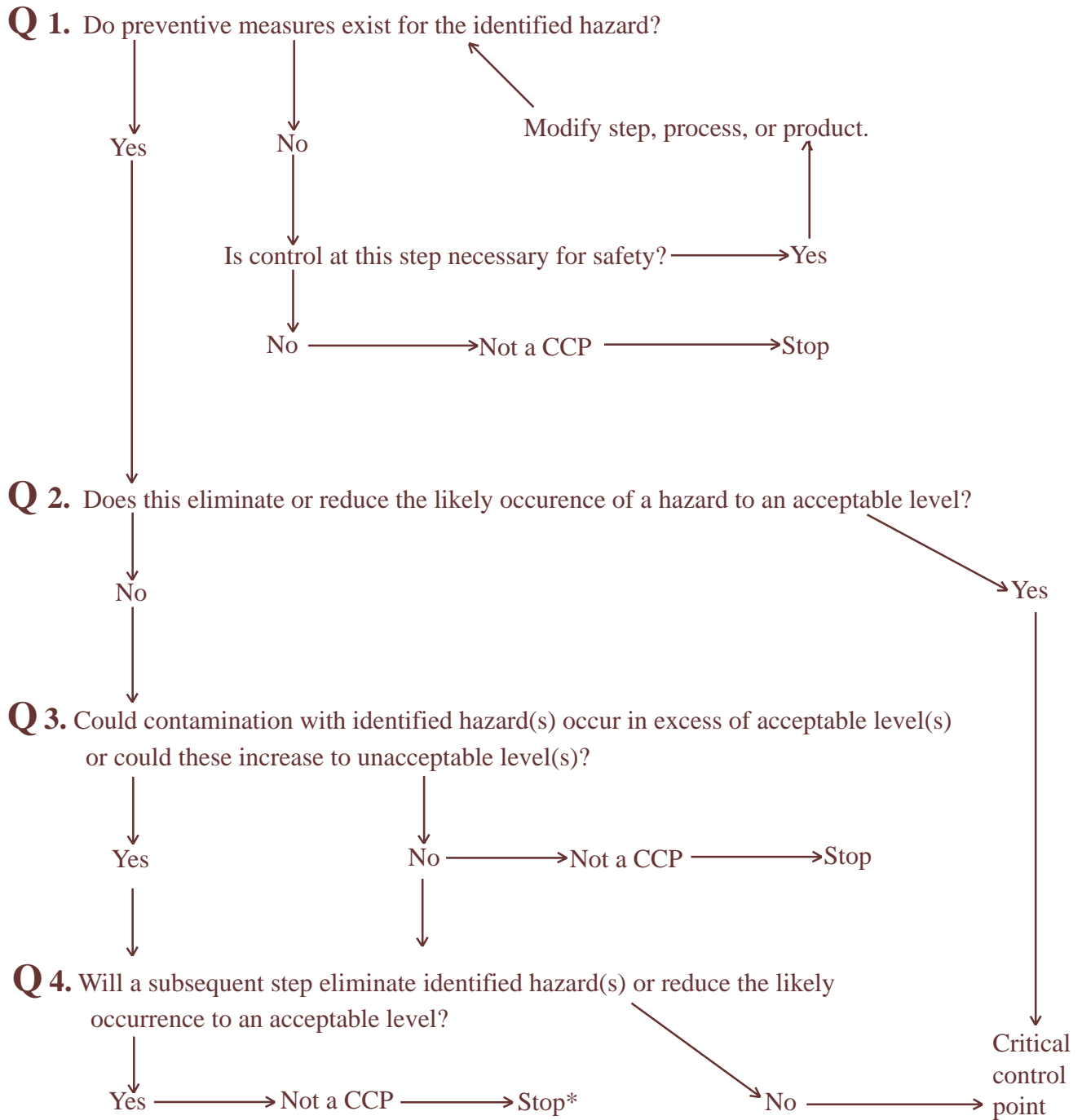
This is a step in the process where a CCP exists, based on an analysis including the use of the CCP decision tree.
These are the identified potential hazards.
These are the limits established to control all hazards. Laws and Regulations, as well as previous experience may dictate these limits.
Persons responsible for doing the monitoring.
Actual and realistic action to be taken to correct a deviation from critical limits.
These may be sporadic or distanced activities to verify that potential hazards are kept under control. Notice that verification is not monitoring.

NOTE: Standard operating procedures (SOPs) need to be written to indicate how to monitor CCPs, how to take corrective actions and how to do verifications. SOPs should be written in a very simple and clear way. Without SOPs it would be difficult to implement HACCP plans.

Figure 1. General Flow Diagram of a Brewing Process



**Figure 2. CCP Decision Tree (apply at each step of the process with an identified hazard)**



\* Proceed to next step in the described process.

## Appendix

Form 1

### Identification of Hazards, Preventive Measures and Critical Control Points

Product \_\_\_\_\_ Plant \_\_\_\_\_ Date \_\_\_\_\_

<b>Processing Step/ CCP Number</b>	<b>Potential Hazard</b>	<b>Preventive Measure</b>	<b>Critical Control Point Description</b>

Form 2

**Critical Limits, Monitoring Procedures, and Corrective Actions**

Product \_\_\_\_\_ Plant \_\_\_\_\_ Date \_\_\_\_\_

<b>Processing Step/ CCP Number</b>	<b>Critical Limit</b>	<b>Monitoring</b>	<b>Person Responsible</b>	<b>Corrective Action</b>

Form 3

**Record Keeping and Verification**

Product \_\_\_\_\_ Plant \_\_\_\_\_ Date \_\_\_\_\_

<b>Processing Step/ CCP Number</b>	<b>Records/Measurement</b>	<b>Verification</b>	<b>SOP Number</b>