FOOD SAFETY

Hazard Analysis and Critical Control Points (HACCP) for Foodservice and Food Retail Operations

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HACCP is an acronym for the Hazard Analysis and Critical Control Point system. HACCP is a preventative system that is used in the food industry to help ensure food safety. The basis for HACCP is to identify potential hazards associated with food production and preparation, and to develop mechanisms to eliminate or control these hazards. HACCP can be applied to all areas of food production, from the farm to the homes of consumers. HACCP is important to all segments of the food industry.

During the past twenty years, most HACCP programs have been dedicated to food processing plants which are in the "middle" of the food production chain. More recently, the food industry has realized the importance of establishing HACCP principles for the end of the food production chain: retail food and foodservice operations.

The use of HACCP can complement quality control programs. When measures are taken to assure food safety, this generally results with better food quality. HACCP is not a stand-alone system! Effective cleaning and sanitizing programs and maintaining the health and cleanliness of the food handler are also important for assuring a safe, high-quality food. These programs are typically not part of HACCP programs because they are difficult to monitor, and safe limits have not been clearly established.

History of HACCP

The concept of HACCP was initiated by the Pillsbury Company. The Pillsbury Company, the National Aeronautic and Space Agency (NASA), the Natick Laboratories of the U.S. Army, and the U.S. Air Force Space Laboratory Project Group worked together on a project in food production for the NASA space program. The pathway of HACCP started in 1959 when Pillsbury was asked to produce a food that could be used under zero gravity conditions in space capsules. In 1959, they began the project knowing basically nothing about how foods might react under zero gravity conditions. The most difficult and perhaps most important aspect of the project was to develop a system to assure that food products would not be contaminated with biological, chemical, or physical hazards. Such hazards might result in an aborted or catastrophic mission.

With these problems in mind, the research groups concluded it was necessary to develop a preventive food safety system that would reduce the likelihood of biological, chemical, and physical hazards. In doing so, control could be achieved over all aspects of food production including raw material, processing, environmental conditions, personnel, storage, distribution, and transport. This approach, referred to as HACCP, worked well for the NASA space program, and was quickly adapted by the food industry.

A Systematic Study

HACCP involves a systematic study of the ingredients, the food product, the conditions of processing, handling,

storage, packaging, distribution, and consumer use. The complete analysis allows for the identification of the "sensitive" areas in the process flow which might contribute to a hazard. From this information, "Critical Control Points" (CCP's) can be determined. Areas identified as CCP's are monitored and limits are determined to control potential hazards. When properly applied, HACCP can be used to control any area or point in the food system which could contribute to a hazardous situation whether it be contaminants, disease-causing microorganisms, physical objects, chemicals, raw materials, an unsafe process, package labeling, or storage conditions.

There are seven principles which are used to develop and implement a HACCP program (Figure 1).

Figure 1. Seven principles of HACCP.

1) Analyze hazards
2) Determine CCP's
3) Establish critical limits for CCP's
4) Monitor CCP's
5) Take corrective action
6) Do record keeping
7) Verify that the system is working

Hazard Analysis

In the first step of HACCP, it is important to identify potential hazards that might be associated with growing, harvesting, raw materials and ingredients for processing, manufacturing, distribution, marketing, preparation, and consumption of the food.

The purpose of hazard analysis is to identify all potential hazards (biological, chemical, and physical) that may be associated with the flow of a given food. Some potential hazards of concern in foodservice and retail foods are identified in Figure 2. The types of hazards depend on the type(s) of foods and preparation practice(s) involved.

Figure 2. Common hazards in foodservice and food retail operations.

Biological:
- Pathogenic bacteria (i.e *Salmonella* spp., *Staphylococcus aureus*)
- Viruses (i.e. Hepatitis A)
- Parasites (i.e. *Trichinella spiralis*)
- Rodents and insects (can carry bacteria, viruses, parasites)

Chemical:
- Naturally occurring (i.e. seafood toxins)
- Added chemicals (i.e. cleaning agents, pesticides)

Physical:
- Inherent to food (i.e. bone particles)
- Non-inherent to food (i.e. glass, stone, wood)

Determine CCP's

This step identifies critical areas or points of the flow of a food product that are required to control the identified hazards. For an area to be considered a CCP, loss of control would mean the likelihood of an unacceptable health hazard. In HACCP programs, sometimes "control points" (CP's) will also be identified. A CCP is different from a CP (Figure 3). A CCP indicates a high food safety risk (likely to occur) and a CP indicates a low food safety risk (not likely to occur). Food safety relies on identification and control of CCP's, while, CP's may be used for quality specifications.

Figure 3. CCP or CP ?

If control is lost, is it LIKELY that a health risk will occur?

If the answer is YES, this is considered a CCP.

If the answer is NO, this is considered a CP.

Establish Critical Limits for CCP's

This step establishes upper and/or lower limits for each CCP. CCP's are set for foods that can naturally carry and/or support the growth of a foodborne hazard. These types of foods are called potentially hazardous foods. Limits for CCP's to control biological hazards in foodservice and food retail operations are usually time and temperature related since they can be easily monitored. Time and temperature are also the most important factors permitting growth of bacteria. Occasionally, a measurement in pH (acidity of a food) may also be used as a critical limit. Although important, limits for chemical and physical hazards are used less often in HACCP plans for foodservice and food retail. Chemical and physical hazard levels are usually more easily monitored and controlled prior to receipt at a foodservice and/or food retail establishment. For chemical hazards, it will be important to ensure that chemicals (cleaning agents) are separated from foods. A visual inspection can be used for physical hazards.

Time and temperature limits can be set for various areas of retail food production. They include receiving, cold storage, thawing, cooking, cooling, reheating, hot-holding, and cold-holding of foods. Some suggested critical limits are included in Figure 4.

Monitoring CCP's

Monitoring CCP's includes the recording of data (temperature, time) for limits which have been set for each CCP in the HACCP plan. Data collection is important to assure that CCP limits are being met. The procedures and frequency for monitor-

ing CCP's will differ depending on the type of food(s) and the preparation practices used.

Corrective Action

If monitoring shows that a limit for a CCP has been exceeded, corrective action procedures must be in place to assure the safety of the food. Corrective action procedures may range from discarding the product to simply cooking the product to a higher temperature. Corrective action procedures will differ depending on the type of foods and the preparation practices used.

Record Keeping

Keeping records of the HACCP plan and for monitored CCP's is extremely important. It is a good idea to have records available for 1 year on location, and for 3 years total. Good record keeping helps to assure proper use of the HACCP program and the safety of foods that are served. During an inspection, a health inspector may ask to see records for the HACCP program.

Verification

Before, during, and after development of a HACCP food safety prevention program, it is important to verify that the program is appropriate. HACCP programs can be verified by a representative from the state or local health department.

Once the program is in place, an employee in charge of food safety and quality should be assigned responsibility for the HACCP program. This individual needs to verify that employees are performing tasks in the HACCP program. This person should also be responsible for training and educating employees on principles of food safety, food quality, and HACCP. Continuing education is the key for preventing risks of foodborne illness.

Monitoring, good record keeping, and corrective action are the heart of a HACCP program. These procedures work best when one person is in charge of verifying that CCP's are being monitored, good records are being kept, and corrective action is taken when needed.

Figure 4. Temperature/time critical limits for retail food preparation.

Receiving: Internal temperature should be <41°F for all potentially hazardous foods.

Cold Storage: Internal temperature should be maintained at <41°F for all potentially hazardous foods.

Thawing: Refrigerator thawing at <41°F is suggested. Microwave thawed foods must be cooked immediately after thawing. Cool water thawing must be done at <70°F for <2 hours from a continuously running potable water supply. Thawing at room temperature is not acceptable.

Preparation of Food: Preparation of potentially hazardous foods should be done so that food is held not between 41-140°F whenever possible. If food must be prepared between 41°-140°F, it can only be exposed in this temperature range for 4 hours total time, however, <2 hours total time is preferred.

Cooking:

Food type	*Internal temperature**	*Holding time*
Beef roast (rare)	130°F	121 minutes
Beef roast (rare)	140°F	12 minutes
Eggs, meat, fish	140°F	15 seconds
Pork, game animals, ground beef	155°F	15 seconds
Poultry, stuffed meats	165°F	15 seconds
*Microwave cooking	Add 25°F	———

Cooling: Potentially hazardous foods must be cooled from 140°F to 70°F within 2 hours, and from 70°F to 41°F within 4 hours (6 hours total time).

Reheating: All foods must be reheated to an internal temperature of 165°F within 2 hours. Foods may only be reheated once.

Hot Holding: After proper cooking, internal temperature should be maintained at >140°F prior to being served for all potentially hazardous foods.

Cold Holding: Internal temperature should be maintained at <41°F prior to being served for all for all potentially hazardous foods.

(From 1995 FDA Food Code)

Developing a HACCP Plan

There are several ways that foodservice and retail food establishments may develop a HACCP program. A practical approach is included in Figure 5. The most important aspect of the process is to select a team of people to develop the HACCP plan and describe a flow diagram of food throughout your establishment. For assistance in HACCP program development, contact your local health department or local county extension office.

Developing and implementing HACCP food safety prevention programs in foodservice and food retail operations is a useful systematic approach to improving food handling practices and decreasing the risk of foodborne illness. It is important to develop HACCP programs using a team approach. Furthermore, it is important that employees in foodservice and food retail establishments, from the food manager to the front line worker, understand the importance of food safety.

Temperature and time are most often used as critical control point limits. Both temperature and time are easily

Figure 5. Steps in Designing a HACCP plan

1) Set up a HACCP team (food manager, cook, local health inspector etc.).
2) Develop a flow diagram of the process (for each food that is served).
3) Perform a hazard analysis.
4) Determine CCP's.
5) Establish critical limits for CCP's.
6) Establish a procedure for monitoring CCP's.
7) Establish plans for corrective action.
8) Establish a method for record keeping.
9) Train employees to understand. HACCP plans (How and Why!)
10) Implement the HACCP plan.
11) Verify that the HACCP plan is effective.

monitored and temperature/time parameters have been established for the elimination, destruction and/or prevention of growth of foodborne hazards. Making sure that employees have good personal hygiene, that employees take measures to avoid cross-contamination, and that the food establishment has an effective cleaning and sanitizing program in place are also important preventative measures to avoid foodborne microbial illness.

Although the latter measures are a big part of food safety prevention, they are usually not part of HACCP. They are part of Standard Operating Procedures (SOP's) or Good Manufacturing Practices (GMP's). These issues are generally not included in HACCP programs because they cannot be monitored easily and critical limits have not been defined. Remember that HACCP is not a stand-alone program. Assuring food safety relies on an effective SOP (or GMP) program coupled with a strong HACCP program.

Figure 6. Product flow diagram: Hamburger patties.

Receiving—> Cold Storage—> Patty Preparation—> Packaging—> Refrig. Storage

Figure 7. Critical control points: Hamburger patties.

CCP 1 CCP 2 CCP 3 CCP 4

Receiving—> Cold Storage—> Patty Preparation—> Packaging—> Refrig. Storage

HACCP Example 1: Preparation and storage of hamburger patties in a supermarket

Description:

Ground beef is received every 2 days in 5 lb packages. The ground beef is held for a maximum of three days in a walk-in cooler (set at 35-37°F). The morning butcher is responsible for weighing and assembling 1/3 lb patties. Patties are repackaged between wax paper, placed on a styrofoam tray, covered with a plastic film, and held at refrigerated storage until sold (Figure 6).

Hazard Analysis

The primary concern with preparation and storage of raw hamburger patties is biological hazards. One should assume that hamburger meat is likely to contain harmful bacteria (i.e. *Escherichia coli*, *Salmonella* spp.). During patty preparation, the meat could be further contaminated from contact with infected food handlers that do not follow proper sanitary practices (i.e. washing hands).

Determine CCP's

During storage and preparation of ground beef patties, it will be important to control the growth of bacteria inherent to the hamburger. To do so, each step in the process (receiving, cold storage, patty preparation) would be considered a CCP (Figure 7). Safe temperature and time guidelines have been established at each step and are needed for the safety of the product.

Establish Critical Limits for CCP's

Recall that critical limits in food retail are usually defined as temperature(s) and time(s). Temperature and time limits can be set for each step in the process (Figure 8). Refer to Figure 4 to establish correct critical limits. For receiving and cold storage, the hamburger meat should arrive and be maintained at <41°F. Hamburger meat should be maintained at <41°F during patty preparation if possible. If not possible, limit patty preparation time to <2hrs. It may be better to work with smaller batches of meat in order to minimize the length of time at room temperature.

Monitoring CCP's

The temperature of the ground beef should be monitored upon receipt, during cold storage, and periodically during patty preparation with an approved and calibrated food thermometer. If possible, upon receiving the meat, check the time/temperature records from the delivery truck.

Corrective Action

Here, corrective action needs to be established if any of the CCP limits are not met. If the product is delivered at >41°F, or if records from the truck indicate that the product was >41°F during distribution, the meat should be rejected. If meat is >41°F for >2 hrs during cold storage or patty preparation, the product should be discarded.

Figure 8. Critical Control Point limits: Hamburger patties.

		<41°F or	
<41°F	<41°F	41-140°, <2hrs	<41°F

Receiving—> Cold Storage—> Patty Preparation—> Packaging—> Refrig. Storage

Figure 9. Record keeping: Hamburger patties.

Date	Time of Day	CCP#	CCP limit(s)	Temp. (°F)	Time	Action Yes/No	Initials
1/5/93	11:21 am	1 (Rec.)	<41°F	38°F	——	No	
1/6/93	1:45 pm	2 (Stor.)	<41°F	37°F	——	No	
1/6/93	6:15 pm	3 (Prep.)	<41°F or 41-140°, <2hr	——	4.5 hr 41-140	Yes, product discarded	
1/6/93	NA*	4(Stor.)	<41°F	NA*	NA*	NA*	

*NA - Data not available since product was discarded at CCP 3 (patty preparation time exceeded limit of 2 hrs).

Record Keeping

Maintain records including date, time of day, CCP#, CCP limit(s), temperature, time (at temperature), corrective action, initials of person recording data (Figure 9). As part of record keeping, if a deviation from the critical limit is noted, there should be clear instructions of what to do.

Verification

Verify that the HACCP plan is working. A supervisor in charge of food safety and quality should ensure that the HACCP plan is working. The supervisor should be checking that CCP's are being properly monitored and that good records are being kept. It may be useful to submit your HACCP plan to the local health inspector to verify that the HACCP plan is effective for assuring safe food.

HACCP Plan Example 2: Preparation and cooking of a frozen boneless turkey roast in a restaurant

Description:

A frozen (0°F) raw turkey roast is received in an 10 lb package. Upon receipt, the turkey is held frozen in the restaurant until thawing in the cooler (35-37°F) for 24-48 hours. The thawed turkey roast is cooked in a conventional oven. Half of the roast will be sliced and served as a hot entree. The other half of the roast is cooled and served cold for sandwiches. Both foods are presented to the customer on a self-service buffet (Figure 10).

Hazard Analysis

Since the turkey roast is coming from a food processing plant, we assume that they have taken appropriate measures to eliminate chemical and physical hazards. The primary concern with a raw processed turkey roast would be biological hazards. Raw poultry naturally contains biological hazards. A good example would be bacteria such as *Salmonella* spp.

Determine CCP's

Raw poultry is a potentially hazardous food that will naturally contain disease-causing microorganisms. Throughout preparation and service, it will be important to keep the product properly stored, to cook the product thoroughly, for cool foods to be served quickly, and for "cold foods to be kept cold" and "hot foods to be kept hot." It will be critical to control and monitor temperature throughout all areas of the process that could allow survival and/or growth of harmful microorganisms.

Critical Control Points for this process would include thawing, cooking, hot-holding, cooling, and cold-holding (Figure 11). At each of these points, safe temperature and time guidelines have been established. If these areas are not controlled, serving this food would likely lead to a health hazard, foodborne illness.

Control Points for this process would include receiving and frozen storage, which are standard for all frozen products. The standard operating procedures for frozen foods would be to check the temperature upon delivery to see if it is <0°F and then store at <0°F. Control points are mainly established for food quality. Critical limits are not set for Control Points.

Figure 10. Product flow diagram: Turkey roast.

Receiving—> Frozen Storage—> Thawing—> Cooking—> Hot Holding or Cooling—> Cold Holding

Figure 11. Critical Control Points: Turkey roast.

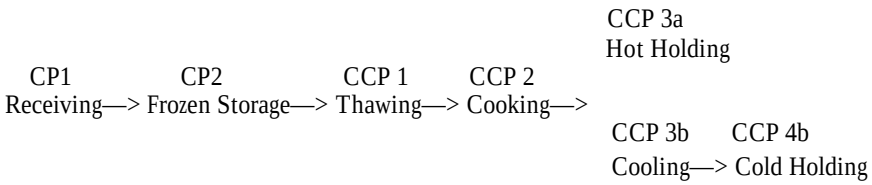

Figure 12. Critical Control Point limits: Turkey roast.

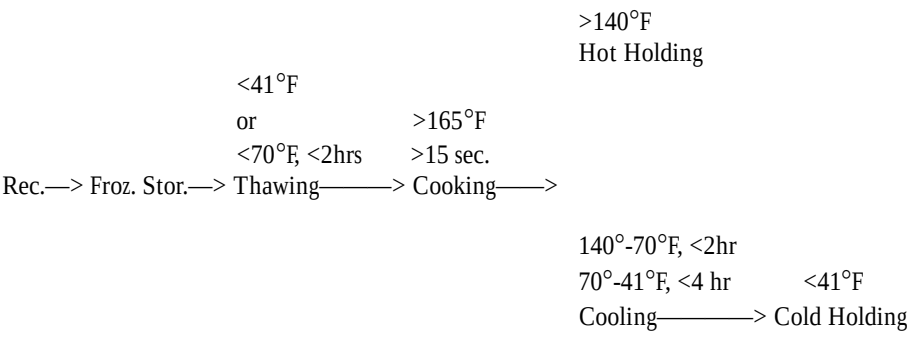

Figure 13. Record keeping: Turkey roast.

Date	Time of Day	CCP#	CCP limit(s)	Temp. (F)	Time	Action Yes/No	Initials
1/4/93	7:30 pm	1 (Thaw)	<41F, or <2hrs, <70F	37F cold room	——	No	
1/5/93	10:00 am	2 (Cook)	>165F, 15sec.	180F	15 sec.	No	
1/5/93	1:25 pm	3a (Hot Hold)	>140F	98F	——	Yes - product discarded	
1/5/93	1:30 pm	3b (Cool)	140-70F, <2hr 70-41, <4hr	38F	at 2:00 pm (<2hrs)	No	
1/5/93	2:30 pm	4b (Cold Hold)	<41F	39F	——	No	

Establish Critical Limits for CCP's

Critical limits for the CCP's defined above can be found in Figure 4. The first CCP is thawing (Figure 12). The safest method to thaw the frozen turkey roast is in a refrigerator maintained at <41°F. Refrigerator thawing takes planning ahead. If the turkey roast is needed sooner, thawing of the packaged turkey roast can be done under running water (<70°F) for <2 hrs. Microwave thawing is another option. However microwave thawing is more suitable for smaller food products (<2 lbs). If the roast is microwave thawed, it needs to be cooked immediately after thawing. The next CCP is cooking. All raw poultry products must be cooked to an internal temperature of >165°F for >15 sec. The process then divides into two separate steps. The part of the food that is to be hot held, identified as CCP 3a, needs to be held at >140°F. The other part of the food that is to be cooled and held cold is identified through CCP's 3b and 4b, respectively. The food must be cooled from 140 to 70°F in <2 hrs and from 70 to 40°F in <4 hrs (total time of 6 hrs). After proper cooling, the food needs to be cold-held at <41°F.

Monitoring CCP's

Thawing will be the first CCP that needs to be monitored. If thawing in the refrigerator, be sure to check that the refrigerator and the food is maintained well below 41°F. If thawing is done under cold running water, keep the turkey in its original plastic wrap and place under cold (<70°F) running water. Make sure that thawing time is less than 2 hrs.

Cooking is the next important CCP that needs to be monitored. Be sure that the internal temperature of the cooked product is at least 165°F for >15 seconds. For hot-held product, monitor the internal temperature every 30-60 minutes. The temperature needs to be at least 140°F. For cooled, cold-held product, measure temperature during cooling to ensure that product is <41°F

within the guidelines described in Figure 12. For cold-held product, monitor the internal temperature every 30-60 minutes. The temperature needs to be below 41°F.

Corrective Action

If any of the CCP limits are exceeded, corrective action must be taken. If CCP limits associated with thawing, cooling, hot holding, or cold-holding are not being met, the product should be discarded or reheated to 165° then hot held. Keep in mind that foods may be reheated only once and only if you can prove that foods are not between 41°-140° for >4 hrs (< 2 hrs is preferred). If, during cooking, the turkey roast is <165°F, continue cooking until 165°F for 15 seconds is obtained.

Record keeping

Maintain records including date, time of day, CCP#, CCP limit(s), temperature, time at temperature, corrective action, initials of person recording data. As part of record keeping, if a deviation from the critical limit is noted, there should be clear instructions of what to do.

Verification

Verify that the HACCP plan is working. A supervisor in charge of food safety and quality should ensure that the HACCP plan is working. The supervisor should be checking that CCP's are being properly monitored and that good records are being kept. It may be useful to submit your HACCP plan to the local health inspector to verify that the HACCP plan is effective for assuring safe food.

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