

Chapter 8

FOOD SAFETY IN CENTRALIZED FOODSERVICE SYSTEMS

Food safety is increasingly important in school foodservice operations. Directors of centralized foodservice systems identify food safety and quality control as being an advantage for these systems, yet often there are more critical control points in these foodservice systems than there are in conventional foodservice systems because food is prepared, chilled, and reheated for service. Centralizing food production necessitates that there be an emphasis on food safety and that a Hazard Analysis Critical Control Point (HACCP) program be in place throughout the entire foodservice system. This chapter focuses on the processes that need to be in place in a centralized foodservice system to ensure food safety and quality. Specifically, this chapter will include information about:

- Prerequisites for food safety and HACCP programs
- Responsibility for HACCP
- Developing and implementing HACCP programs
- HACCP principles
- Integrating technology into HACCP programs
- Research related to food safety in central kitchens

Prerequisites for Food Safety and HACCP Programs

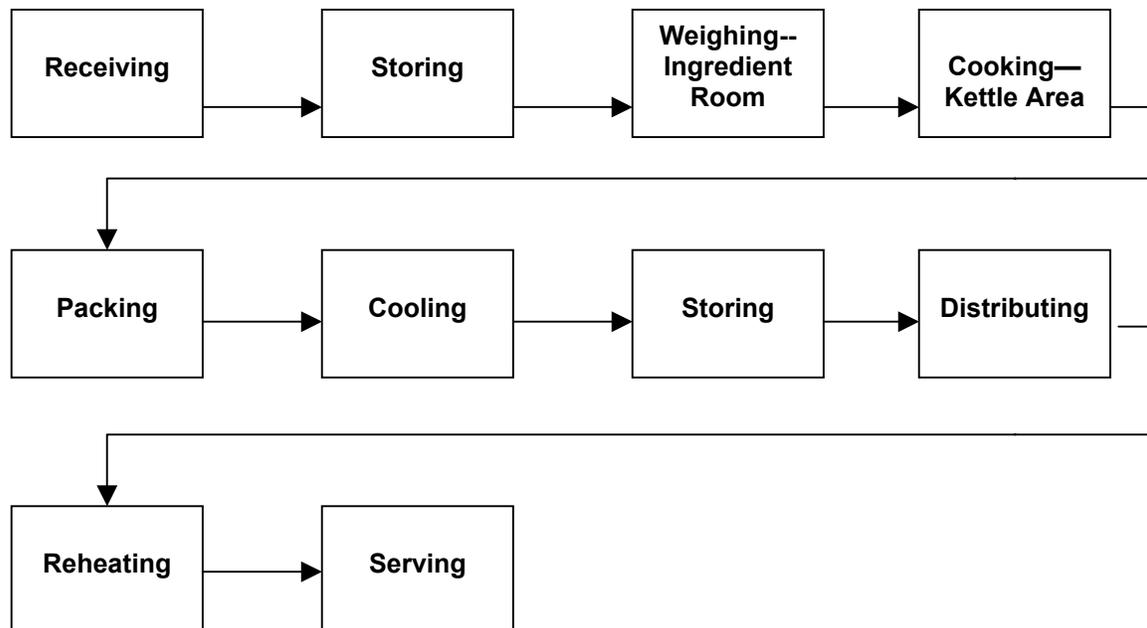
The development and application of HACCP programs needs to be considered from a systems perspective, analyzing an operation for critical control points. Ultimately, the **menu** will drive all decisions about HACCP implementation. The National Advisory Committee on Microbiological Criteria for Foods (1998) identified application guidelines for HACCP. The committee identified prerequisite programs that must be in place to ensure food safety. HACCP programs build on these prerequisites: facilities; supplier control; specifications; production equipment; cleaning and sanitation; personal hygiene; training; chemical control; receiving, storage, and shipping; traceability and recall; and pest control. Quality assurance procedures, standard operating procedures, and standardized recipes also are important prerequisites for food safety. Complete prerequisite programs are necessary to implement HACCP programs in central kitchens. Without them, HACCP programs will not succeed.

Food Safety Considerations when Planning Facilities

This process would ideally begin when new or renovated facilities are planned. Some school foodservice directors may find that they are centralizing food production in an existing facility and do not have the resources to make substantive changes. If this is the case, it is imperative that analysis be done to ensure that time and temperature controls can be achieved to ensure the safety of food served to children.

Flow of Food. In planning a new or renovated central kitchen, it is important for the planning team to determine the flow of food through the operation. The food flow diagram is an important component of the HACCP program. In existing operations, the foodservice director or quality assurance supervisor needs to analyze the operation to determine the flow of food, and develop HACCP programs related to that flow. The steps in the flow of food vary slightly by system, and directors need to develop their own food flow diagrams for their specific operation. One example of product flow in a centralized cook/chill system is depicted in Figure 8.1.

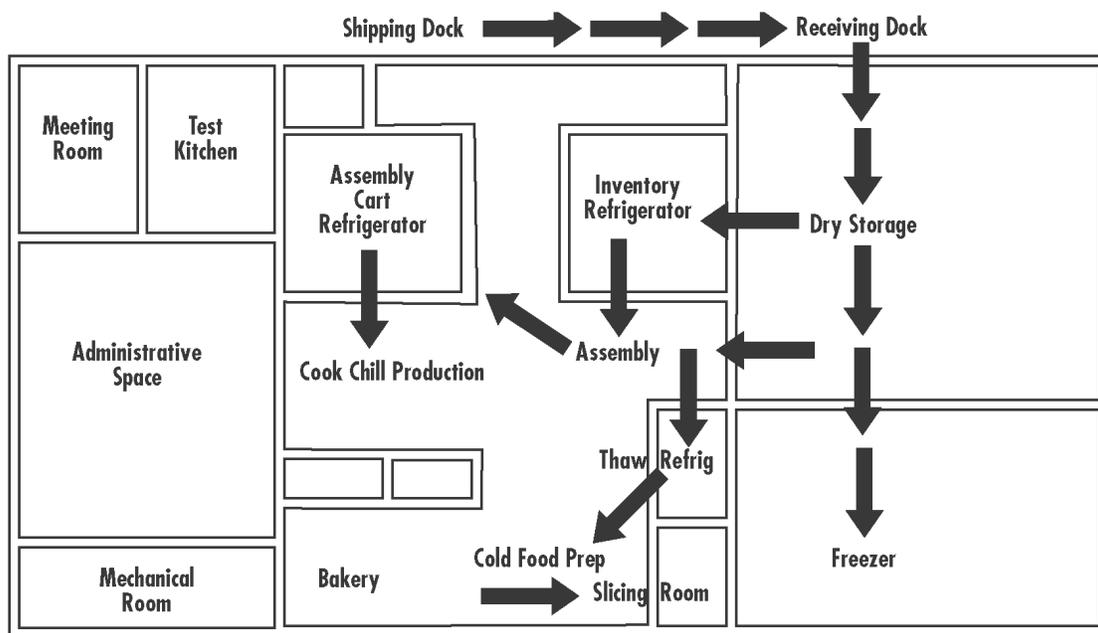
Figure 8.1 Sample Food Flow Diagram



For the centralized foodservice systems that are hot bulk, there would not be a cooling and storing step in the process. **Once the flow of food is determined, the general layout of the foodservice operation can be developed.**

Figure 8.2 shows how the food flow may be evaluated from an operational perspective. The functional areas are designated, and arrows show the flow of food through the operation from receiving to transporting.

Figure 8.2 Sample Kitchen Food Flow



This operational layout helps minimize potential for cross contamination of food products. Ideally the incorporation of HACCP principles would be apparent by clearly separating various areas of food processing such as receiving, storage, food processing, equipment cleaning, and transportation. For example, the receiving area would be separated from other parts of the operation by doors. These doors would be closed to the outside to minimize physical hazards such as exhaust fumes and dirt. Ideally, delivery vehicles would be kept in an enclosed receiving area. Other examples of physical separation include:

- Storage areas are often separated from preparation areas;
- Dish and ware washing areas are in a separate room; and
- Refrigerated cooked products are in a separate area from raw ingredients.

CASE IN POINT

The dish room in the Saint Paul School Food Service facility in St. Paul, Minnesota is designed with a wall to separate the dirty and clean ends of the dish machine. This physical barrier helps ensure that there is not cross contamination between clean and dirty cooking utensils.

Production Equipment

Selection of equipment for central kitchens should include consideration of food safety. Specifications for equipment would indicate that equipment is constructed and operated following industry standards such as those from the National Sanitation Foundation (NSF) and Underwriters Laboratories (UL). Consideration also needs to be given to local regulations for equipment operation and installation. Installation of equipment and other parts related to equipment use, such as drains, would need to be done properly to ensure that sanitation standards can be followed. Once the equipment is installed, preventive maintenance schedules should be implemented. For equipment that requires temperature calibration, a regular schedule with appropriate documentation needs to be in place.

Because central kitchens are producing large quantities of food at a time, special consideration needs to be given to cooling of food products. Blast or tumble chillers should be purchased to speed the cooling process of food products. For example, a large batch of Sloppy Joe mixture may be produced in a 100-gallon steam jacketed kettle. The production manager would need to make sure that the chilling equipment such as a tumble chiller could adequately reduce the temperature of the packaged product from that batch to meet food safety regulations.

When selecting equipment, consideration needs to be given to critical control point (CCP) information that can be collected automatically by built-in sensors. Thermometers with recording devices should be specified for cooking and chilling equipment, such as freezers, refrigerators, and steam-jacketed kettles. Ideally, this information could be collected automatically at intervals determined by the operator. This information could readily be reviewed by the foodservice managers to make adjustments during the preparation, production, storage, and transportation of food products. For example, all refrigerator and freezers could be equipped with automatic temperature sensors that have a running log of temperatures. These data could be sent to a computer system where the foodservice manager could review the performance of all equipment in the centralized foodservice system.

Prerequisite Programs for Implementing HACCP in Centralized Foodservice Systems

The basis for HACCP programs is prerequisite programs. These programs include food temperature control, cleaning and sanitizing, employee personal hygiene, and pest control. These programs should be formally documented and implemented through Standard Operating Procedures (SOP). The SOP will include several of the prerequisites including supplier control, specifications, cleaning and sanitation, personal hygiene, chemical control, receiving and storage, transportation (shipping), traceability and recall, and pest control. The SOP will be presented by functional areas, including each of these aspects of the production system. If SOP currently exist, they need to be reviewed carefully to determine if food safety controls and monitoring are included adequately.

SOP are needed for each of the following areas:

Procurement. Procurement is the function by which foods and supplies are purchased and received into the facility. Procurement is a general category that includes prerequisite programs related to supplier control, specifications, chemical control, and receiving and storage. SOP that will need to be in place include:

- **Writing clear purchasing specifications**, including all of your requirements for food products, including food safety.
- **Selecting suppliers**, preferably those with their own HACCP programs. Depending on the food item, HACCP programs should be required of the supplier. For example, prepared products such as salads and sandwiches would need to be purchased from a vendor who has a HACCP program in place. Inspecting the delivery trucks for temperature and cleanliness and checking temperatures of products delivered are steps that should be included
- **Receiving products**, including requirements such as checking temperatures of foods upon delivery, moving the frozen and refrigerated items quickly into storage, priority list for foods to be stored first, etc.
- **Storage**, designating specific areas for appropriate products. This includes maintaining a separate storage area for all chemicals.
- **Managing inventory**, including inventory turnover procedures, monitoring the shelf life of products, etc. All cook/chill operations should track their inventory to ensure that food is used within a safe period of time.

CASE IN POINT

The school district staff in Olathe, Kansas have developed shelf life guidelines that are posted in various areas of the food production facility. In the salad preparation area, they have a chart that lists all of the fresh fruits and vegetables (such as carrot sticks, lettuce, shredded carrots, diced tomatoes, etc.) that they use. The number of days an item may be kept is listed for each item.

They also developed a form to be used with cold cuts/lunch meats. The form has the following headings:

Item	Maximum Shelf Life	Expiration Date/Code	Processing Date	Date Schools Use
Brand Turkey	90 Days			
Brand Deli Ham	180 Days			

They have developed instructions on how to use the code number on the product box to determine when the item was produced. The maximum shelf life is based on when the item was produced, not when it was received in the central kitchen.

Food production. Food production, or the transformation of raw food into cooked food, requires several SOP. These relate to prerequisite programs for cleaning and sanitation and personal hygiene.

- **Managing employee hygiene,** including hand washing procedures, proper personal hygiene, and uniform policies for all employees.
- **Producing food.** For all potentially hazardous foods, there should be handling procedures established. These handling procedures may be designated in standardized recipes, charts, posters, production records, and other documents that employees see on a regular basis.
- **Cleaning and sanitizing programs,** including when and how cleaning and sanitizing should be done. Assignment of responsibility to a specific individual and/or job position also will need to be done.

- **Maintaining equipment**, including preventive maintenance plans for all equipment.
- **Monitoring food safety and sanitation**, including monitoring of time and temperatures, testing food samples, taking surface swabs of equipment and food contact surfaces to determine bacterial count, etc.

CASE IN POINT

Saint Paul School Food Service has “recipes” for sanitizing equipment. Employees follow those recipes just as they would recipes for food production.

CASE IN POINT

Minneapolis Public Schools Food Service Department selects a food item and follows it through each step of the food flow to determine time and temperature. If temperatures are not appropriate or food is held too long, they make changes in their process. They also take swabs of equipment to determine if it is being cleaned thoroughly. Through this process, they found levels of bacteria beyond acceptable limits in one of their steam-jacketed kettles, which prompted them to modify their cleaning and sanitizing processes. Once they modified their procedures, the procedures were verified with swabs tested for microbiological counts. They modified their Standard Operating Procedure for cleaning kettles based on their findings.

Transportation. In centralized foodservice systems, food is transported from a central kitchen to receiving kitchens at schools. SOP for transportation include procedures for time, temperature maintenance, and sanitation of transportation vehicles and equipment.

Service. Service of the food takes place at the schools. SOP are established for how food will be served:

- **Storage**, storage areas, holding areas, temperatures, inventory rotation, etc.
- **Service temperatures**, final end-point temperatures for service and cooling time and temperature guidelines for excess food.

- **Reheating**, final end-point temperatures for food and procedures for when and how temperatures of food will be taken.
- **Handling leftovers**, how and when they should be discarded.
- **Dishwashing**, proper procedures for handling dirty and clean dishes and checking temperatures, or concentrations of detergents/sanitizers.
- **Cleaning and sanitation programs**, when and how cleaning and sanitizing will be done in the receiving kitchen and dining room.

Chemical Control. When planning a central kitchen, separate areas for storage of chemicals should be included. Separate chemical storage areas are needed in the receiving kitchens, too. These areas should be physically separated from other storage areas and often are locked. All chemicals need to be stored in their original containers, or be marked clearly to ensure that all employees know the contents of the container. They should not be stored in food containers that might confuse employees about the contents. Employees need to be trained on the proper use of chemicals, including when to use, how much to use, testing for concentration levels, etc. Also, Material Safety Data Sheets (MSDS) should be stored in a notebook near where the chemicals are used and must be accessible to all employees. Employees should know where the MSDS are located and how to use them. MSDS are available from the product manufacturer. The vendor also may be able to provide this information as a service to customers.

Pest Control Program. A pest control program needs to be in place at the central kitchen and all receiving kitchens. A certified pest control operator should be contracted to provide pest control services on an on-going basis.

Some of these procedures seem basic, but following these SOP is intrinsic to supporting good HACCP programs. If SOP are written, employees should be trained to follow them and supervisors should be trained to follow and enforce them. A common understanding and set of expectations about following established procedures for all employees will increase the likelihood that proper procedures are followed. For example, consider how many different service utensils and dishes come in contact with food during preparation and service. Failure to maintain a working dish machine for proper cleaning and sanitizing would negate a great deal of work done during other phases of production. Daily monitoring of dish machine temperatures by employees and regular preventive maintenance ensures that the dish machine is functioning during critical times. Thus, SOP must specify what will be done and must be followed at each step to ensure that foods served are safe.

Responsibility for HACCP

For a HACCP program to be successful, its use must become a central part of a school foodservice system. That means that every single employee throughout the system

values food safety and is trained to implement the standard operating procedures. Each employee needs to understand that he/she is responsible for the safety and quality of food.

Food safety needs to be integrated into each of the human resource activities. When new employees are hired, the orientation session should include information on food safety. The basic importance of and methods for hand washing must be covered in the orientation of all employees. Training for food safety and HACCP needs to be ongoing. Certification programs such as ServSafe™, Serving It Safe, or local food handling courses need to be provided for all employees. Ongoing supervision for employees' food handling practices will ensure SOP are being followed. Finally, performance appraisals should include at least one food safety criterion. The consistent emphasis on food safety will increase the likelihood that the HACCP program is implemented as intended.

There will be a need for someone in the central kitchen to have major responsibility for HACCP. It is often recommended that an operation establish a HACCP team (National Advisory Committee, 1998). The HACCP team should be a multidisciplinary team including representatives from quality assurance, food production, transportation, service, and maintenance. This team may need to consult with experts about certain aspects of the HACCP program. The National Advisory Committee on Microbiological Criteria for Foods (1998) recommends that the team be involved in describing the food (what menu items and how prepared) and its distribution, developing food flow diagrams describing the processes used in the operation, and verifying the flow.

Ideally, a team would be assembled with one person designated to have the lead role to help guide the HACCP program. This individual and the HACCP team will have primary responsibility for:

- Developing and updating SOP as needed to remain current with food products, equipment, and staffing;
- Training staff members;
- Ensuring that critical control points (CCP) are monitored; and
- Maintaining appropriate records.

The team also should be responsible for conducting periodic verification of HACCP procedures. It may be useful to retain the services of an expert to verify the HACCP program.

Developing and Implementing HACCP Programs

Once the decision has been made to implement a HACCP program, the process consists of four phases: planning and preparation, HACCP program development, implementing the HACCP program, and maintaining the program. A summary of the process is shown in Figure 8.3. Before beginning the planning process, Mortimore and Wallace (1998)

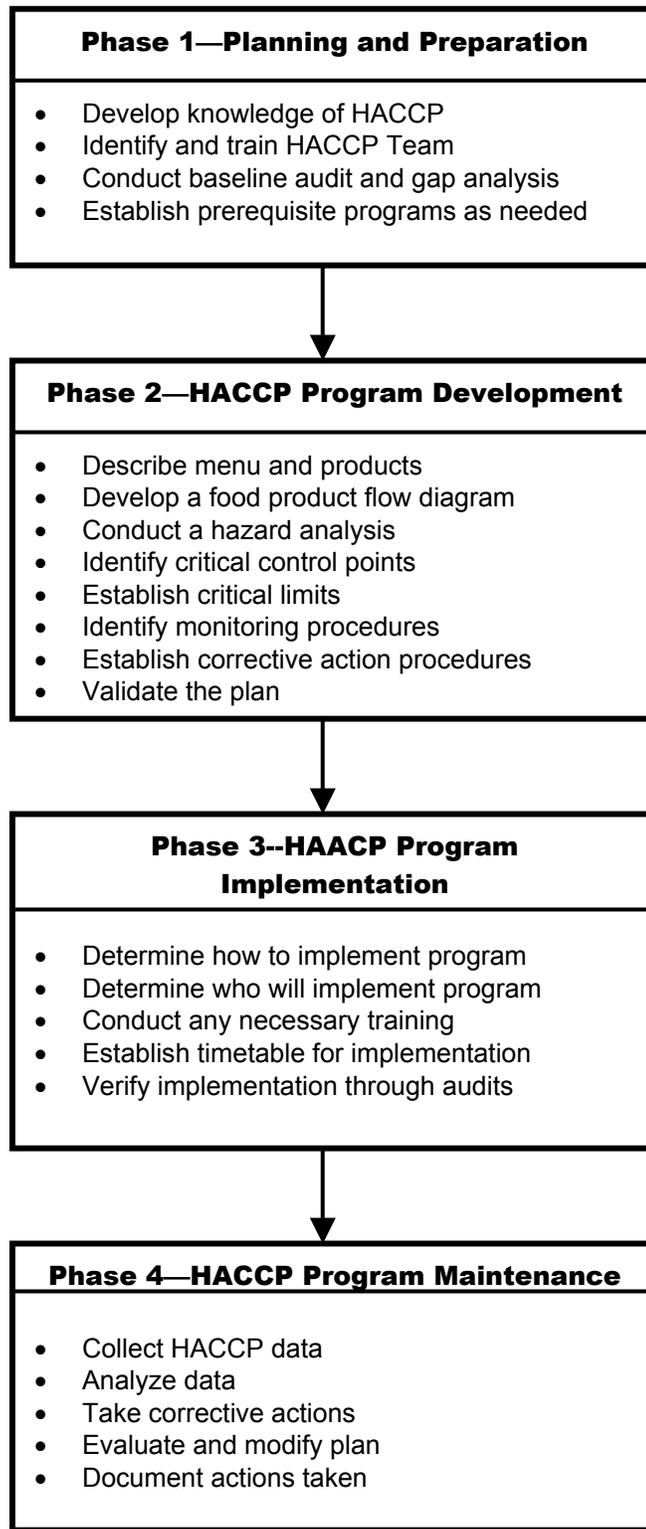
stipulate that a HACCP plan should not be developed without sufficient employee training and support systems in place.

The process begins by clarifying the concept of HACCP for all employees who will be involved in its implementation. This step helps clarify what a HACCP program is so that all team members are working from the same point of reference. School administrators also should be educated whenever possible on what HACCP is and its benefits to the school system. Members of the team may need to be educated on HACCP principles. Efforts should be made to send team members and other critical staff to a training program if possible.

Since school foodservice operations generally have some prerequisite programs in place, a baseline audit of existing resources, systems, and employee practices should be conducted and a gap analysis completed. A gap analysis will compare the results of the baseline audit against the standards required to support a HACCP program. For example, HACCP programs need to include procedures for assuring that specific internal temperatures are met for serving hot food. If an operation already has those procedures and documentation in place, they would not need to spend time developing new standards and procedures but would need to make sure they are being met and followed. If certain prerequisite programs are not in place, they may be able to be developed and put into place during the HACCP program implementation. A result of the analysis is a summary of areas that need development or improvement. The list will become the basis for developing the HACCP implementation plan.

Once the gap analysis is completed, the planning process for implementing HACCP should begin. During the planning stage, the project team may consider using project management tools such as Gantt or Program Evaluation and Review Technique (PERT) charts to help manage the task of implementing a HACCP program. This project plan should include tasks for the project, start and completion deadlines for each task in the program, and assigned responsibility for each task. The remaining stages are completed during the process of applying the HACCP principles to the existing foodservice system.

Figure 8.3 HACCP Process



HACCP Principles

A Hazard Analysis Critical Control Point (HACCP) system focuses on the prevention of food safety hazards in a foodservice operation. The hazard analysis part of the system focuses on identifying potential hazards that might cause customers to become sick or injured. These hazards might be physical, chemical, or microbiological. Physical hazards would be non-food items in food, such as a rock in beans or a piece of metal in meat, that might cause injury. A chemical hazard would be chemicals that accidentally get into foods, such as a cleaner or sanitizer. A microbiological hazard would occur when food is contaminated with a microorganism, such as salmonella or E.coli:0157:H7, that can cause illness.

The critical control point (CCP) part of the HACCP system focuses on the flow of food through the foodservice system. A critical control point is defined as “a step where control can be applied and is essential to prevent, eliminate, or reduce a food safety hazard to acceptable levels” (Mortimore & Wallace, 1998). An example critical control point in the food flow is the cooking process. By cooking foods to a sufficient temperature and time, the number of bacteria is reduced to acceptable levels. Other CCPs would include receiving, storing, and transporting food. At each of these points, controls must be in place to ensure that food is handled properly to prevent illness.

Each central kitchen needs to have a HACCP plan implemented to ensure food safety. The HACCP plan is developed using the seven HACCP principles:

1. Conduct a hazard analysis and risk assessment.
2. Determine critical control points.
3. Establish critical limits for each CCP.
4. Establish monitoring procedures for each CCP.
5. Establish corrective action to be taken if a deviation occurs at a CCP.
6. Establish verification procedures.
7. Establish a record keeping system.

Each of these principles will be discussed briefly and examples of how these principles are applied in centralized foodservice systems will be presented.

1. Conduct a hazard analysis and risk assessment.

The first step in developing a HACCP plan is conducting a hazard analysis and risk assessment. There are two major considerations in the step:

1. What is the flow of food through the foodservice system?
2. What are the potentially hazardous foods handled in the foodservice system?

In planning a centralized foodservice system, a diagram of the flow of food through the operation should be drawn. That will serve as the basis for developing standard operating procedures and a comprehensive HACCP program.

Potentially Hazardous Foods

Potentially hazardous foods are those foods in which bacteria can grow most rapidly. These foods are most often high in protein and moisture, such as meats, milk, and eggs. They may also be foods that are not heated after receiving and handling, for example bean sprouts.

The menu must be reviewed to determine the foods that are potentially hazardous. The FDA’s *Plan Review Guide* (2000) identified the following categories of potentially hazardous foods. Review this checklist and examples of foods typical of school foodservice to determine products for which food flow diagrams and critical control points are needed.

Potentially Hazardous Food Checklist		
	YES	NO
Thin meats, poultry, fish, eggs (hamburgers, sliced meats, chicken patties/nuggets)	<input type="checkbox"/>	<input type="checkbox"/>
Thick meats, whole poultry (Roast beef, whole turkeys, turkey rolls)	<input type="checkbox"/>	<input type="checkbox"/>
Cold Processed Foods (salads, sandwiches, vegetables, fruits)	<input type="checkbox"/>	<input type="checkbox"/>
Hot Processed Foods (soups, chili, sloppy Joes, spaghetti sauce, pasta)	<input type="checkbox"/>	<input type="checkbox"/>
Bakery Goods (puddings, toppings)	<input type="checkbox"/>	<input type="checkbox"/>
Other Foods		

2. Determine critical control points (CCP).

As the food flow is developed, critical control points need to be identified. Steps that prevent, eliminate, or reduce a food safety hazard to acceptable levels are critical control points. Determining the CCP is not always easy. Members on the HACCP team may not agree on where the CCP are in a particular food flow. To assist HACCP teams in identifying where correct CCP are, a tool called a CCP Decision Tree may be used. Several versions of CCP Decision Trees have been developed (Food and Drug Administration [FDA], 1999; National Advisory Committee on Microbiological Criteria for Foods [NACMCF], 1992). Though they may differ slightly in wording, they are designed to promote structured thinking and ensure a consistent approach at every process step. An example CCP Decision Tree is shown in Figure 8.4.

3. Establish critical limits for each CCP.

Critical limits are standards that are specific and measurable. Examples of critical limits include temperature and time. Critical limits are established for each critical control point. Examples include internal temperature for frozen ground beef patties when received should be lower than 32°F, dish machine final rinse temperature should be 180°F, and the final internal temperature of food to be served should exceed 140 °F. An example of a time-based critical limit is that food should be cooled from 140 °F to 70 °F within two hours.

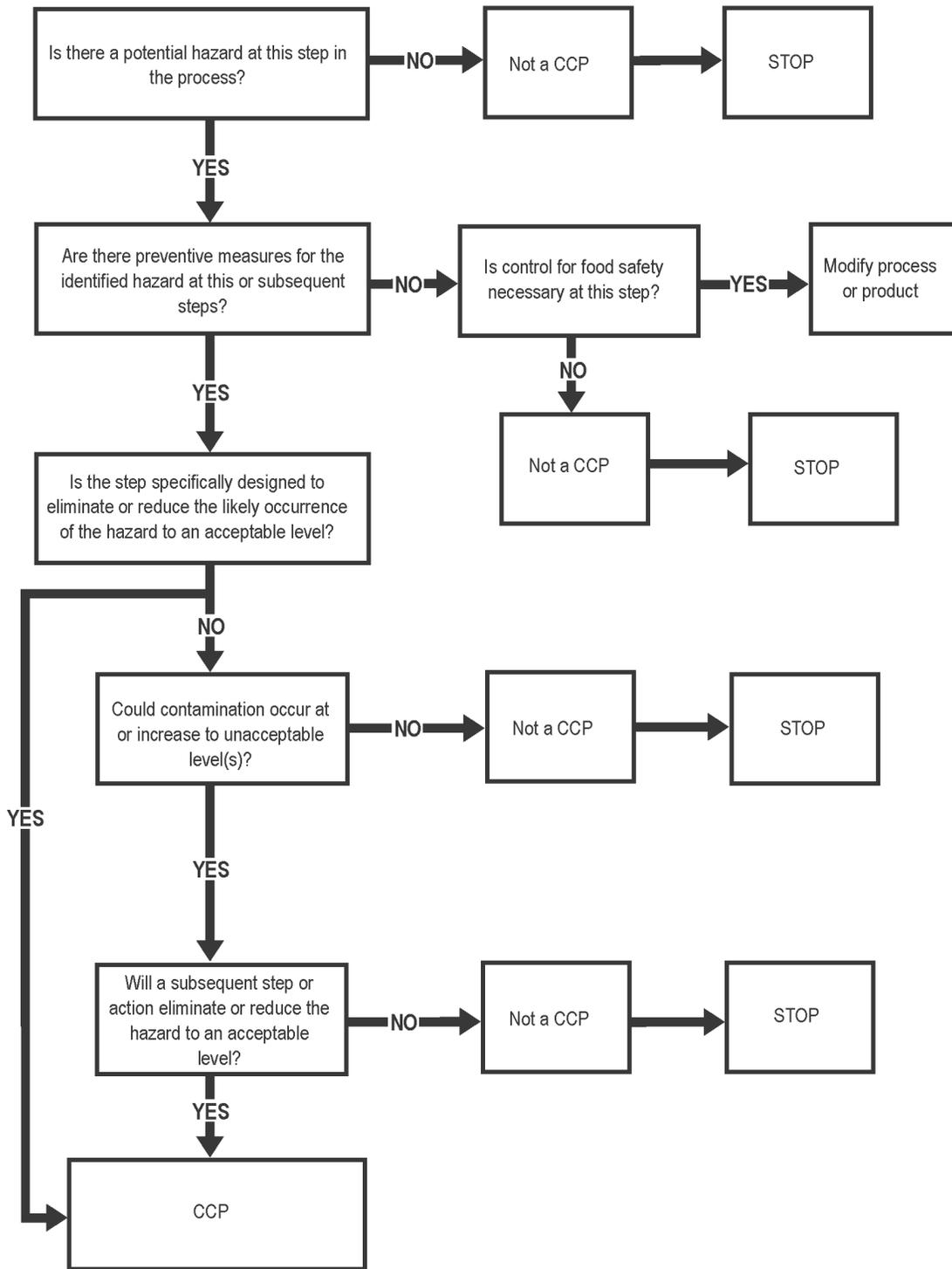
4. Establish monitoring procedures for each CCP.

For each CCP, monitoring procedures will be established. The HACCP team will establish answers to the following questions:

- What will be monitored (i.e. time, temperature, process, microbiological quality)?
- When and how often will monitoring occur (daily at the beginning of first shift, hourly, randomly)?
- How will monitoring be done?
- How will results be documented?
- Who will be responsible for completing the documentation?
- What type of training is necessary to properly document a CCP?

In addition to these questions, logistical issues also must be addressed such as where will documentation be stored in the operation.

Figure 8.4 Example of a Critical Control Point Decision Tree



Adapted from National Advisory Committee on Microbiological Criteria for Foods (1998) and FDA *Food Code* (1999)

5. Establish corrective action to be taken if a deviation occurs at a CCP.

Procedures for corrective action will need to be part of the HACCP program. If monitoring shows that a deviation from the critical limits has occurred, the following questions should be addressed:

- What was the cause of the deviation? For example, if monitoring of refrigerator temperatures indicated that temperatures were too warm, why did that occur? Is there a mechanical problem? Has the door been left open due to deliveries? The cause of the deviation would indicate the appropriate corrective action.
- How can the deviation be corrected?
- Does the deviation pose a threat to the food product? For example, if the refrigerator temperature were 40°F rather than 36°F, there may be no impact on food quality if the problem can be corrected before the product warms further. If, on the other hand, products were found to be at 55°F and there was no way to tell how long the food had been at that temperature, there would be a threat to food safety and the food should be discarded.
- How are corrective actions going to be documented?

6. Establish verification procedures.

This step establishes that the HACCP program is implemented and functioning as planned.

7. Establish a record keeping system.

There are many records that need to be maintained to document that the HACCP program is operating as it should. Records that need to be maintained include:

- List of potentially hazardous foods
- Food flow diagrams
- Summary of hazard analysis
- HACCP program plan
- HACCP team members
- Results of monitoring and corrective action

Integrating Technology into HACCP Programs

Information on critical control points is collected and analyzed regularly by employees to ensure a properly administered HACCP program. One criticism of comprehensive HACCP programs is the significant amount of required documentation. With central kitchens, it becomes even more critical to have access to information due to the potentially large impact of foodborne illness. Collecting CCP information often is challenging because some school foodservice employees feel they do not have time to do additional tasks such as recording service temperatures. However, design changes in foodservice equipment and improvements in computer production planning systems have made it easier for foodservice managers to automatically monitor CCP and collect necessary information required for HACCP program documentation.

Technological advances in the foodservice industry have made it easier to collect and manage the large amounts of data generated from central kitchen HACCP programs. Selecting the types of technology that are feasible for your operation will be influenced by the age of the facility and equipment. Some advances in foodservice equipment are found only in newer equipment. Technology integration into HACCP generally falls into one of four areas:

1. Computerized food production and planning systems
2. HACCP plan maintenance
3. Equipment design
4. Employee manual processes

Computerized food production and planning systems. Since incorporating HACCP usually is not the primary purpose of computerized food production and planning systems, there is a great deal of variation in the ways food safety principles are integrated into these systems. Another issue is the cost of the systems. Computerized production and planning systems require standardized recipes. School foodservice directors should include HACCP instructions in the recipe format. Some computer food production systems have standard CCP instructions for inclusion during ingredient preparation and service. These instructions can be highlighted on the recipe for easy recognition by staff. For other computer programs, creative school foodservice managers have developed “work-arounds” (other methods to achieve an objective) to have HACCP instructions printed on recipes where needed. Other managers have spent a great deal of time entering HACCP instructions on each of the recipes in their facility.

HACCP plan maintenance. There are several software programs developed to guide school foodservice managers through the process of developing HACCP programs. These programs facilitate the development of the HACCP plan by taking managers step-by-step through the process. Many programs have included references to the FDA’s *1999 Food Code* for various aspects of the plan. While these programs can serve as a reference, the school foodservice manager must still spend time customizing the plan to their operation. Though these types of programs exist, most of them do not easily

integrate existing computerized information from other programs such as standard operating procedures, recipes, and critical control point limits.

The ability to relate CCP data to recipes on specific production and service days is another challenge in using computerized systems for collecting data for HACCP programs. Many computer systems do not have the ability to accept information like service temperatures or link CCP data to recipes on a specific production day. Future computer systems should correct this deficiency as the demand for managing HACCP data increases, employees become more familiar with technology, and more food production systems become based on industry database standards.

Equipment design. Technology has impacted changes in foodservice equipment design. Computerized parts are more integrated into foodservice equipment, making it more functional but sometimes more difficult to maintain. Use of computerized systems in foodservice equipment usually is not sufficient to collect and use CCP information efficiently. For example, a dish machine may be able to record not only temperatures for wash, rinse, and final rinse cycles but also how many containers of detergent and sanitizer are used. If the information from the dish machine is not transmitted to the manager or can only be accessed by a technician, only part of the HACCP program is met. Though the information is being collected, the ability for someone to react to the information and take necessary corrective action is impeded. There is no replacement for foodservice staff collecting and analyzing data related to HACCP program implementation.

Equipment manufacturers are incorporating networked software monitoring systems into their equipment. Newer refrigerators and freezers are examples. Temperatures are automatically recorded by the software, transmitted, and recorded in a central database for analysis. In addition, if a refrigerator or freezer reaches a pre-determined critical limit, these systems can be programmed to place a phone call or notify a manager to inform him or her of the situation. Though computerized foodservice equipment has many benefits, many school districts with older facilities cannot afford new equipment. Given the average number of years foodservice equipment is used, most foodservice equipment works satisfactorily but may not be designed to include new computer systems.

Employee manual processes. There are smaller, more reasonable investments that can be made to integrate technology into HACCP programs. Processes that are typically done manually by foodservice employees are areas where simple technology can help collect CCP data. Service temperature monitoring is a good example. Computerized thermometers can be programmed to collect temperatures for specific food items. More sophisticated thermometers can have acceptable temperature ranges programmed for individual foods. For example, chicken breasts should be cooked to 165°F. If the cook takes the temperature of the chicken breasts and it was 155°F, the temperature would be recorded in the memory of the thermometer. The thermometer beeps and informs the cook that the temperature is outside the critical limit. The cook takes corrective action by

reheating the chicken and recording the temperature. Not only are the temperatures recorded for the chicken, a date and time stamp is recorded when the temperatures are taken. The school foodservice manager can review this information for the chicken later and compare it with other data to see if this problem was an isolated incident or whether the problem occurs every time this item is on the menu. This information can be shared with cooks to review problems with equipment or cooking procedures.

Conducting facility audits is another area in which computers can be used to collect data. Mobile auditing systems have become more affordable as the price of personal digital assistants (PDA) has decreased. Handheld devices using Palm™ or Pocket PC™ operating systems are beginning to be used by organizations. Auditing forms typically done on paper can be transferred to the PDA. Handheld computers can collect this audit information automatically. Each element of the audit has a date and time stamp to indicate when the information was recorded and the name of the auditor. After the audit is complete, the information is recorded in a central database either through a connection via a local area network, dial-up, or wireless access. The ability to have the data automatically transferred allows the HACCP team to analyze the data from a systems perspective. It also can be used to generate appropriate corrective action plans to have managers make improvements in their systems.

Research Related to Food Safety in Centralized Foodservice Systems

Much of the research related to food safety in various foodservice production systems was conducted in the 1970s. Klein, Matthews, and Setser (1984) summarized the research studies related to food quality, including food safety, nutrient retention, and sensory quality. Studies in actual foodservice operations (Cremer & Chipley, 1977a; Cremer & Chipley, 1977b; Cremer and Chipley, 1979) found variations in microbiological quality and end-point temperatures in spaghetti, chili, frozen hamburger patties, and meat loaf prepared in commissary food production systems. They noted the importance of appropriate cooking and reheating to ensure food safety.

Simulation studies (Tuomi, Matthews, & Marth, 1974a; 1974b) found that reheating procedures were critical to food safety. Results of these studies showed that actual end-point temperatures were needed since reheating times did not always result in adequate temperatures.

In the early 1980s, Brown, McKinley, Aryan, and Hotzler (1982) studied food safety practices in ten school satellite kitchens. They observed practices related to employee hygiene and food handling and holding times for foods. They also took food temperatures throughout the service period, aerobic plate counts (APC) for 20 entrees, and swab samples of utensils, equipment, and work surfaces. They found that nine of the

20 entrees were between 45° and 140°F and were above the acceptable limit of 100,000 APC per gram. The APC for utensils found that plate counts usually were within acceptable limits. Thirteen of the 17 work surface samples in large schools and 14 of 26 in small schools exceeded acceptable limits.

Recently, Kim and Shanklin (1999) conducted a time and temperature study in a school district that was converting from a cook/serve to a cook/chill system. They observed a test menu item (spaghetti with meat sauce) at three elementary schools before and after the system was changed. They found that the reheating methods and holding times were inconsistent among the schools for both systems. Temperatures at the point of consumption tended to be higher for cook/chill systems. The major recommendation based on this study is the need to have standard operating procedures for handling and rethermalizing foods at the receiving kitchens.

Klein, Matthews, and Setser (1984) concluded that time and temperature relationships must be managed in all systems. In addition, they stated that microbiological quality of food is dependent on many factors, including the type of food, quality of raw ingredients, batch size, type of equipment, and position of menu items in the equipment. These factors all point to the need for having a comprehensive HACCP program in place in any foodservice operation.

In the past 15 years, technology has improved foodservice operators' ability to safely produce food, particularly with the blast chilling technology. It appears that technology supports production of safe food using any of the four foodservice systems, but procedures are not consistently applied to use the technology properly. The key seems to be to develop standard operating procedures, train employees to follow the standard operating procedures, and supervise employees to ensure that procedures are followed. If these procedures are followed, any foodservice system can be used to produce safe food.

References

- Avens, J.S., Poduska, P.H., Schmidt, F.P., Jansen, G.R., & Harper, J.M. (1978). Food safety hazards associated with school food service delivery systems. *Journal of Food Science*, 43, 453-456.
- Brown, N.E., McKinley, M.M., Aryan, K.L., & Hotzler, B.L. (1982). Conditions, procedures, and practices affecting safety of food in 10 school food service systems with satellites. *School Food Service Research Review*, 6, 36-41.
- Center for Environment and Health Systems. (1996). *Food sanitation rules*. Portland, OR: Oregon Health Division.
- Cremer, M.L., & Chipley, J.R. (1977a). Satellite food-service system assessment in terms of time and temperature conditions and microbiological and sensory quality of spaghetti and chili. *Journal of Food Science*, 42, 225-229.
- Cremer, M.L., & Chipley, J.R. (1977b). Satellite food-service system: Time and temperature and microbiological and sensory quality of precooked frozen hamburger patties. *Journal of Food Science*, 42, 603-607.
- Cremer, M.L., & Chipley, J.R. (1979). Time and temperature, microbiological and sensory quality of meat loaf in a commissary foodservice system transporting heated food. *Journal of Food Science*, 44, 317-321.
- Division of Human Resource Development. (2000). *Plan review guide*. Rockville, MD: Food and Drug Administration.
- Food and Drug Administration. (n.d.). *Food Code 1999*. Retrieved May 15, 2001, from <http://www.cfsan.fda.gov/~dms/foodcode.html>
- Kim, T., & Shanklin, C.W. (1999). Time and temperature analysis of a school lunch meal prepared in a commissary with conventional versus cook-chill systems. *Foodservice Research International*, 11, 237-249.
- Klein, B.P., Matthews, M.E., & Setser, C.S. (1984). *Foodservice systems: Time and temperature effects on food quality*. (North Central Regional Research Publication No. 293, Illinois bulletin 779), Urbana-Champaign, IL: University of Illinois at Urbana-Champaign Agricultural Experiment Station.
- Mortimore, S., & Wallace, C. (1998). *HACCP: A practical approach*. Gaithersburg, MD: Aspen Publishers.

National Advisory Committee on Microbiological Criteria for Foods. (1998). Hazard analysis and critical control point principles and application guidelines. *Journal of Food Protection*, 61, 1246-1259.

Snyder, O.P. (2000). HACCP in retail operations integrating FDA fisheries, USDA, FDA industrial, and FDA retail HACCP into one set of retail food industry self-control requirements. *Foodservice Research International*, 12, 119-140.

Tuomi, S., Matthews, M.E., & Marth, E.H. (1974a). Temperature and microbiological flora of refrigerated ground beef gravy subjected to holding and heating as might occur in a school foodservice operation. *Journal of Milk Food Technology*, 37, 457-462.

Tuomi, S., Matthews, M.E., & Marth, E.H. (1974b). Behavior of *Clostridium perfringens* in precooked chilled ground beef gravy during cooling, holding, and reheating. *Journal of Milk Food Technology*, 37, 494-498.

Other Resources

- Corlett, D.A. (1998). *HACCP user's manual*. Gaithersburg, MD: Aspen Publishers.
- Custer, M.J. (1989). The challenge of sanitation. *Food Management*, 24(4), 56.
- Food and Drug Administration. (1999) *Cook it safely: Consumer education planning guide*. Washington, DC: U.S. Department of Agriculture.
- Food and Drug Administration. (2000). *Report of the FDA retail food program database of foodborne illness risk factors*. Washington, DC: U.S. Department of Agriculture.
- Ghazala, S. (1998). *Sous vide and cook-chill processing for the food industry*. Gaithersburg, MD: Aspen Publishers.
- Lachney, A. (1997). *The HACCP cookbook and manual*. Eatonville, WA: Nutrition Development Systems.
- Linton, R., & Almanza, B. (1996). *Hazard Analysis Critical Control Points (HACCP) for foodservice and food retail operations*. West Lafayette, IN: Purdue University Cooperative Extension Service.
- Pierson, M.D., & Corlett, D.A. (1992). *HACCP principles and applications*. New York: Van Nostrand Reinhold.
- Hemminger, J. M. (2000). *Food safety: a guide to what you really need to know*. Ames, IA: Iowa State University Press.
- Hui, Y.H., & Yiu, H. (2001). *Foodborne disease handbook*. New York: Marcel Dekker.
- International Commission on Microbiological Specifications for Foods. (1988) *Application of the hazard analysis critical control point (HACCP) system to ensure microbiological safety and quality*. Boston: Blackwell Scientific.
- Keener, L. (2000-2001). HACCP systems are prone to failure. *Food Safety Magazine*, 6(6), 17-19, 40.
- King, P. (1992). Implementing a HACCP Program. *Food Management*, 27(5), 58.
- Mortimore, S., & Wallace, C. (1998). *HACCP: a practical approach*. (2nd ed.) Gaithersburg, MD: Aspen Publishers.
- Neumann, R. (1998). The eight most frequent causes of foodborne illness. *Food Management*, 33(6), 28.

Redman, N. (2000). *Food safety: A reference handbook*. Santa Barbara, CA: ABC-CLIO.

Satin, M. (1999). *Food alert: The ultimate sourcebook for food safety*. New York: Checkmark Books.

Technology TEAM, Inc. (1999). *Your self-study guide to understanding how to develop a HACCP plan*. Alexandria, VA: Author.

Unnevehr, L. J. (2000). *The economics of HACCP: Costs and benefits*. St. Paul, MN: Eagan Press.

U. S. Food Safety and Inspection Service. (1999). *Generic HACCP model for fully cooked, not shelf stable meat and poultry products*. Washington, DC: U. S. Department of Agriculture.

U. S. Food Safety and Inspection Service. (1999). *HACCP and your workplace*. Washington, DC: U. S. Department of Agriculture.

U. S. Food Safety and Inspection Service. (1999). *What is HACCP*. Washington, DC: U. S. Department of Agriculture.

World Health Organization. (2000). *Food safety for nutritionists and other health professionals*. Washington, DC: Author.