#6. THE MENU / RECIPE SECTION OF YOUR RETAIL HACCP OPERATIONS MANUAL

By O. Peter Snyder, Jr., Ph.D.
Hospitality Institute of Technology and Management

Section 6 of the HITM retail HACCP policies, procedures, and standards manual deals with the actual HACCP of the menu / recipe items. This is the "heart" of retail HACCP recipe process control.

Prerequisite programs

First, understand that it is assumed that you have implemented the National Advisory Committee on Microbiological Criteria for Foods' prerequisite programs as we have discussed in previous articles. These programs are found in what I described in my last article as the Good Manufacturing Practices (GMPs). Under the Management component of the GMPs, one finds policies, procedures, and standards dealing with management commitment, an organization chart (so that each person's duties are described), recall procedure, and training standards of all employees. The Personnel component contains the personnel rules as to dress, personal hygiene, sickness, hand washing, etc. The Environment, Facilities, and Equipment components contain the rules for controlling cleaning chemicals; keeping pests out of the facility; maintaining the water, electrical power, and sewage systems of the facility; and assuring that all food contact surfaces are kept sufficiently clean to be safe. The Supplier component must have certification requirements stating that any food / item purchased by the facility that is to be sold without the operation performing a hazard control is supplier certified in terms of the microbiological, chemical, and physical safety. With these prerequisite GMP controls in place, the only hazards remaining, which the cook and food preparation personnel must control, are the vegetative cells and spores that are in the food being prepared.

Process microbiological "target" organisms

The first step in recipe HACCP is to specify which vegetative or spore pathogens are being controlled at what temperatures during any retail food process. In raw food, from 30 to 60ºF, *Listeria monocytogenes* is the choice for the "target" organism, because it begins to multiply at 29.3ºF. We will limit multiplication to less than 10 generations / multiplications, as per the FDA model code (explained later).

From 60 to 130ºF, *Clostridium perfringens* is the target organism, because it is a very fast-growing organism and will multiply if food being cooked does not reach 130ºF within 6 hours. The critical limit for multiplication will be 10 generations, as per the 1999 Food Code, which established 41ºF / 7 days and above 41ºF / 4 hours as time controls. 41ºF / 7 days allows for about 10 multiplications of *L. monocytogenes*, and 4 hours at about 110ºF allows for about 10 multiplications of *Salmonella* or *C. perfringens* after spore outgrowth. While the FDA provides time at only two temperatures, it is possible to calculate equivalent times at temperatures over the multiplication range of 30 to 127.5ºF for pathogen growth control, using the method of Ratkowsky et al. (1983). Table 1 lists some representative values for equivalent multiplication based on FDA Food Code food holding values of 41ºF / 7 days and 4 hours at other temperatures.

Table 1. Ten Multiplications of Pathogens Based on the FDA Model Food Code

Temperature (ºF)	Time
29.3	No growth
35	19.3 days
40	7.5 days
50	2.4 days
60	1.2 days
70	16.9 hours
80	11.2 hours
90	7.9 hours
100	5.9 hours
110	4.7 hours
120	5.6 hours
130	No growth

Above 130ºF, there is no growth of pathogens; there is death. (Actually, *Salmonella*, *L. monocytogenes*, shigellae, and most vegetative pathogens stop multiplying at 115ºF.) For pasteurization, *Salmonella* is the organism to target, because it causes more deaths than any other pathogen. A 7D reduction (10,000,000 to 1) should be used as per USDA regulations for poultry (9 CFR, Part 381.150). While 9 CFR, Part 318.17 (Federal Register, January 6, 1999) says that beef and other meat products will be given a 6.5D destruction (ground beef is still 5D), the difference between 6.5D and 7D is so slight that they are insignificant in retail cooking. For simplicity, a 7D destruction can be used.

Table 2. 7D Values for Roast Beef

Temperature (ºF)	Time
130	121 minutes
140	12.1 minutes
150	1.21 minutes (72 seconds)
160	0.12 minute (7.2 seconds)

Note that the USDA now allows the roast beef D-value to be used with other meat items. Actually, the USDA has stated that at 159ºF and above, a minimum of 10 seconds dwell time will be used.

The target organism for hot holding is the spore of *C. perfringens*, since the vegetative cells have been reduced to a safe level. *Clostridium perfringens* ceases to multiply at 126 to 127.5ºF. Therefore, the food is safe for as long as the temperature is above 130ºF. This time can extend to many hours, as is the case with prime rib and roast beef being held for 24 to 36 hours in slow-cook ovens.

The next control that is necessary for recipes applies to cooling. Of the three spores--*C. perfringens*, *Clostridium botulinum*, and *Bacillus cereus*, *C. perfringens* comes out of lag and begins to multiply first and is the fastest as food cools below 127.5ºF. While the FDA says that cooling should be 140 to 41ºF in 6 hours, and the USDA says that it can be 130 to 40ºF in 6.5 hours or 120 to 55ºF in 6 hours, none of these standards is based on valid research data. These standards have all been simply professional guesses in past years. The technically validated, correct cooling standard is 130 to 45ºF in 15 hours or less, as developed by Juneja et al. (1994).

Below 59ºF, which is the point at which *C. perfringens* stops multiplying, *B. cereus* becomes the target organism down to 40ºF. While *C. botulinum* can multiply down to 50ºF, *B. cereus* and *C. perfringens* are faster. *Bacillus cereus* is an organism of concern, because it contaminates a lot of foods, and the spore will be ready to outgrow and the vegetative cells ready to multiply in the range of 40 to 60ºF. It does have to multiply to a high level of more than 100,000 per gram to be a problem, however.

It is true that non-proteolytic *C. botulinum* will multiply down to a temperature of 38ºF, but it is only found in seafood and can be inactivated at 185ºF in approximately 5 minutes. Since cooked seafood does not reheat well and once cooked, is not normally saved, this is another valid reason for it not being a reasonable hazard, and non-proteolytic *C. botulinum* is an organism of very low risk.

If one keeps chilled food at less than 40ºF, based on control of *B. cereus*, it will "spoil safe" from *Clostridia* and *Bacillus* spoilage microorganisms. Times will range from 14 to 90 days. Note, the vegetative cells of *L. monocytogenes*, *Aeromonas hydrophila*, and *Yersinia enterocolitica* would have been destroyed during pasteurization, and GMPs prevent cross-contamination to cooked, ready-to-eat food. Hence, they are not a risk.

pH control of cooling

If the pH of the food is less than 4.6, and the food is pasteurized, the food does not need refrigeration. The spores are controlled. In retail operations today, many foods such as spaghetti sauce, chili, wine-flavored beef broths and desserts, and most salad dressings and cold sauces have a pH below 4.6 and do not need refrigeration for safety. Spoilage molds and yeasts might grow, but that can take many days. In retail operations, these foods can be cooled and stored at room temperature. It is important that the retail operator know the pH of menu items so that refrigerated space is not wasted.

Summary of retail process rules

In summary, the retail food process rules are as shown in Table 3.

Table 3. Retail Process Rules

Hazard	Critical Control Limits
Refrigerated, raw food contaminated with vegetative pathogens	Use before 10 multiplications of *Listeria monocytogenes* has occurred.
Heating	50 to 130ºF in <6 hours.
Pasteurization	7D reduction of salmonellae.
Hot hold	>130ºF.
Cooling	130 to 45ºF in 15 hours.
Cold holding	<40ºF or <10 multiplications of *Bacillus cereus*.
Reheating	Not used as a hazard control, because it will not inactivate bacterial toxins.
Acidity	<4.6 for pasteurized food.

Block flow diagramming a recipe

Now that the retail process time-temperature rules are established, the next step to "HACCPing" a recipe is to do a block flow chart of a recipe in order to validate that the recipe procedure assures safety. This is unique to each kitchen, because actual recipe times and temperatures will vary for each kitchen, although they must all be within the critical limits listed above. The actual, logical writing of the flow diagram is taken directly from the computer arena. Note, in the next couple of years, we will be able to do these flow diagrams using computer flow chart software that will automatically validate a recipe as safe, if all steps are within critical limits.

Recipe flow charting is a powerful analytical tool. It clarifies the logic of cooking in terms of what order steps should be performed. For example, one can see that it is important to chop all of the vegetables first or make the sauce before the meat is cooked. If the meat, poultry, or fish is started to be cooked, and the cook must stop to chop vegetables or make a sauce, a serious problem is introduced, because the spores may have a chance to grow out in the food.

The National Advisory Committee on Microbiological Criteria for Foods is correct in that the recipe process needs to be flow diagrammed. However, the NACMCF flow diagrams are much too simplistic and are inadequate for retail food HACCP. In retail HACCP, one must exercise time-temperature control of vegetative bacteria and spores at virtually every step in a recipe. These times and temperatures must be identified at every step in the process flow to assure safety.

An example of a block flow diagram

Figure 1 (all figures follow references) is a model of a typical block flow diagram illustrating steps at which process times and temperatures are inserted. In this case, a recipe for Chicken Cacciatore is used as an example. Note, there are many ways that this recipe could be done. This is only one example. Also, to simplify the example, multiple steps are actually combined in one step. For example, Step 1, "Prepare sauce," could be broken down into more than 50 steps.

Note that each block is numbered sequentially so that the steps can be identified in discussion. The type of operation in the step is identified as "O" (operate), "I" (inspect), "T" (transport), "D" (delay), and "S" (store). The efficiency of a recipe can be checked by adding up the number of different steps. The goal is a recipe with the minimum number of steps. The Inspect step is equivalent to the HACCP monitor step.

Next, each block contains a description of what is being done.

Finally, each block has "Ti" ("temperature in" -- food temperature at the beginning of the step); "To" ("temperature out" -- food temperature at the end of the step); and "t" (time it takes to complete the step). The "Ti" is normally the "To" of the previous step.

Using the times and temperatures listed above, one can now read a recipe block flow diagram and make an absolute judgment as to the safety of the recipe. Remember, all chemicals and physical hazards are controlled by the GMPs.

The HACCP recipe

The block flow diagram of a recipe is totally inappropriate for the cook. The cook follows recipes. Actually, a recipe is a flow diagram as well, but in this case, it is a narrative flow diagram. While doing the block flow diagram is a superior analytical technique, it is unworkable in terms of daily food preparation. The cook is used to reading the recipe, which is a narrative flow diagram in the strict sense of computer programming.

Figure 2 illustrates a standardized, quality-assured recipe procedure. This is based on the recipe format commonly used at vocational / technical schools. It has four sections. The first section is the recipe identification information, in this case, for Chicken Cacciatore, which is a combination-style recipe. This section shows who wrote the recipe, the portion size, preparation time, etc.

The second section is the ingredient list. It is wise to divide the ingredient lists by groups for process control. It is also essential that each ingredient size be carefully controlled, because it is important that the center temperature of each ingredient reach a critical control limit. In addition, listing the ingredients is critical in terms of consumer allergy problems. If a consumer tells a server about an allergy to a certain food, the server can ask the chef in the kitchen if that food is an ingredient in the recipe. Only when there are written recipes with specified ingredients can there be assurance that an allergy-causing ingredient has not been added by the cook as a "special flavor of the day." The ingredient section lists edible portion by weight or volume and weight percent in order to control the percent of each ingredient. This also makes it easier to scale the recipe. This is, again, essential for hazard control because, with some additives, we must comply with the CFRs and must control the percents of those additives. An example is adding a specific percent of acidifying ingredients such as wine, vinegar, and lemon juice, which provide control over pH, so that we know that we have met minimal acid contents. The recipe also accounts for weight loss during cooking. In this case, the 62 lb. becomes 40 lb. by the time the food is ready to be served. Finally, the nutrition reference column is used in order to tell consumers the specific nutrient content of the recipe, if a consumer is interested.

In the third section, the operations section, the multiple steps of the flow chart are compacted into, in this case, nine steps of instructions. The unit's HACCP team has decided on the best sequence of operations using the block flow diagram. At this point, the information from the flow diagram becomes the information for the chef to learn and follow when preparing the recipe. It is important to realize, though, that the times and temperatures of each step of the recipe will match the beginning and ending temperatures for a group of steps in the block flow diagram. The block flow diagram is, then, a detailed representation of the recipe procedures written in this section. The recipe steps are divided into general categories--preparation, serve, and leftovers--in order to make it more readable. Finally, the recipe has a line listing ingredients that could produce possible allergic reactions, in order to alert the cook to potential problems.

Summary

HACCP as specified by the NACMCF is a general document and must be interpreted, and process control procedures must be documented in a different way in order to be compatible with conventional cooking. Conventional cooking uses recipes, not block flow diagrams. Flow diagrams are excellent analytical tools, but are for use by scientists, HACCP teams, and process authorities. After the analysis is completed, the cook works with a recipe.

This article has developed the time-temperature controls for retail processes and has presented the fundamentals of block flow diagramming and recipe writing for retail food operations. The details of how to develop the block flow diagrams and recipes are taught in HITM's two-day manager certification course, 1901: Food Safety through Quality Assurance Management and its five-day advanced course, 2902: HACCP-Based Safety- and Quality-Assured Retail Food Systems. For further course information, to include schedules and costs, see HITM's website, http://www.hi-tm.com, Education sidebar.

The next article continues with Section 6, with a detailed account of block flow diagramming of recipes.

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FIGURE 1. CHICKEN CACCIATORE QA RECIPE FLOW

Preparation

1a. Prepare sauce. Get chopped onions, mushrooms, green peppers, minced garlic. Sauté in oil. Add crushed tomatoes, juice, wine and seasoning. Bring to a simmer.
O
Ti 40°F To 205°F t 20 min.

→ 1b. Hold in bain marie.
D
Ti 212°F To 165°F t 20 min.

↓

2a. Get chicken quarters from refrigerator. Remove rib bones. Place quarters, one layer deep in shallow roasting pan. Bake (brown) in convection oven at 350°F.
O
Ti 40°F To >160°F t 30 min.

↓

3a. Remove pan(s) of chicken from oven.
O
Ti >150°F To 145°F t 15 min.

→ 3b. Pour off liquid. Chill. Refrigerate liquid. (Save for chicken stock).
S
Ti 150°F To 40°F t <4 hr.

↓

4a. Cover chicken quarters with sauce (← from 1b)
O
Ti 145°F To 145ºF t <10 min.

↓

5a. Bake at 300°F in convection oven until chicken reaches a temperature of 175°F.
O
Ti 145°F To >175°F t 45 min.

↓

6a. Check. Is the temperature >175ºF? If not, continue to cook.
I
No → back to 5a

↓ Yes

7a. Cover and transfer to 150°F hot holding unit.
T
Ti 175°F To 170°F t 5 min.

↓

8a. Hold. Serve 1/4 chicken and 3 oz. sauce. Use within < 2 hr.
D
Ti 170°F To 150° t <120 min.

Leftovers

↓

9a. Discard if not used within 2 hours or cool to <45°F within 15 hr. Reheat to 165°F. Reheat only once.
O
Ti 150ºF To 150ºF t <2 hr.

FIGURE 2. QUALITY-ASSURED HACCP RECIPE PROCEDURES

Recipe Name:
Chicken Cacciatore
Production style: **Combination**
Written by: **O. P. S.** Date: 10/95
SA/QA by: **J. Bell** Date: 12/95

Portion size (vol./wt.):
1/4 (6 oz.) chicken + 3 oz. sauce
Number of portions: **100**
Final yield (AS):100
Final yield:

Preparation time: 2 hours
Prepared by: **S. P.**
Supervisor:

Gp. #	**Ingred. #**	**Ingredients and Specifications**	**EP Weight %**	**Edible Portion (EP) (weight or volume)**		**As served (weight**	**Nutrition Ref. #**
I	1	Onions, chopped (1/2" x 1")	13.26	3.0 lb	1,360.00 g		633
	2	Mushrooms, cut (1/2 ", both caps and stems)	13.26	3.0 lb	1,360.00 g		630
	3	Peppers, green, cut (1/2" x 1")	8.84	2.0 lb	907.20 g		643
	4	Garlic, chopped	0.83	6 Tbsp.	85.05 g		1,067
	5	Tomatoes, canned, crushed (2 - #10 cans)	58.58	13.25 lb	6,010.00 g		12,320
	6	Oil, vegetable	0.53	1/4 cup	54.00 g		122
	7	Wine, Marsala or Madeira	4.60	2 cups	472.00 g		1,481
	8	Oregano, crushed	0.03	2 tsp.	3.00 g		815
	9	Salt	0.05	1 tsp.	5.50 g		822
	10	Pepper	0.02	1 tsp.	2.10 g		818
		Total	100.00	22.6 lb	10,258.85 g		
		Approx. gallons		2.5 gal.			
II	11	Chickens, whole (25 - 2¼ to 2½ lb.)		62 lb		40 lb	

Preparation

1. **Prepare sauce**. Get chopped onions, mushrooms, green peppers and garlic (40°F) from refrigerator. Get large heavy container. Sauté the vegetables in vegetable oil for about 10 minutes. (212°F, 20 min.)
2. Add crushed tomatoes with juice, wine, and seasonings (72°F). Bring sauce to a simmering temperature (205°F, 10 min.). Hold sauce in bain marie (165°F, 20 min.)
3. **Prepare chicken**. Get chicken quarters (40°F) from meat and poultry refrigerated storage area. Remove rib bones. (45°F, 10 min.)
4. Place quarters, one layer deep in shallow roasting pans. Brown chicken by baking it in a convection oven at 350°F for 30 min. (>160°F)
5. Remove pans of chicken from oven (145°F, 15 min.). Pour off excess liquid. Cool (40°F, <4 hours).
6. Cover the chicken quarters with sauce (145°F, <10 min.).
7. Return the pans of chicken and sauce to convection ovens at 300°F and continue baking until all parts of the chicken reach a temperature of 175°F (about 45 minutes). Cover, transfer to 150°F hot holding unit and serve within <2 hours.

Serve

8. Serve 1/4 chicken for each portion, using either white or dark meat. Chicken should be accompanied by 3 ounces of sauce (about 3 tablespoons).

Leftovers

9. Discard, if not used within <2 hours, or cool to <45°F in <15 hours. Reheat to 165°F in <6 hours.

Ingredients that could produce possible allergic reactions

Tomatoes, wine

Process step #	Start food ctr. temp., ºF	Thickest food dimension (in.)	Container size HxWxL (in.)	Cover Yes/No	Temp. on/ around food	End food ctr. temp., ºF	Process step time, hr./min.