as chlorine (50 mg/L) or an organic acid (1–2% acetic, lactic, or citric acids) at a temperature of  $120-140^{\circ}$ F and a pressure of 70-275 kPa (10–40 psi) (Prasai, et al., 1991). Monitoring of this CCP should be conducted by continuous confirmation of concentration, temperature, pressure, and chain speed.

Validation of CCP 2 should be accomplished by microbiological testing of carcasses before and after CCP 2. A reasonable level of testing should be performed at the initiation of a HACCP program to establish baselines for total aerobic, mesophilic bacteria and/or Enterobacteriaceae. These microbiological indices are useful indicators of process control and overall sanitation, but are not effective as indicators of enteric pathogens. All testing should be performed using standard methods (Vanderzant and Splittstoesser, 1992). After establishment of the baseline. verification of CCP 2 can be achieved by periodic sampling of carcasses for the two microbiological indicators, using the same methods employed in establishing the baseline. These data should be reviewed using trend analysis and statistically significant increases should prompt a review of CCP 2 operations. Literature indicates a functioning wash and bactericidal rinse step in conjunction with acceptable adherence to CCP 1 should deliver an approximate 90% reduction in microbial levels. Specific bactericidal agent concentrations, temperatures, and pressures to be used should be based on appropriate available literature and inplant testing to obtain optimal bacterial reductions (Patterson, 1968, 1969: Kotula, et al., 1974; Emswiler, et al., 1976; Quartey-Papafio, et al., 1980; Osthold, et al., 1984; Woolthuis and Smulders, 1985; Acuff, et al., 1987; Prasai, et al., 1991; and Dickson and Anderson 1992).

### CCP 3: Evisceration

The intestinal tract is the second major source of enteric pathogens during the slaughtering process. Although the animals may be asymptomatic, they can still harbor large populations of enteric pathogens in their intestinal tract. The bunging and evisceration operators must be properly trained in removing the intestinal tract intact to successfully adhere to the control parameters of CCP 3. It is essential that the viscera not be accidentally cut and the contents contaminate the carcass, the operator, or equipment (Empey and Scott, 1939; Mackey and Derrick, 1979; Eustace, 1981; Smeltzer and Thomas, 1981; Grau, 1987). When the intestines are

accidentally cut and contamination occurs, immediate sanitizing of equipment and knives should be performed with 180°F water, and involved personnel should utilize hand washing and sanitizing facilities to avoid contamination of subsequent carcasses. The most effective means of control lies in adequate training of the operator in the correct procedures, including providing the rationale on the importance of maintaining the viscera intact, coupled with positive reinforcement through appropriate supervision. Accordingly, monitoring this CCP entails periodic observation of the evisceration operations including visual inspection of eviscerated carcasses. This can correlate to potential carcass contamination.

# CCP 4: Carcass Final Wash

Additional microbial contamination of the carcass surface is likely to occur as a result of evisceration, viscera handling, and carcass splitting. An inline, potable water wash at 90-100°F and a pressure of 345-2070 kPa (50-300 psi) will help reduce microbial levels, including enteric pathogens (DeZuniga, et al., 1991). This final water wash should be followed by a bactericidal rinse containing an approved antimicrobial agent such as chlorine (50 mg/L) or an organic acid (e.g., 1-2%acetic, lactic, or citric acids) at a temperature of 120-140°F and a pressure of 70-275 kPa (10-40 psi) (Prasai, et al., 1991).

This combination of a final wash and bactericidal rinse will help minimize carriage of pathogens through the remaining beef fabrication and packaging processes. Monitoring of this CCP should be through continuous confirmation of antimicrobial concentration, temperature, pressure, and chain speed. Verification can be achieved by conducting microbiological testing as described in CCP 2 to confirm that CCP 4 is providing the anticipated level of control of microbial levels. Maximum effectiveness of CCP 4 can only be realized if the critical limits for CCP 1–3 are maintained. Any deviations associated with the earlier CCPs must be corrected before the product is subjected to the final wash. Specific bactericidal agent concentrations, temperatures, and pressures to be used should be based on appropriate available literature and inplant testing to obtain optimal bacterial reductions (Patterson, 1968, 1969; Kotula, et al., 1974; Emswiler, et al., 1976; Quartey-Papafio, et al., 1980; Osthold, et al., 1984; Snijders, et al., 1985; Woolthuis and Smulders, 1985; Smulders, et al., 1986; Acuff, et al., 1987; Prasai, et al., 1991; and Dickson

and Anderson 1992; Siragusa and Dickson, 1992; Dickson, 1992).

### CCP 5: Chill

The bacterial flora including any enteric pathogens found on the sides of fresh beef could multiply if the meat is not properly chilled. Cooling rates must be sufficient to limit the growth of enteric pathogens. Temperature guidelines would include a deep muscle (6 in.) temperature of  $\leq 45^{\circ}$ F within 36 hours, with a temperature of  $\leq 50^{\circ}$ F reached within the first 24 hours (Reuter, 1990). Overnight rapid chilling of properly spaced beef sides is a proven system to control the multiplication of enteric pathogens (Grau, 1987; Mackey, et al., 1980). The CCP can be monitored through the continuous confirmation of physical factors affecting cooling rates such as environmental temperatures and air circulation rates. Verification can be achieved through the periodic recording of deep muscle cooling rates for selected carcasses, using appropriately calibrated temperature recording devices (e.g. thermocouple).

# **CCP 6: Refrigerated Storage**

After chilling, the carcasses and resulting raw products must be maintained under adequate refrigeration during all subsequent handling and processing until the final product is ultimately consumed. This highly diffuse CCP requires that manufacturers, distributors, retailers, food service operators, and consumers each take responsibility for assuring that raw beef products are kept under adequate refrigeration. Maintaining products in a refrigerated state (product temperature  $\leq$ 45°F), along with appropriate cleaning and sanitizing of equipment and food contact surfaces, will control the multiplication or accumulation of nonpsychrotrophic pathogens. Further, maintaining storage temperatures as close to freezing as practical will enhance control of psychrotrophic pathogens.

#### CCP 7: Labeling

Adequate product identification (e.g., code dates, lot identification) is necessary for product control in the event that product must be traced or retrieved. To facilitate the responsibilities of distributors, retailers, food service operators and consumers, all raw and partially cooked beef products should be labeled to indicate that the product must be refrigerated, handled, and cooked properly to ensure safety. Methods of cooking and sanitary handling should reflect the needs of the specific product. Labels should be appropriate for either retail and