antimicrobial treatment for purposes of this proposal because irradiation facilities are to date extrinsic, standalone operations that cannot easily be integrated into a slaughter operation the focus of the present effort. Furthermore, although irradiation has been shown to be a highly effective pathogen control mechanism, it is a capital-intensive process largely unavailable to most inspected slaughter establishments. Notwithstanding these considerations, firms would be able to use irradiation on raw poultry under existing regulations, in addition to the antimicrobial treatments now being proposed.

## Approved Antimicrobial Treatments

A number of methods for reducing the number of bacteria that may be on carcasses have been suggested, e.g., exposing the carcass to hot water, chemical sanitizers, such as chlorine or trisodium phosphate (TSP), and short chain food grade acids, such as lactic, acetic, and citric acids.

Antimicrobial treatments currently permitted by FSIS are techniques involving the rinsing of carcasses with a wash or spray, normally using either hot water or a solution of water and a substance approved by FSIS for that use on the basis that it has been found to be effective and its use is consistent with applicable FDA regulations governing food additives. Some mechanical process modifications currently in use have been shown to enhance the results of rinsing procedures. Countercurrent scald tanks with a postscale spray have been shown to be effective in reducing bacterial levels on poultry carcasses.

Equipment and utensils used in preparing or handling meat and poultry products in inspected establishments are subject to inspection to ensure that their use will not result in adulteration or misbranding of the finished product. To promote efficiency and uniformity in this element of FSIS's inspection duties, FSIS reviews newly developed equipment and utensils intended for use in inspected establishments and publishes a listing of equipment and utensils found to be acceptable for that use (9 CFR 380.5, 381.53). Establishments and other manufacturers of mechanical devices designed for antimicrobial treatments, such as scalding tanks and spray cabinets and devices, must obtain approval of their equipment from the Facilities, Equipment and Sanitation Division, Science and Technology, Food Safety and Inspection Service, U.S. Department of Agriculture, Washington DC 20250. A copy of the current list of approved

equipment and utensils also is available from that office.

The use of an antimicrobial treatment on raw meat and poultry carcasses would reduce the levels of bacteria on the product, but it would not eliminate the need for continued careful handling of those products before and after the antimicrobial treatment. The following are available antimicrobial treatments that FSIS tentatively concludes could satisfy its proposed requirements for a mandatory antimicrobial treatment. FSIS invites comment on each of these.

(a) *Hot water.* Hot potable water or steam may be used to reduce microbiological counts on meat and poultry. Washing carcasses with hot water has been shown to be effective in reducing the level of bacteria on carcass surfaces.

The decontamination of carcasses using hot water has a number of advantages. These include: (1) reliable reduction of contaminants, (2) removal of loose extraneous material, (3) no impairment of meat properties, (4) no chemical reaction with equipment, such as the corrosive effects associated with acetic acid, (5) no disposal problems, and (6) readily available and easily accomplished.

Disadvantages with hot water sprays include: (1) the need for greater pumping pressures, (2) less recoverable heat energy from the outlet water steam, (3) the likelihood of nozzle blockage if water is recirculated, and (4) the production of mist which condenses on surfaces in the vicinity of the cabinet if baffles are not used.

Scientific studies over the course of the past twenty years have investigated whether the use of hot water (74°-95°C, 165°–201°F) instead of the commonly used lower water temperatures (30°-35°C, 85°–95°F) can reduce the general microflora of aerobic mesophiles present on the carcass, including members of the family Enterobacteriaceae. This taxonomic group includes some of the most important foodborne pathogens. Hot water rinses have been shown to be effective against a number of foodborne pathogens including Escherichia coli 0157:H7, Salmonella, Yersinia enterocolitica, and Listeria monocytogenes. Quantitative studies assessing the impact of hot water treatment on the survival of E. coli O157:H7 have suggested that it can reduce the levels present on the carcasses by 84-99.9 percent, as well as the number of contaminated carcasses. Other studies with E. coli biotype 1 (E. coli O157:H7 is one of hundreds of E. coli serovars) have indicated that hot

water can reduce levels by 99–99.9 percent.

The effects of hot water washing are dependent on two separate mechanisms. The first is simply the physical washing action of the rinsing. This can account for a significant portion of the overall effect, particularly if the bacteria are only loosely attached to the carcass surface. In addition, the thermal effects of the elevated temperatures produce some degree of heat inactivation. As with any thermal processing, the extent of the inactivation will be directly proportional to both the duration and temperature of the heating material (i.e., water temperature). A hot water rinse can achieve up to a 99.9 percent (3 log) decrease in the levels of various pathogenic and non-pathogenic bacteria. It potentially can achieve up to a 99.9 percent reduction in E. coli O157:H7.

Hot water sprays are most effective when applied in a manner that raises the water film on the surface of the carcass (surface temperature of the carcass) to 82°C (180°F) for 10 seconds. Exposure of beef carcasses to 80°C (176°F) water results in a greying of the meat surfaces; however, the color returns to its normal appearance after chilling. When the carcass surface is exposed to 82°C (180°F) for more than 20 seconds, tissue discoloration becomes permanent.

Researchers have tested the effectiveness of hot water using sprays or dips and using decontamination cabinets, with hot water only and with chemical sanitizers.

One study found that treating beef carcasses with a steam and hot water spray at 176°F–205°F (80°C–96°C) for 2 minutes, sprayed from one foot (25 cm.), lowered bacterial numbers. A volume of 18.9 liters of water was sprayed for each carcass. Some discoloration of the carcass surface occurred initially, but normal color returned after cooling for 24 hours.

Another study found a hot water treatment of beef and mutton samples inoculated with E. coli more effective in reducing bacterial numbers than a naked flame, steam chamber, steam ejection, or washing with water at 37°C (99°F). When hot water temperatures were below 60°C (140°F), no significant color change was noted. Above 85°C (185°F), the color change was marked and permanent. Permanent color changes of the surface tissues caused by using water at 95°C (203°F) for three minutes did not extend more than about 0.5 mm below the surface. Temperatures of 70°C (158°F) and above gave at least a two log (99 percent) reduction of inoculated E. coli on samples.