Appendix A Guidance on Relative Humidity and Time/Temperature for Cooking/Heating and Applicability to Production of Other Ready-to-Eat Meat and Poultry Products

I. PURPOSE

The purpose of this FSIS Compliance Policy Guideline is to clarify how Appendix A, "Compliance Guidelines for Meeting Lethality Performance Standards for Certain Meat and Poultry Products," to the final rule "Performance Standards for the Production of Certain Meat and Poultry Products" (http://www.fsis.usda.gov/OPPDE/rdad/FRPubs/Docs_95-033F.htm) may be used to support validation of the cooking or heat treatment steps in an establishment's HACCP plan for ready-to-eat (RTE) meat and poultry products.

II. BACKGROUND

Appendix A is intended primarily as guidance for processors of cooked poultry products and cooked beef, corned beef, and roast beef. The time and temperature tables in Appendix A also can be used as supporting documentation for the heat treatment of other RTE meat and poultry products if such products critical factors are equivalent to the products specifically covered in Appendix A. Critical factors are those characteristics, conditions, or aspects of the product or processing environment such as pH, product formulation, water activity, percent salt, etc., that affect the adequacy of the process.

The relative humidity levels suggested in Appendix A for cooked beef under 10 pounds do not apply to all products. Although the use of relative humidity during cooking is not specified in the Guidelines for Cooked Poultry Rolls and Other Cooked Poultry Products in Appendix A, the same scientific principles and reasoning apply to poultry products. The following explains the reason for the suggested relative humidity levels and provides examples of some products and processes for which they are applicable:

High relative humidity (or moisture) during cooking is a critical factor for ensuring adequate lethality for pathogens in RTE products. "Relative humidity" is defined as the ratio of the amount of water vapor in the air to the maximum capacity of the air at the same temperature. High relative humidity around a product during cooking promotes heat process lethality in two ways. First, the humidity reduces surface evaporation and the energy or heat that evaporation removes from the product during heating. Thus, if a sufficiently high relative humidity surrounding the product is not maintained during heating, undesirable evaporative cooling at the surface will occur. Products produced under conditions of high humidity must reach a higher temperature before evaporation will occur.

Secondly, the humidity keeps the product (and any pathogens) wetter and prevents unwanted concentration of solutes (e.g., sugar and salt) as a result of

drying. Research has demonstrated that bacteria can become more heat resistant as their moisture level decreases, and increased concentrations of solutes, especially sugars, increase the heat resistance of bacteria. Therefore, drying of the product surface before the pathogens are destroyed will increase pathogen heat resistance and allow them to survive the heating process. By incorporating humidity to minimize evaporation, the D values (time at a constant temperature necessary to destroy 90% or 1 $\log_{10}$ of the target organism) that are the basis for Appendix A will remain valid. If evaporation or an increase in solute concentration are likely to occur, the times and temperatures in Appendix A are not likely to be sufficient to provide the required lethality.

III. Suggested Relative Humidity Levels

- The relative humidity levels suggested in Appendix A for cooked, roast, and corned beef (e.g., 90% relative humidity for the entire process, 90% relative humidity for at least 50% of the cooking time, but in no case less than 1 hour) apply only to those processes in which the surface moisture of the product can evaporate, and surface drying can occur, prior to destruction of the microorganisms. Such processes include the production of meat and poultry jerky.

For certain other processes, humidity around the product is inherently maintained and does not have to be added or monitored. Such processes include, but are not limited to:

- Immersing the product in a liquid cooking medium.
- Cooking the product in a sealed, moisture impermeable bag (e.g., cook-in-bag meat or poultry).
- Applying direct heat, such as a grill, heating coil, flame, or rotisserie, which will heat the surface rapidly enough to attain a lethal effect before evaporation or surface cooling does occur.
- Using a product casing – almost all casings will prevent or inhibit moisture loss, so that the heat resistance of pathogens is not affected during the cooking process (e.g., sausages cooked in casings).
- Cooking beef patties - The phrase “cooked beef” in Appendix A was intended to refer to a large mass product, such as a brisket, and not to cooked beef patties that generally are small mass products. A lethality performance standard for uncured, cooked beef patties was not established with humidity being considered essential for adequate lethality because these products are cooked with direct heat. Thus, for these products the times and temperatures listed in Appendix A are deemed to be sufficient to achieve the necessary lethality for safety, without the need to also consider humidity.

If the establishment uses Appendix A as supporting documentation for a lethality step for products other than those described in the preceding bulleted paragraphs, the addition of humidity may be required. If humidity is not added during the process (e.g., preparation of meat or poultry jerky) or maintained by the process (e.g., cook-in-bag, direct heat, use of adequate casing), then the establishment should include documentation to support why Appendix A is relevant as part of its validation.

If the establishment is using Appendix A as supporting documentation for a process but not ensuring 90% relative humidity for the length of the cooking process, then the establishment's validation should also provide documentation that a lower level of relative humidity can be used.

IV. Reference Materials

Blankenship, L. C. 1978, Survival of a *Salmonella typhimurium* experimental contaminant during cooking of beef roasts. Appl. Environ. Microbiol. 35:1160.

Goepfert, J. M., I. K. Iskander and C.H. Amundson. 1970. Relation of the heat resistance of salmonellae to the water activity of the environment. Appl. Microbiol. 19(3):429-33.

Goodfellow, S. J. and W. L. Brown. 1978. Fate of *Salmonella* inoculated into beef for cooking. J. Food Prot. 41(8):598-605.