

CALCULATING THE TOTAL GROWTH OF BACTERIA IN COOKED FOOD USING THE FDA CODE CONTROLS

The FDA Food Code tells us that cooked food can be held at 41°F for 7 days or at any temperature between 41 and 140°F, if the time is limited to 4 hours. This, of course, is scientifically wrong, because pathogen growth actually starts at about 29.3°F and stops, for all practical purposes, at 125°F.

Using the well-established Radkowsky bacterial growth predication equation (Radkowsky, 1983), and setting 30°F as the start point, 41°F for 7 days as a second point, putting 4 hours at about 115°F (because it fits the equation), and setting the upper growth limit at 125°F, I calculated the equivalent growth times from 30 to 125°F (Snyder, 1998). Remember, the FDA does not refer to specific bacteria. This is based on FDA code time-temperature controls. The FDA has never cited a source for the numbers in the code. It appears to be 10 generations of *Listeria monocytogenes* at 41°F and 10 generations of *Salmonella* / *Staphylococcus aureus* at 115°F. (See Table 1.)

Table 1. Maximum Holding Times at Specified Temperatures

°F	°C	1 Multiplication of Pathogens	SAFETY LIMIT* 10 Multiplications of Pathogens
<30	<-1.1	Safe	Safe
30	-1.1	297.14 hours	123.8 days
35	1.7	46.34 hours	19.3 days
40	4.4	17.99 hours	7.5 days
41	5.0	15.55 hours	6.5 days
45	7.2	9.49 hours	4.0 days
50	10.0	5.85 hours	2.4 days
55	12.8	3.96 hours	1.7 days
60	15.6	2.86 hours	1.2 days
65	18.3	2.16 hours	21.6 hours
70	21.1	1.69 hours	16.9 hours
75	23.9	1.36 hours	13.6 hours
80	26.7	1.12 hours	11.2 hours
85	29.4	0.93 hours	9.3 hours
90	32.2	0.79 hours	7.9 hours
95	35.0	0.68 hours	6.8 hours
100	37.8	0.59 hours	5.9 hours
105	40.6	0.52 hours	5.2 hours
110	43.3	0.47 hours	4.7 hours
115	46.1	0.46 hours	4.6 hours
120	48.9	0.56 hours	5.6 hours
125	51.7	3.10 hours	31.0 hours

Now, how does a foodservice operator use this? I have developed a simple calculation sheet so that the operator can find the equivalent growth in a process between 30 and 125°F. First, the operator must collect times and temperatures for a process and put it in the blank table (Table 2). Then, for each temperature, the operator looks up the growth / hour from Table 3, fills in this information on Table 2, and calculates the growth for each step in the process. (See next page for tables.) When the growth reaches 10 generations, the operator must have used up the food. This is exactly equivalent to what the FDA allows with 41°F for 7 days or 4 hours at 115°F.

References:

Ratkowsky, D. A., R. K. Lowry, T. A. McMeekin, A. N. Stokes, and R. E. Chandler. 1983. Model for bacterial culture growth rate throughout the entire biokinetic temperature range. *J. Bacteriol.* 154(3):1222-1226.
 Snyder, O.P. 1998. Updated guidelines for use of time and temperature specifications for holding and storing food in retail food operations. *Dairy Food Environ. Sanit.* 18(9):574-579.

