Table 2. Time-Temperature Combinations for Meat Products to Achieve Lethality

Temperatures stated are the minimum internal temperatures that must be met in all parts of the meat product for the total dwell time listed.[5] An establishment must ensure both time and temperature parameters are met to use this table to support its process achieves the Log reduction target. **Relative humidity**[6] and heating **come-up-time (CUT)**[7] are also **critical operating parameters** when using this table. (See pages 37 and 38 for poultry endpoint time-temperature tables).

Degrees Fahrenheit	Degrees Centigrade	6.5-log $_{10}$ Lethality	7-log $_{10}$ Lethality
130	54.4	112 min.	121 min.
131	55.0	89 min.	97 min.
132	55.6	71 min.	77 min.
133	56.1	56 min.	62 min.
134	56.7	45 min.	47 min.
135	57.2	36 min.	37 min.
136	57.8	28 min.	32 min.
137	58.4	23 min.	24 min.
138	58.9	18 min.	19 min.
139	59.5	15 min.	15 min.
140	60.0	12 min.	12 min.
141	60.6	9 min.	10 min.
142	61.1	8 min.	8 min.
143	61.7	6 min.	6 min.
144	62.2	5 min.	5 min.
145	62.8	4 min.	4 min.
146	63.3	169 sec.	182 sec.
147	63.9	134 sec.	144 sec.
148	64.4	107 sec.	115 sec.
149	65.0	85 sec.	91 sec.
150	65.6	67 sec.	72 sec.
151	66.1	54 sec.	58 sec.
152	66.7	43 sec.	46 sec.
153	67.2	34 sec.	37 sec.
154	67.8	27 sec.	29 sec.
155	68.3	22 sec.	23 sec
156	68.9	17 sec.	19 sec.
157	69.4	14 sec.	15 sec.
158	70.0	0 sec.**	0 sec.**
159	70.6	0 sec.**	0 sec.**
160	71.1	0 sec.**	0 sec.**

[5] The required Log reductions are achieved instantly (0 seconds) when the internal temperature of a cooked meat product reaches 158°F or above.

[6] Time-Temperatures ≥ 145°F (in blue square) are eligible for FSIS Relative Humidity Options 1 and 2. All time-temperatures may apply FSIS Relative Humidity Options 3 and 4 (page 26).

[7] FSIS recommends limiting the total time product temperature is between 50 and 130°F to 6 hours or less (see page 23).

Additional Critical Operating Parameters for Poultry Products

The following are additional critical operational parameters that should be considered when cooking poultry products using FSIS newer guidance in the poultry time-temperature tables.

Note: The older poultry recommendations for Cooked Poultry Rolls on page 39 apply regardless of species or fat because these were not considered critical operating parameters at the time the recommendation was developed. FSIS is not aware of any outbreaks or food safety incidents as a result of applying these recommendations to products of varying species or fat level.

Product Species

Generally, FSIS accepts that research for an intervention's effectiveness on one species of poultry (*i.e.,* chickens, turkeys, ducks, geese, ratites, and squabs) can be applied to another species of poultry without additional support (FSIS Directive 5000.6, *Performance of the Hazard Analysis Verification Task*). However, research by Juneja *et al.* (2001a) demonstrated that in cooking processes, *Salmonella* heat tolerance depends on the poultry species. Therefore, when FSIS developed its time-temperature tables for poultry it developed two unique poultry time-temperature tables: one for chicken (page 37), another for turkey (page 38).

When making poultry products containing **poultry species other than chicken or turkey**, or products made with a **mixture of poultry species**, FSIS recommends selecting an endpoint temperature, then using the longest dwell time recommended for the product fat content and endpoint temperature in either the chicken or turkey table. Comparing the tables and using the longest recommended dwell time ensures the HACCP system is designed to address the worst-case scenario for *Salmonella* survival in the product. Products that are a **mixture of poultry and meat** must achieve a 7-Log reduction of *Salmonella* (see Key Question on page 19).

Fat Content

In the presence of fats, the heat tolerance of some microorganisms generally increases (Jay *et al.,* 2000). This is sometimes referred to as fat protection and is presumed to increase heat tolerance by affecting cell moisture. Juneja *et al.,* (2001b) showed that higher fat levels in beef result in increased heat resistance of *Salmonella*, which is in agreement with publications regarding other food borne pathogens (Line *et al.,* 1991; Ahmed *et al.,* 1995). The Poultry Time-Temperature Tables (pages 37 and 38) provide establishments with time-temperature combinations that can be used to cook chicken and turkey products with different fat levels.

Table 3. Time-Temperature Combinations for Chicken Products to Achieve Lethality

Times for given temperatures and fat levels that are needed to obtain a 7-Log reduction of *Salmonella* in chicken products.[8] As described on page 23, **relative humidity**[9] and heating **come-up-time (CUT)**[10] are **critical operating parameters** when using this table.

Degrees Fahrenheit	Degrees Centigrade	1% fat	2% fat	3% fat	4% fat	5% fat	6% fat	7% fat	8% fat	9% fat	10% fat	11% fat	12% fat
136	57.8	63.3 min	64.5 min	65.7 min	67 min	68.4 min	69.9 min	71.4 min	73 min	74.8 min	76.7 min	78.9 min	81.4 min
137	58.3	50.1 min	51 min	52.1 min	53.2 min	54.3 min	55.5 min	56.8 min	58.2 min	59.7 min	61.4 min	63.3 min	65.5 min
138	58.9	39.7 min	40.5 min	41.3 min	42.2 min	43.2 min	44.2 min	45.3 min	46.4 min	47.7 min	49.2 min	50.9 min	52.9 min
139	59.4	31.6 min	32.2 min	32.9 min	33.6 min	34.4 min	35.2 min	36.2 min	37.2 min	38.3 min	39.6 min	41.1 min	43 min
140	60.0	25.2 min	25.7 min	26.2 min	26.8 min	27.5 min	28.2 min	29 min	29.8 min	30.8 min	32 min	33.4 min	35 min
141	60.6	20.1 min	20.5 min	21 min	21.5 min	22 min	22.6 min	23.2 min	24 min	24.9 min	25.9 min	27.1 min	28.7 min
142	61.1	16.1 min	16.4 min	16.8 min	17.2 min	17.6 min	18.1 min	18.7 min	19.4 min	20.1 min	21 min	22.1 min	23.5 min
143	61.7	13 min	13.2 min	13.5 min	13.8 min	14.2 min	14.6 min	15.1 min	15.6 min	16.3 min	17.1 min	18.1 min	19.3 min
144	62.2	10.4 min	10.6 min	10.8 min	11.1 min	11.4 min	11.8 min	12.2 min	12.6 min	13.2 min	13.9 min	14.8 min	15.9 min
145	62.8	8.4 min	8.6 min	8.7 min	8.9 min	9.2 min	9.5 min	9.8 min	10.2 min	10.7 min	11.3 min	12.1 min	13 min
146	63.3	6.8 min	6.9 min	7 min	7.2 min	7.4 min	7.6 min	7.9 min	8.2 min	8.6 min	9.1 min	9.8 min	10.6 min
147	63.9	5.5 min	5.5 min	5.6 min	5.7 min	5.9 min	6.1 min	6.3 min	6.6 min	6.9 min	7.4 min	7.9 min	8.6 min
148	64.4	4.4 min	4.4 min	4.5 min	4.5 min	4.7 min	4.8 min	5 min	5.2 min	5.5 min	5.8 min	6.3 min	6.8 min
149	65.0	3.5 min	3.5 min	3.5 min	3.6 min	3.6 min	3.8 min	3.9 min	4.1 min	4.3 min	4.6 min	4.9 min	5.4 min
150	65.6	2.7 min	2.7 min	2.7 min	2.7 min	2.8 min	2.9 min	3 min	3.1 min	3.3 min	3.5 min	3.8 min	4.2 min
151	66.1	2.1 min	2 min	2 min	2.1 min	2.1 min	2.1 min	2.2 min	2.3 min	2.5 min	2.6 min	2.9 min	3.1 min
152	66.7	1.5 min	1.5 min	1.5 min	1.6 min	1.6 min	1.6 min	1.7 min	1.7 min	1.8 min	1.9 min	2.1 min	2.3 min
153	67.2	1.2 min	1.2 min	1.2 min	1.2 min	1.3 min	1.3 min	1.3 min	1.3 min	1.4 min	1.4 min	1.4 min	1.6 min
154	67.8	55.9 sec	56.9 sec	58 sec	59.1 sec	1 min	1 min	1 min	1.1 min	1.1 min	1.1 min	1.1 min	1.1 min
155	68.3	44.2 sec	45 sec	45.9 sec	46.8 sec	47.7 sec	48.6 sec	49.5 sec	50.4 sec	51.4 sec	52.4 sec	53.4 sec	54.4 sec
156	68.9	35 sec	35.6 sec	36.3 sec	37 sec	37.7 sec	38.4 sec	39.2 sec	39.9 sec	40.7 sec	41.4 sec	42.2 sec	43 sec
157	69.4	27.7 sec	28.2 sec	28.7 sec	29.3 sec	29.8 sec	30.4 sec	31 sec	31.6 sec	32.2 sec	32.8 sec	33.4 sec	34 sec
158	70.0	21.9 sec	22.3 sec	22.7 sec	23.2 sec	23.6 sec	24 sec	24.5 sec	25 sec	25.4 sec	25.9 sec	26.4 sec	26.9 sec
159	70.6	17.3 sec	17.6 sec	18 sec	18.3 sec	18.7 sec	19 sec	19.4 sec	19.8 sec	20.1 sec	20.5 sec	20.9 sec	21.3 sec
160	71.1	13.7 sec	14 sec	14.2 sec	14.5 sec	14.8 sec	15 sec	15.3 sec	15.6 sec	15.9 sec	16.2 sec	16.5 sec	16.9 sec
161	71.7	10.8 sec	11 sec	11.2 sec	11.5 sec	11.7 sec	11.9 sec	12.1 sec	12.4 sec	12.6 sec	12.8 sec	13.1 sec	13.3 sec
162	72.2	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	9.6 sec	9.8 sec	10 sec	10.2 sec	10.3 sec	10.5 sec
163	72.8	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**
164	73.3	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**
165	73.9	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**

[8] A 7-Log reduction of *Salmonella* is achieved instantly at internal temperatures in which the holding time is 0 seconds (0 sec.).

[9] Time-Temperatures ≥ 145°°F (in blue square) are eligible for FSIS Relative Humidity Options 1 and 2. All time-temperatures may apply FSIS Relative Humidity Options 3 and 4 (page 26).

[10] FSIS recommends limiting the total time product temperature is between 50 and 130°F to 6 hours or less (see page 23).

Table 4. Time-Temperature Combinations for Turkey Products to Achieve Lethality

Times for given temperatures and fat levels that are needed to obtain a 7-Log reduction of *Salmonella* in turkey products.[11] As described on page 23, **relative humidity**[12] and heating **come-up-time (CUT)**[13] are **critical operating parameters** when using this table.

Degrees Fahrenheit	Degrees Centigrade	1% fat	2% fat	3% fat	4% fat	5% fat	6% fat	7% fat	8% fat	9% fat	10% fat	11% fat	12% fat
136	57.8	64 min	64.3 min	64.6 min	64.9 min	65.3 min	65.8 min	66.3 min	66.9 min	67.6 min	68.4 min	69.5 min	70.8 min
137	58.3	51.9 min	52.2 min	52.4 min	52.8 min	53.2 min	53.6 min	54.1 min	54.7 min	55.3 min	56.2 min	57.2 min	58.5 min
138	58.9	42.2 min	42.5 min	42.7 min	43 min	43.4 min	43.8 min	44.2 min	44.8 min	45.4 min	46.2 min	47.2 min	48.5 min
139	59.4	34.4 min	34.6 min	34.9 min	35.1 min	35.4 min	35.8 min	36.2 min	36.7 min	37.3 min	38.1 min	39.1 min	40.4 min
140	60.0	28.1 min	28.3 min	28.5 min	28.7 min	29 min	29.3 min	29.7 min	30.2 min	30.8 min	31.5 min	32.5 min	33.7 min
141	60.6	23 min	23.2 min	23.3 min	23.5 min	23.8 min	24.1 min	24.4 min	24.9 min	25.5 min	26.2 min	27.1 min	28.2 min
142	61.1	18.9 min	19 min	19.1 min	19.3 min	19.5 min	19.8 min	20.1 min	20.5 min	21.1 min	21.7 min	22.6 min	23.7 min
143	61.7	15.5 min	15.6 min	15.7 min	15.9 min	16.1 min	16.3 min	16.6 min	17 min	17.4 min	18 min	18.8 min	19.8 min
144	62.2	12.8 min	12.8 min	12.9 min	13 min	13.2 min	13.4 min	13.7 min	14 min	14.4 min	15 min	15.7 min	16.6 min
145	62.8	10.5 min	10.6 min	10.6 min	10.7 min	10.8 min	11 min	11.3 min	11.5 min	11.9min	12.4 min	13 min	13.8 min
146	63.3	8.7 min	8.7 min	8.7 min	8.8 min	8.9 min	9 min	9.2 min	9.5 min	9.8 min	10.2 min	10.8 min	11.5 min
147	63.9	7.1 min	7.1 min	7.1 min	7.2 min	7.3 min	7.4 min	7.5 min	7.7 min	8 min	8.4 min	8.8 min	9.4 min
148	64.4	5.8 min	5.8 min	5.8 min	5.8 min	5.9 min	6 min	6.1 min	6.3 min	6.5 min	6.8 min	7.2 min	7.7 min
149	65.0	4.7 min	4.7 min	4.7 min	4.7 min	4.7 min	4.8 min	4.9 min	5 min	5.2 min	5.4 min	5.8 min	6.2 min
150	65.6	3.8 min	3.7 min	3.7 min	3.7 min	3.7 min	3.8 min	3.9 min	4 min	4.1 min	4.3 min	4.5 min	4.9 min
151	66.1	3 min	2.9 min	2.9 min	2.9 min	2.9 min	2.9 min	3 min	3.1 min	3.2 min	3.3 min	3.5 min	3.8 min
152	66.7	2.3 min	2.3 min	2.3 min	2.3 min	2.3 min	2.3 min	2.3 min	2.3 min	2.4 min	2.5 min	2.7 min	2.8 min
153	67.2	1.8 min	1.8 min	1.9 min	1.9 min	1.9 min	1.9 min	1.9 min	1.9 min	1.9 min	1.9 min	1.9 min	2.1 min
154	67.8	1.5 min	1.5 min	1.5 min	1.5 min	1.5 min	1.5 min	1.5 min	1.5 min	1.5 min	1.6 min	1.6 min	1.6 min
155	68.3	1.2 min	1.2 min	1.2 min	1.2 min	1.2 min	1.2 min	1.2 min	1.3 min	1.3 min	1.3 min	1.3 min	1.3 min
156	68.9	59 sec	59.3 sec	59.5 sec	59.8 sec	1 min	1 min	1 min	1 min	1 min	1 min	1 min	1 min
157	69.4	47.9 sec	48.1 sec	48.3 sec	48.5 sec	48.8 sec	49 sec	49.2 sec	49.5 sec	49.7 sec	49.9 sec	50.2 sec	50.4 sec
158	70.0	38.8 sec	39 sec	39.2 sec	39.4 sec	39.6 sec	39.8 sec	40 sec	40.1 sec	40.3 sec	40.5 sec	40.7 sec	40.9 sec
159	70.6	31.5 sec	31.7 sec	31.8 sec	32 sec	32.1 sec	32.3 sec	32.4 sec	32.6 sec	32.7 sec	32.9 sec	33 sec	33.2 sec
160	71.1	25.6 sec	25.7 sec	25.8 sec	26 sec	26.1 sec	26.2 sec	26.3 sec	26.4 sec	26.6 sec	26.7 sec	26.8 sec	26.9 sec
161	71.7	20.8 sec	20.9 sec	21 sec	21.1 sec	21.2 sec	21.3 sec	21.4 sec	21.5 sec	21.6 sec	21.7 sec	21.8 sec	21.9 sec
162	72.2	16.9 sec	16.9 sec	17 sec	17.1 sec	17.2 sec	17.3 sec	17.3 sec	17.4 sec	17.5 sec	17.6 sec	17.7 sec	17.7 sec
163	72.8	13.7 sec	13.7 sec	13.8 sec	13.9 sec	13.9 sec	14 sec	14.1 sec	14.1 sec	14.2 sec	14.3 sec	14.3 sec	14.4 sec
164	73.3	11.1 sec	11.2 sec	11.2 sec	11.3 sec	11.3 sec	11.4 sec	11.4 sec	11.5 sec	11.5 sec	11.6 sec	11.6 sec	11.7 sec
165	73.9	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**	0 sec.**

[11] A 7-Log reduction of *Salmonella* is achieved instantly at internal temperatures in which the holding time is 0 seconds (0 sec.).

[12] Time-Temperatures ≥ 145°°F (in blue square) are eligible for FSIS Relative Humidity Options 1 and 2. All time-temperatures may apply FSIS Relative Humidity Options 3 and 4 (page 26).

[13] FSIS recommends limiting the total time product temperature is between 50 and 130°F to 6 hours or less (see page 23).