Stove Temperature Profiles

prepared by:

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Summary

Efficiency determinations require the temperature of the gas leaving the heated space of a home to be approximated by measurement at the center of the stack at eight-foot height. "The flue gas temperature shall be measured by means of a Type K, sheathed thermocouple, or equivalent, located in the centroid of the stack 2.44 m ±150 mm [8 ft ± 6 in] above the platform scale." (Section 6.2.2, Draft Standard, B415.1, August 29, 2009). Because the temperature is not uniform across the diameter of the stack and the method, in effect, assumes that that temperature measured in the center of the stack is representative of total exhaust gas and because the method allows a 1-foot range in the height at which the temperature may be measured, an evaluation of the change in temperature across the stack and at either end of the 1-foot height range was evaluated.

Two different non-catalytic certified wood heater models at several different Method 28 burn rate categories were used for the evaluation. The locations of the thermocouples are shown in Figures 1-3.

Figures 4-8 show the effect of height measured at the center of the stack at 7½, 8 and 8½ feet for each individual run over the course of a Method 28 test. Table 1 summarizes the effect for all test runs.

Figures 9-13 show the average temperature across the diameter of the chimney in two directions for each individual run. Figure 14 and Table 2 show the average differences in temperatures at each point as compared to the center point.

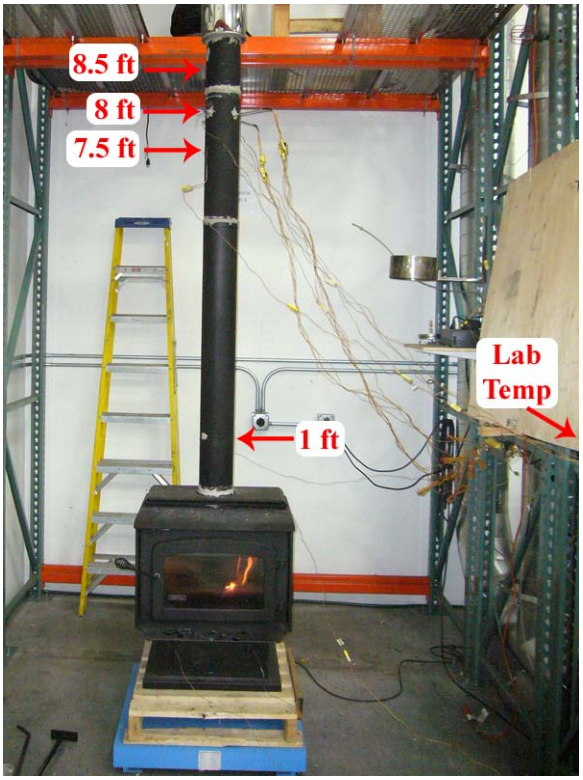

Figure 1. Location of temperature probes.

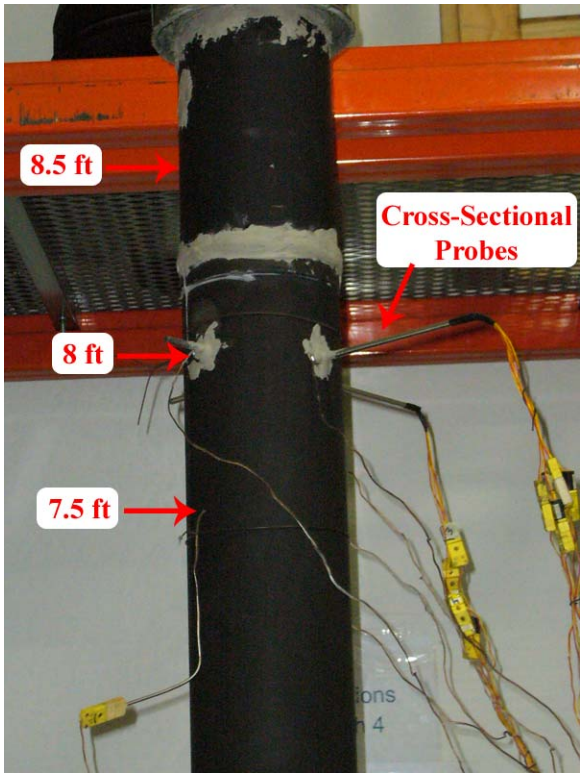

Figure 2. Close-up of temperature probes.

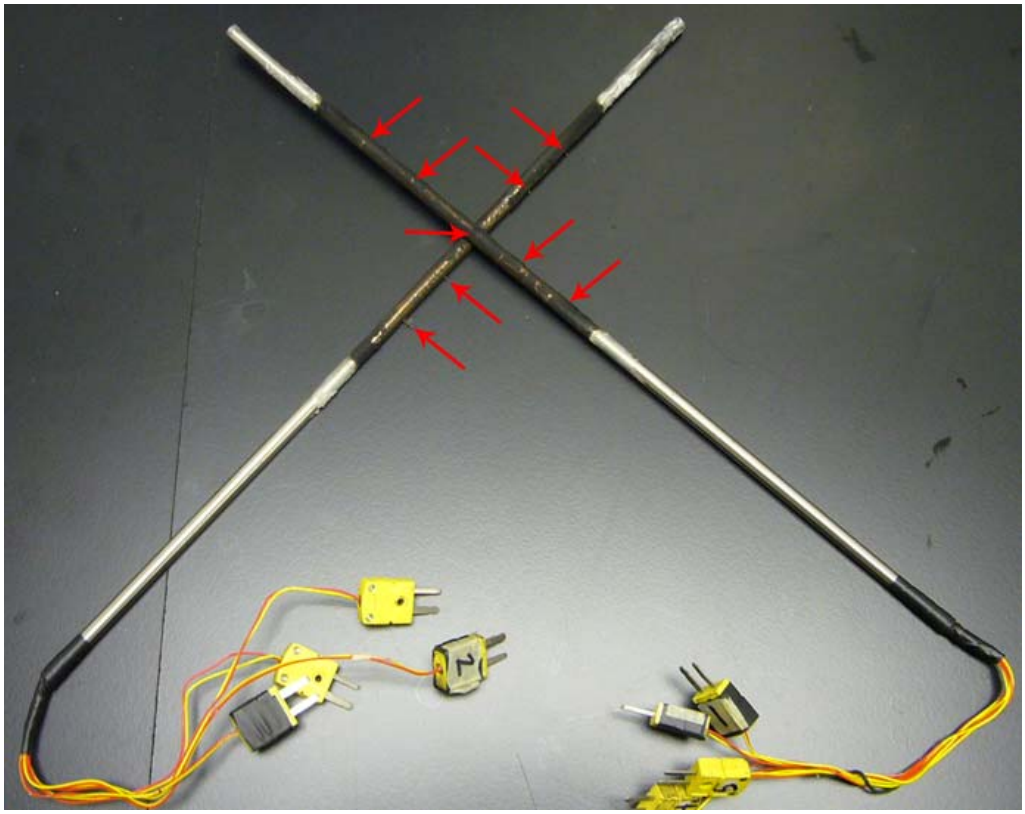
Figure 3. Cross-section probes; arrows show locations of thermocouples.

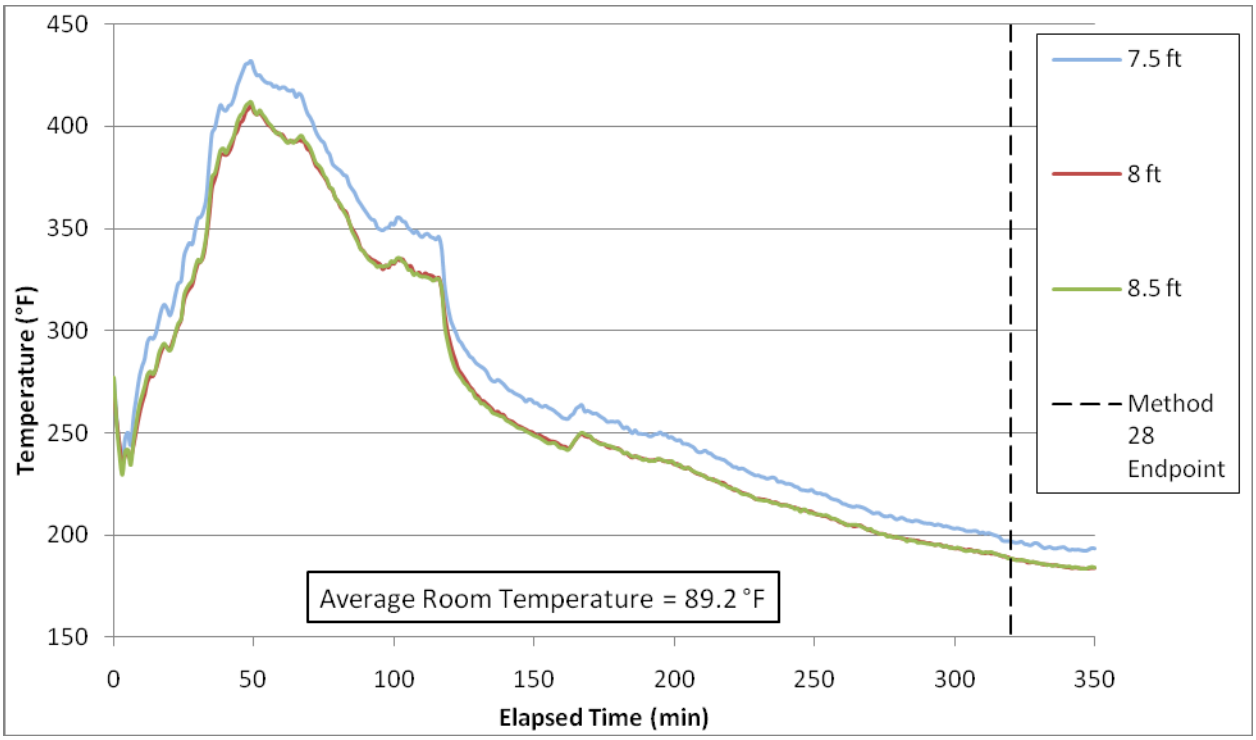

Figure 4. Stack temperatures at eight feet ± one half-foot, stove model A, category 2 (1.07 Kg/h).

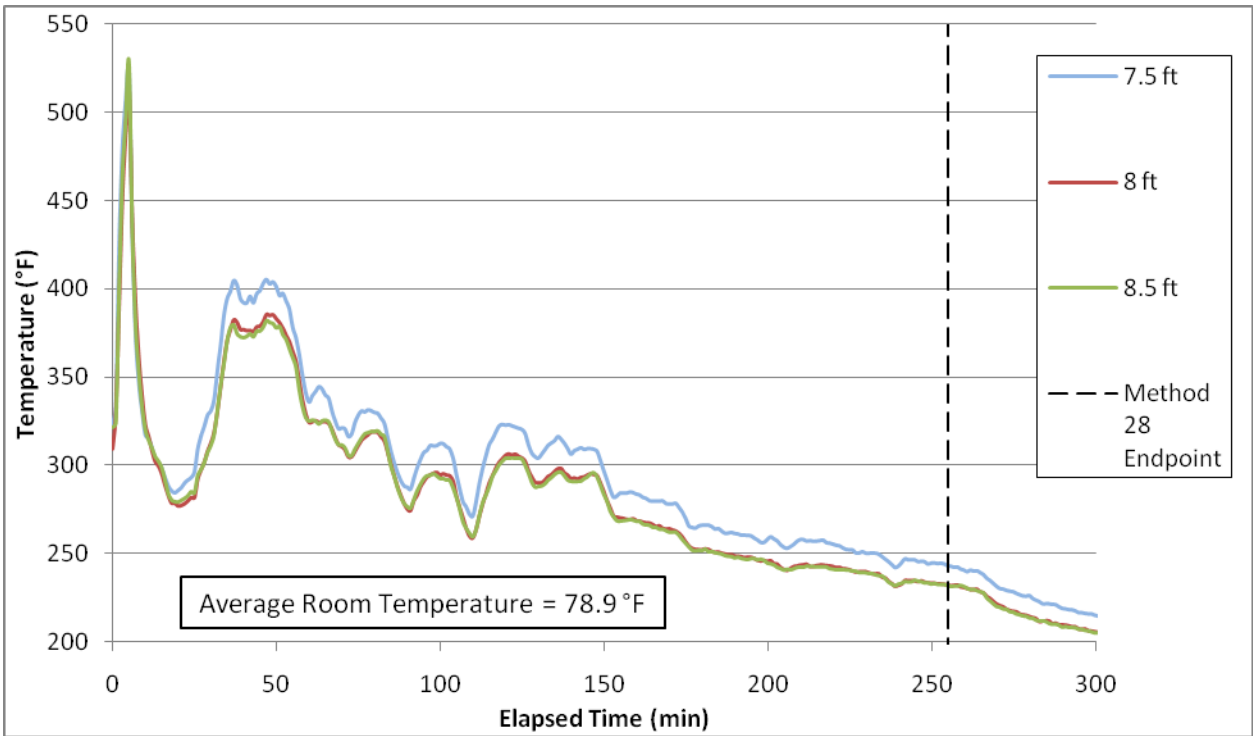

Figure 5. Stack temperatures at eight feet ± one half-foot, stove model A, category 3 (1.27 Kg/h).

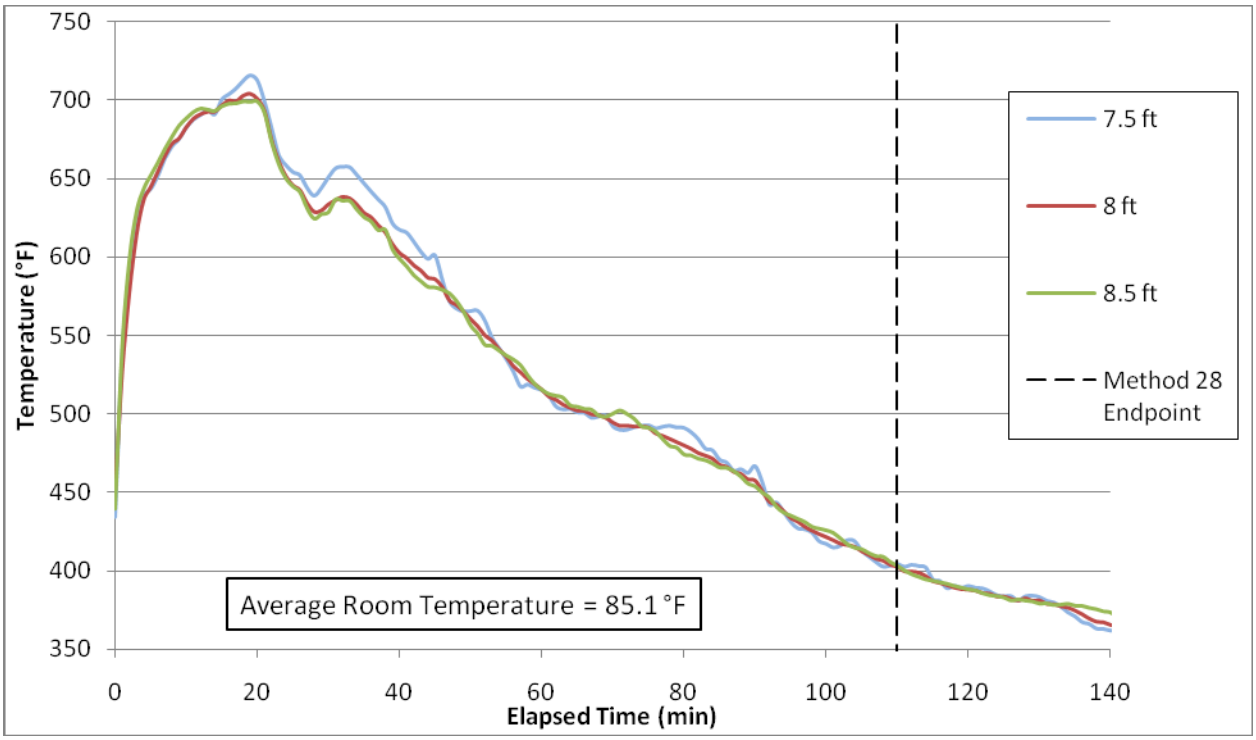

Figure 6. Stack temperatures at eight feet ± one half-foot, stove model A, category 4 (2.85 Kg/h). Note: 8.5 ft probe was located in double-walled chimney.

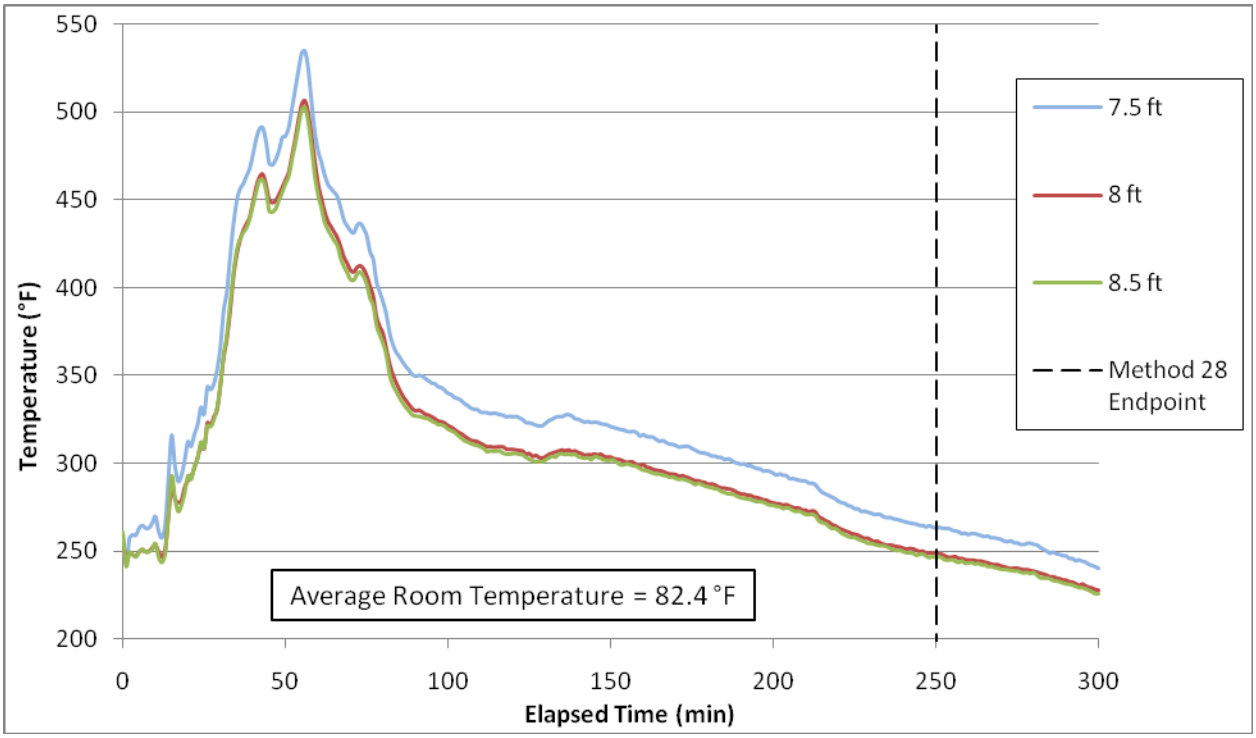

Figure 7. Stack temperatures at eight feet ± one half-foot, stove model B, category 2 (1.26 Kg/h).

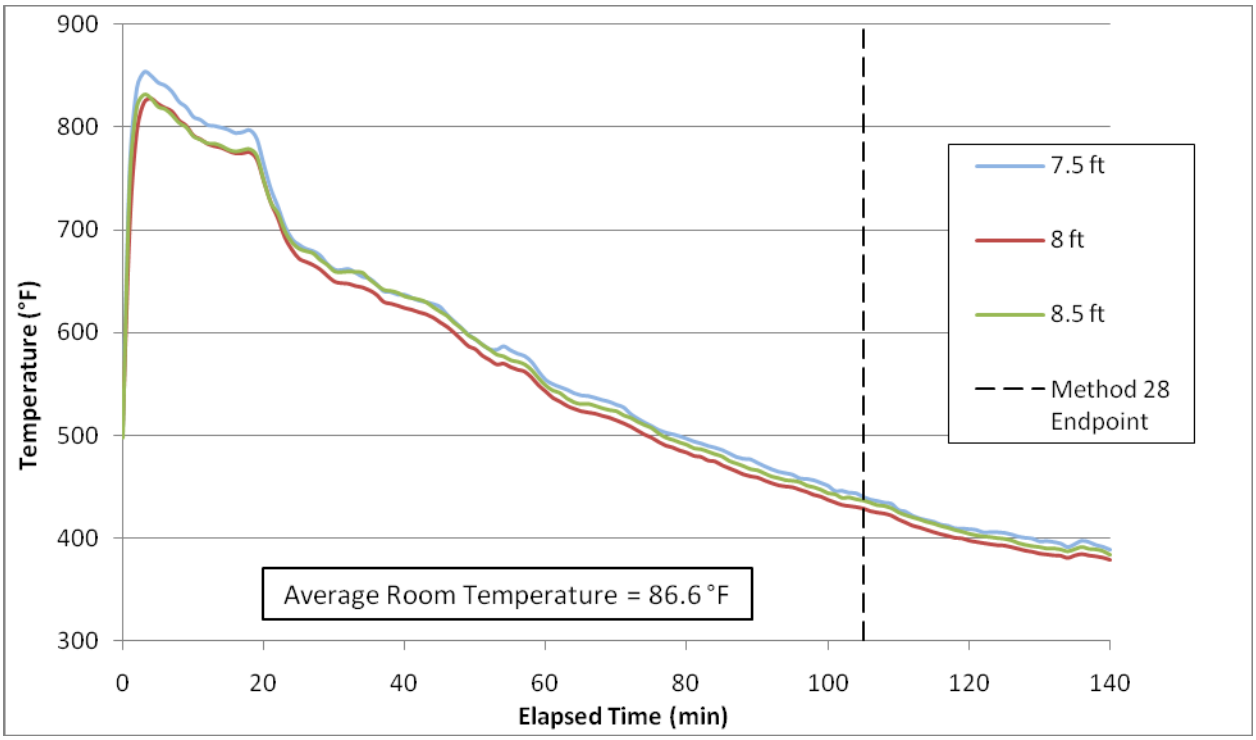

Figure 8. Stack temperatures at eight feet ± one half-foot, stove model B, category 4 (2.85 Kg/h).

Table 1
Summary of the Height Effect on Flue Temperatures

Stove Model	Burn Rate (Kg/h)	Burn Rate Category	Average Temperature to Method 28 Endpoint (°F)			
			Room	7.5 ft	8 ft	8.5 ft
A	2.85	4	85.6	551	547	547*
	1.27	3	79.3	302	289	288
	1.07	2	89.3	283	269	269
B	2.85	4	86.8	606	591	598
	1.26	2	82.4	338	319	317
Average			84.7	416	403	404
Δ 8 ft			N/A	13	0	1

*8.5 ft probe was located in insulated double-walled chimney.

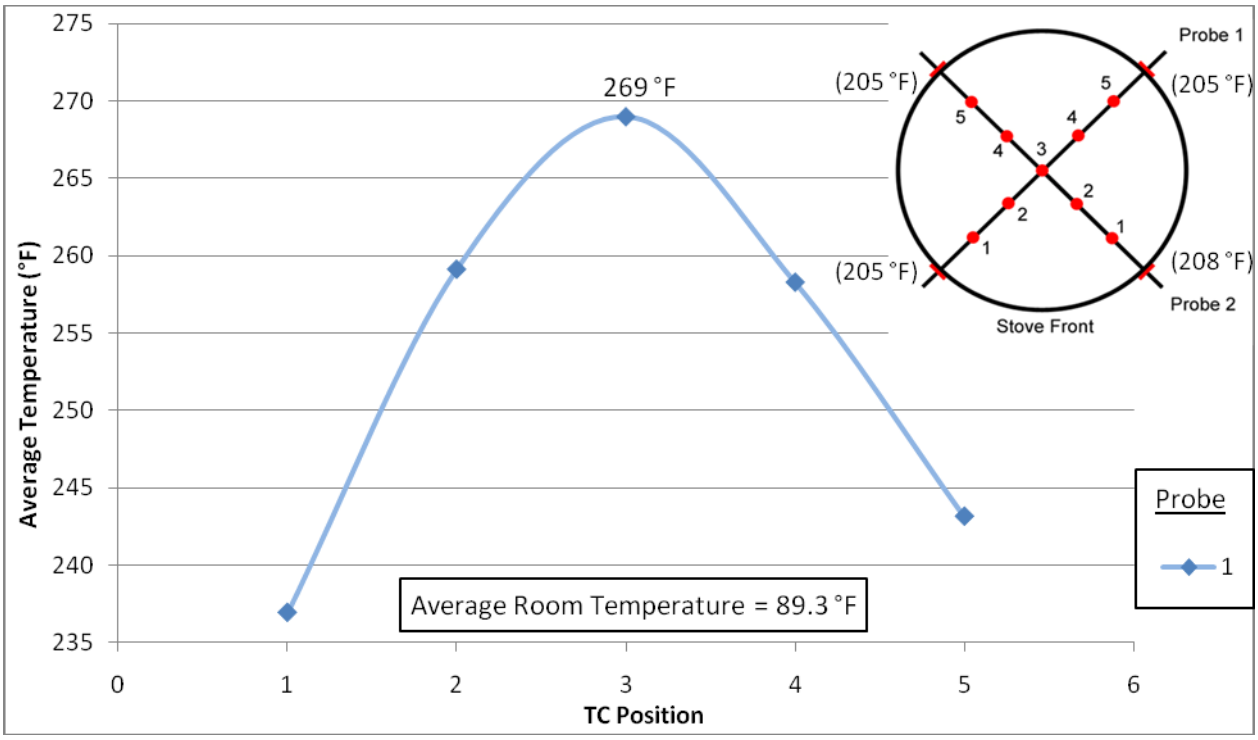

Figure 9. Stack cross-section average temperature profile to Method 28 endpoint, stove model A, category 2 (1.07 Kg/h)); represents the lowest burn rate achievable with the heater. Note: Data from probe 2 deemed void due to unrealistic outliers.

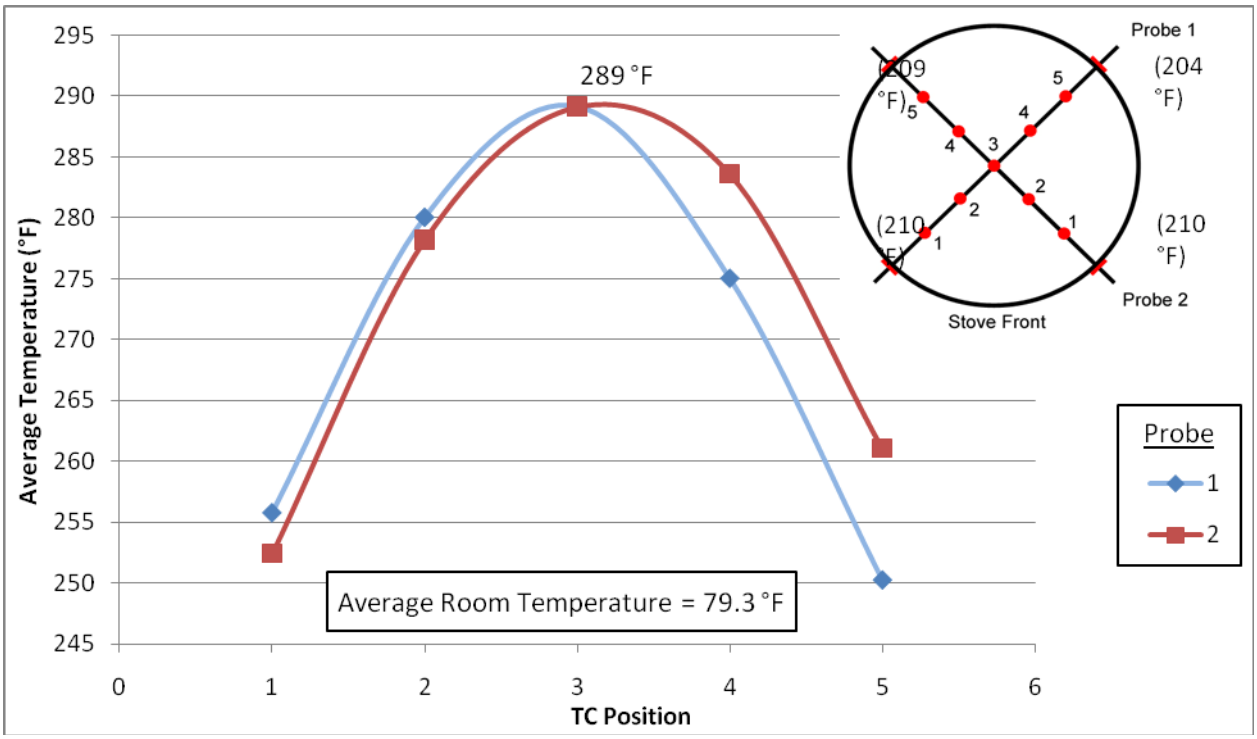

Figure 10. Stack cross-section average temperature profile to Method 28 endpoint, stove model A, category 3 (1.27 Kg/h).

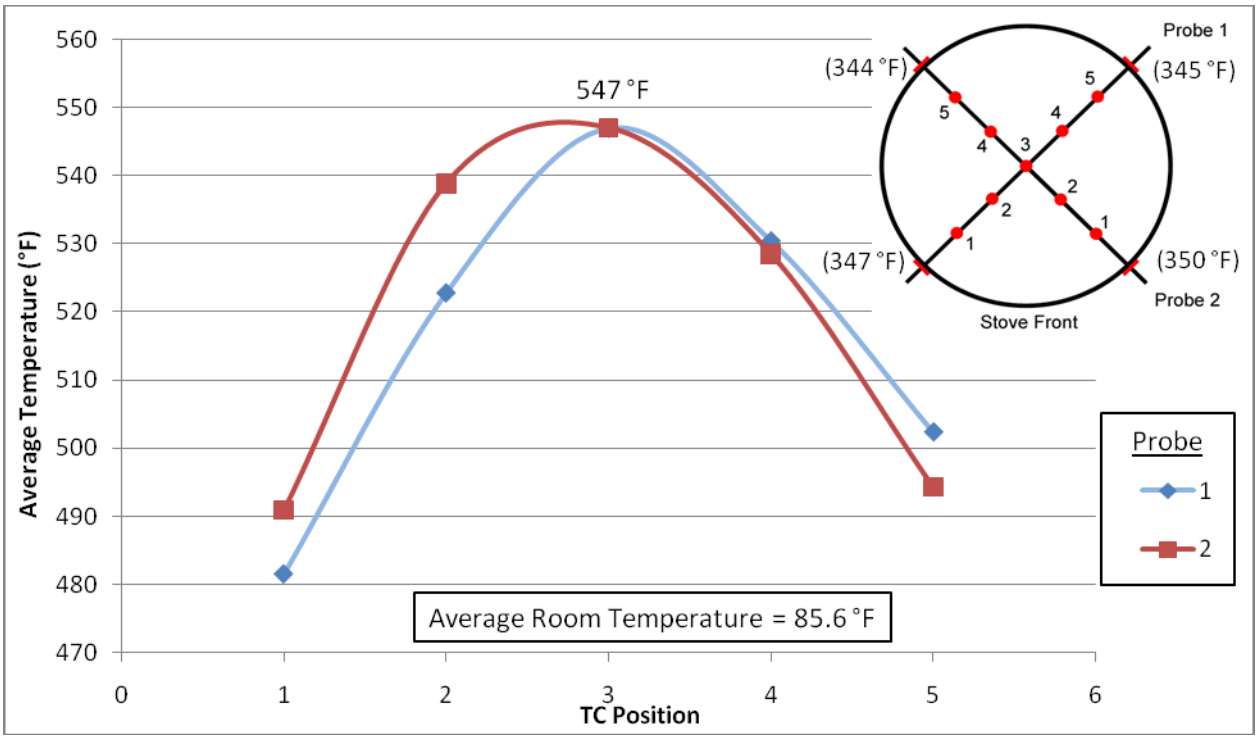

Figure 11. Stack cross-section average temperature profile to Method 28 endpoint, stove model A, category 4 (2.85 Kg/h).

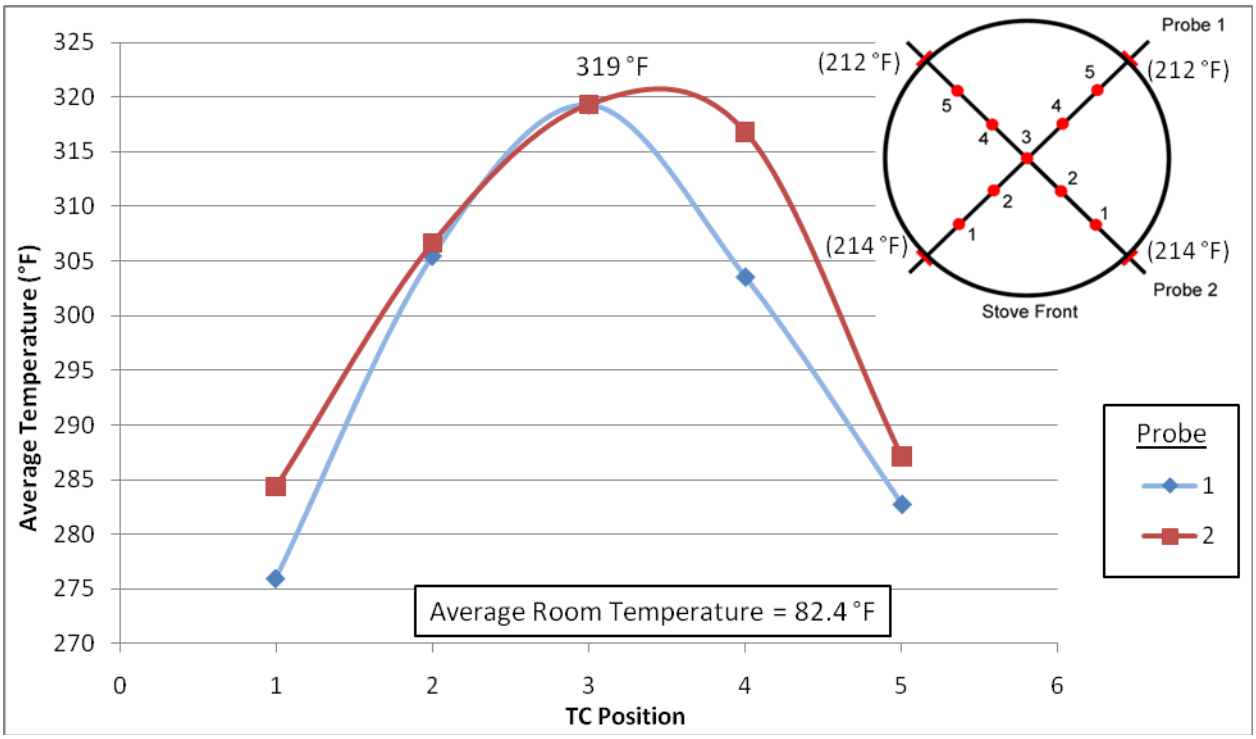

Figure 12. Stack cross-section average temperature profile to Method 28 endpoint, stove model B, category 3 (1.26 Kg/h).

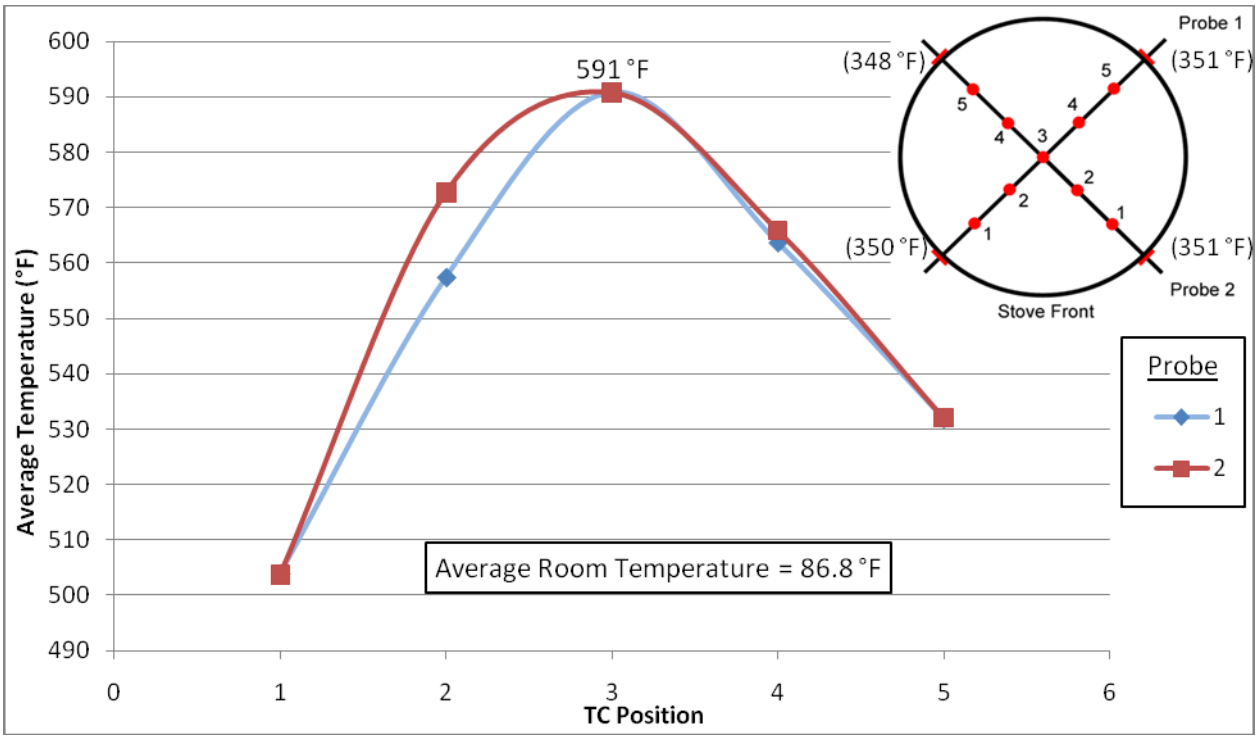

Figure 13. Stack cross-section average temperature profile to Method 28 endpoint, stove model B, category 4 (2.85 Kg/h).

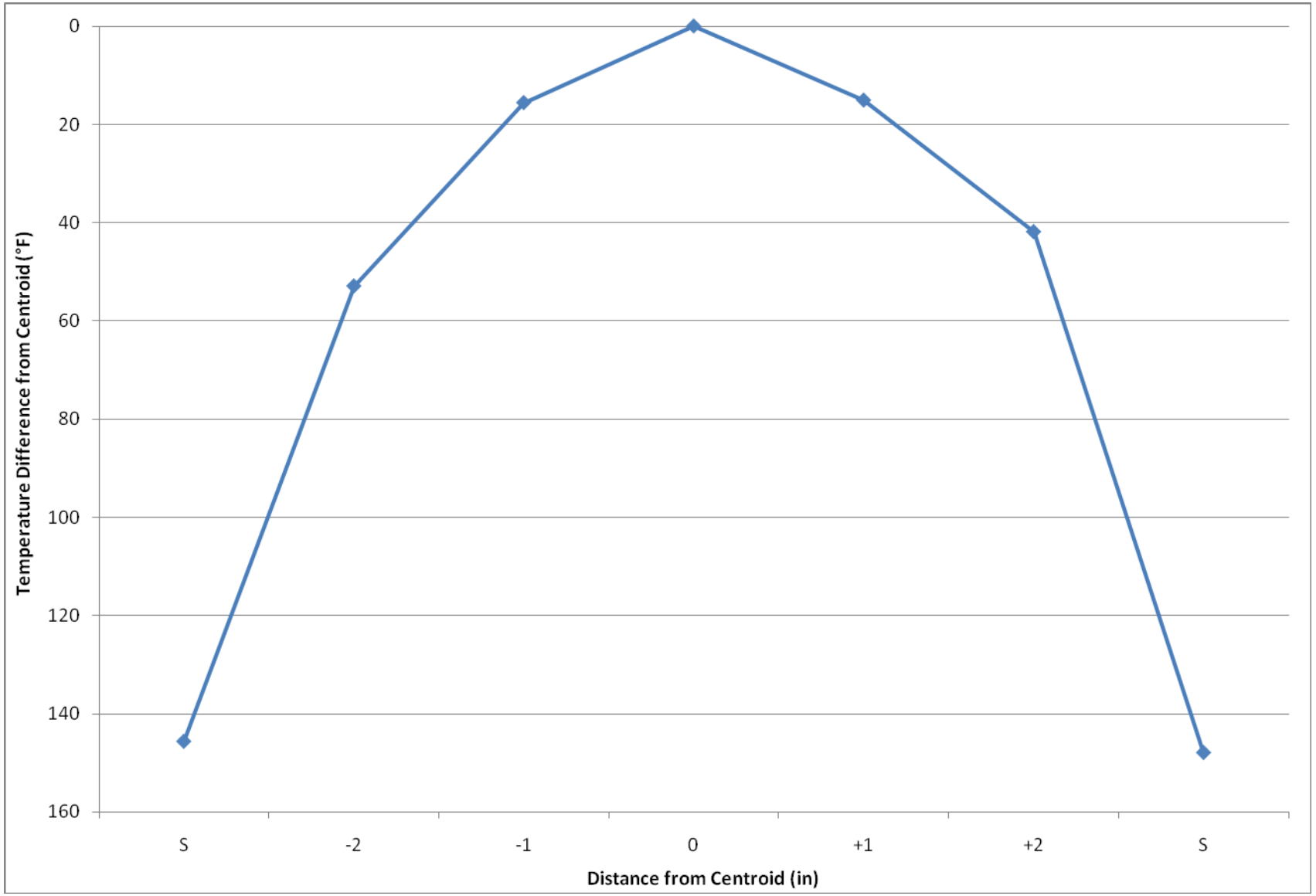

Figure 14: Average Temperature Difference from Centroid of Six-Inch Chimney Connector, Both Stove Models, All Runs

Table 2

Summary of Temperature Differences from Centroid of Six-Inch Chimney Connector

Probe	Stove Model	Category	Burn Rate (Kg/h)	Temperature Difference (°F) with Distance (inches) from Centroid						
				Surface	-2	-1	0	+1	+2	Surface
1	A	4	2.85	200	66	24	0	17	45	202
		3	1.27	79	33	9	0	14	39	85
		2	1.07	64	32	10	0	11	26	64
	B	4	2.85	241	87	33	0	27	59	240
		3	1.26	106	43	14	0	16	37	107
	Average			138	52	18	0	17	41	140
2	A	4	2.85	197	56	8	0	19	53	203
		3	1.27	79	37	11	0	5	28	80
		2	1.07	nd	nd	nd	nd	nd	nd	nd
	B	4	2.85	240	87	18	0	25	59	243
		3	1.26	105	35	13	0	3	32	108
	Average			155	54	12	0	13	43	158
1+2	Overall Average			146	53	16	0	15	42	148