The Rodeo™
The Good-One®

Performance Testing of
Rodeo Model Good-One® Smoker
August 29, 2008

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1. Introduction

A test program was conducted to examine the performance of the Rodeo Model Good One Smoker. Over the course of about two months, several tests were performed to measure the operating temperatures of the smoker under various conditions. The tests have proven sufficient for determining the performance of the smoker.

The report is written in sections, each addressing a particular testing parameter of interest (for instance, temperature stability). The report contains data and plots selected and derived from a variety of tests, thus, it may appear to the uniformed that the temperatures have "suddenly changed". This is because no two tests were exactly the same. Nevertheless, the results and conclusions drawn would be valid for all conditions a customer may experience.

2. Testing set-up and procedures

Smoker tests were run using hardwood lump charcoal as supplied. Each test used 30 pounds of lump charcoal. Smoker vents were adjusted open to 2-1/2 turns for the intake and 1-1/2 turns for the exhaust. Two gallons of water were added to the smoking chamber. The damper valve was adjusted to achieve the nominal smoking temperature desired, typically in the 250 degree F range.

All efforts were made to achieve optimal smoking conditions.

- Tests were conducted during similarly warm weather days.
- Shelter from the wind was employed as necessary.
- Smoker was leveled prior to each test.
- Prior to testing, the smoker was seasoned to avoid complications associated with testing on a factory finish (primarily those associated with uneven radiation effects).

The smoker was fitted with 18 fire-rated thermocouples, connected to a PC-based data acquisition system, as shown in Figures 1-4. Temperature measurements were automatically recorded every 5 seconds during the duration of the test. The accuracy in temperature measurements is within 1 degree Fahrenheit.

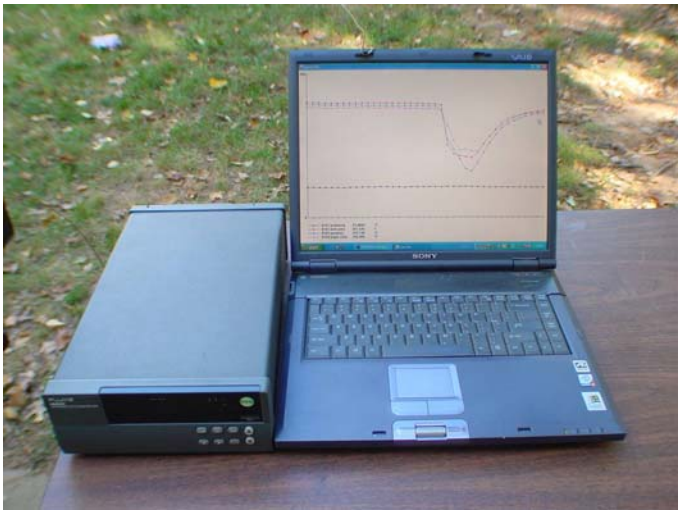

Figure 1. Close-up of the computer and data acquisition system. Picture taken during data acquisition, showing data from a lid opening experiment.

The cooking grate in the smoke chamber was instrumented on all 4 food grates, at 18 locations (see Figure 2-4).

The nomenclature used in this report defines the uppermost (smaller) grate as the top grate. The remaining 3 grates are numbered 1, 2 and 3 from top to bottom. Temperature measurements were made laterally across the grates (left, center, and right) and centered front to back (see Figure 2). The left and right measurements were made 6 inches from each side of the smoking chamber. The front and rear measurements were made 3 inches from the edges of the grate. Temperature measurement locations are identified in Table 1.

Grate	Center	Left Side	Right Side	Front	Rear
Top	yes	yes	yes		
1	yes	yes	yes	yes	yes
2	yes	yes	yes	yes	yes
3	yes	yes	yes	yes	yes

Table 1. Temperature locations in the smoke chamber.

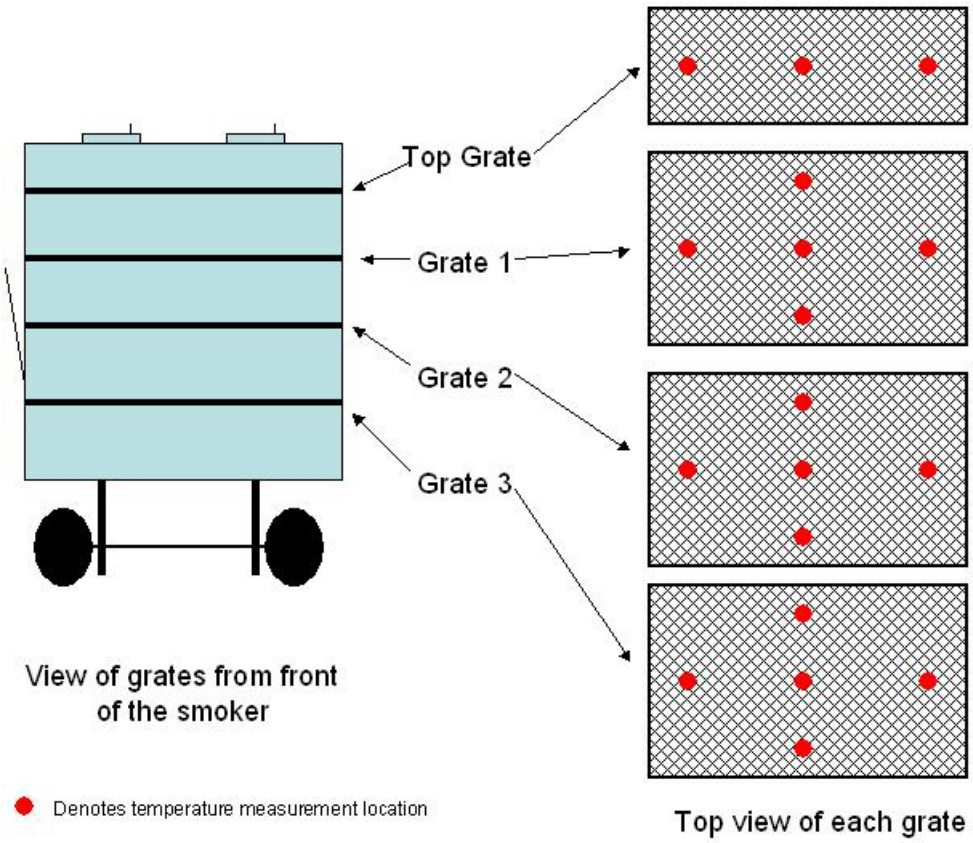

Figure 2. Drawing depicting locations of temperature measurements within the smoker.

Additionally, a measurement was made coincident with the location of the tip of the factory installed dial thermometer, and on the grate in the firebox.

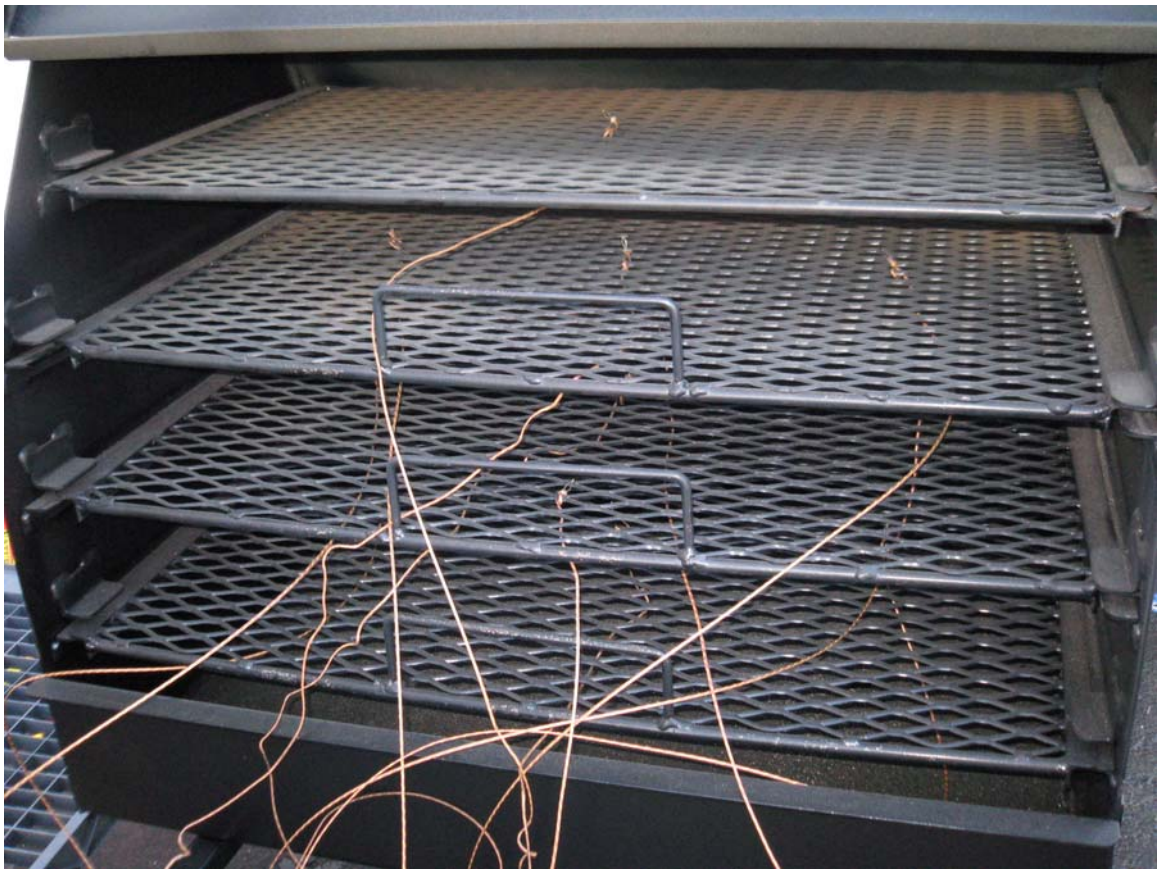

Figure 3. A view of a partial installation thermocouples. All wires are then ported out to the front bottom of the lid.

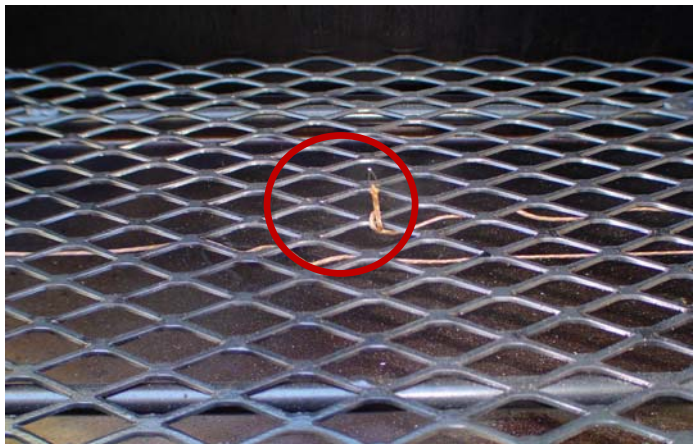

Figure 4. A close-up view of the center thermocouple (circled in red). Measurement is one inch above the grate.

3. Test Matrix

Several tests were performed over a period of two months. Table 1 identifies the tests that were run. Additional information regarding each test is provided in the table. This report will reference the test number in the matrix when describing testing.

Test number	Date	Type of test	Nominal smoking chamber temperature (F)	Nominal outdoor temperature (F)
1	May 24	Shakedown	250	70
2	June 1	Full Burn	250	85
3	June 7	Full burn	255	88
4	July 16	Full Burn	250	75

Table 1. Test matrix

4. Temperature Uniformity

Tests 2-4 were conducted to examine the uniformity and stability of the temperatures within the smoker. A 4-hour span from test #4 is shown in Figure 5.

- Temperature stability over a 4-hour period can easily be kept steady to within 7 degrees of the target temperature, with only a few minor adjustments to the damper valve.

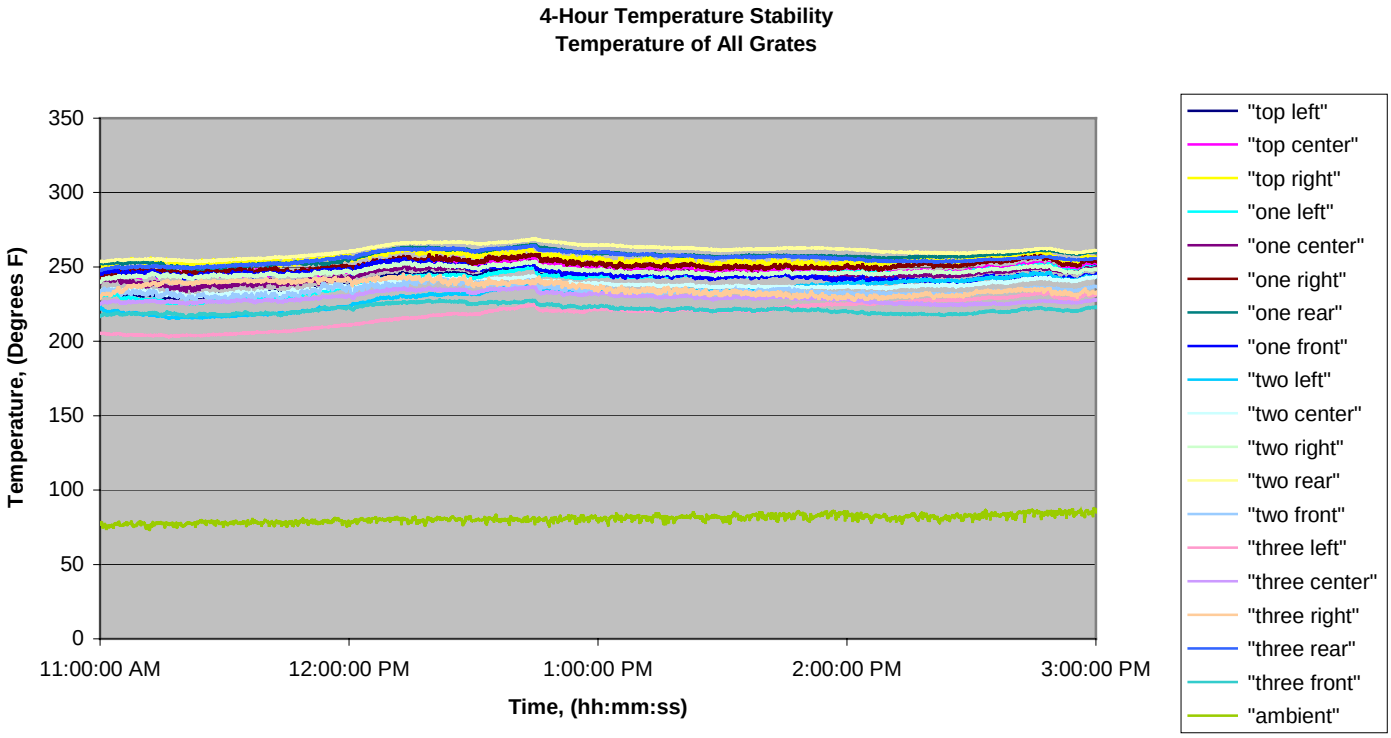

Figure 5. Four-hour stability, test #4.

- Over a 4- hour period, at a nominal temperature of 250 degrees, the following temperature variations were observed.
    - Vertical temperature differences can be expressed as follows:

Nominal temperature difference between grates	Degrees F
top and #1	2 to 4
#1 and #2	8 to 9
#2 and #3	6 to 8
#1 and #3	14 to 16

Table 2. Vertical temperature variations of each grate

These temperature differences are to be expected, as the hot air rises in the smoking chamber.

- The temperature differences when running the smoker with and without water were examined. In general, the stability of the temperatures over time did not significantly change. However, a slight variation in vertical temperature differences was noted. Generally, when water is not used, the temperature of

the lower grates is slightly lower than when water is used, thus marginally increasing the vertical temperature differences, as shown in the following table.

Nominal temperature difference between grates	With water	Without water
	(Degrees F)	(Degrees F)
top and #1	2 to 4	3 to 5
#1 and #2	8 to 9	10 to 12
#2 and #3	6 to 8	13 to 15
#1 and #3	14 to 16	22 to 25

Table 3. Vertical temperature variations, showing effect of water

Test #4 was used to illustrate lateral temperature differences along each grate (side to side, front to back). The results are shown in Table 4, as the difference in temperature from the temperature of the center of the grate. Temperature distributions plots for all four grates are shown in Figures 6-9.

- Lateral (left and right) temperature differences ranged between 6 and 12 degrees for all grates. In this example, the left side is lower in temperature than the right. This is simply a function of the location of the burning embers in the firebox. As the fire gradually consumes the charcoal in the firebox, the zone of lit coals moves throughout the firebox. Thus, depending on its location at any given time, a small lateral temperature difference will be obtained.

- In general, the upper grates were slightly more uniform than the lower.

- Front to back temperature differences were more significant. Differences ranges from 1 to 8 degrees for the front of each grate, to 13 to 27 degrees for the rear of each grate. In general, the rear of each grate is hotter than the remainder of the grate, due to its proximity to the firebox and damper valve.

	Top grate	**Grate #1**	**Grate #2**	**Grate #3**
Left	-4	-1	-4	-9
Right	+4	+5	+7	+3
Center	0	0	0	0
Front	N/A	-1	-3	-8
Rear	N/A	+13	+24	+27

Table 4. Temperature differences across each grate, relative to its center. (in degrees F)

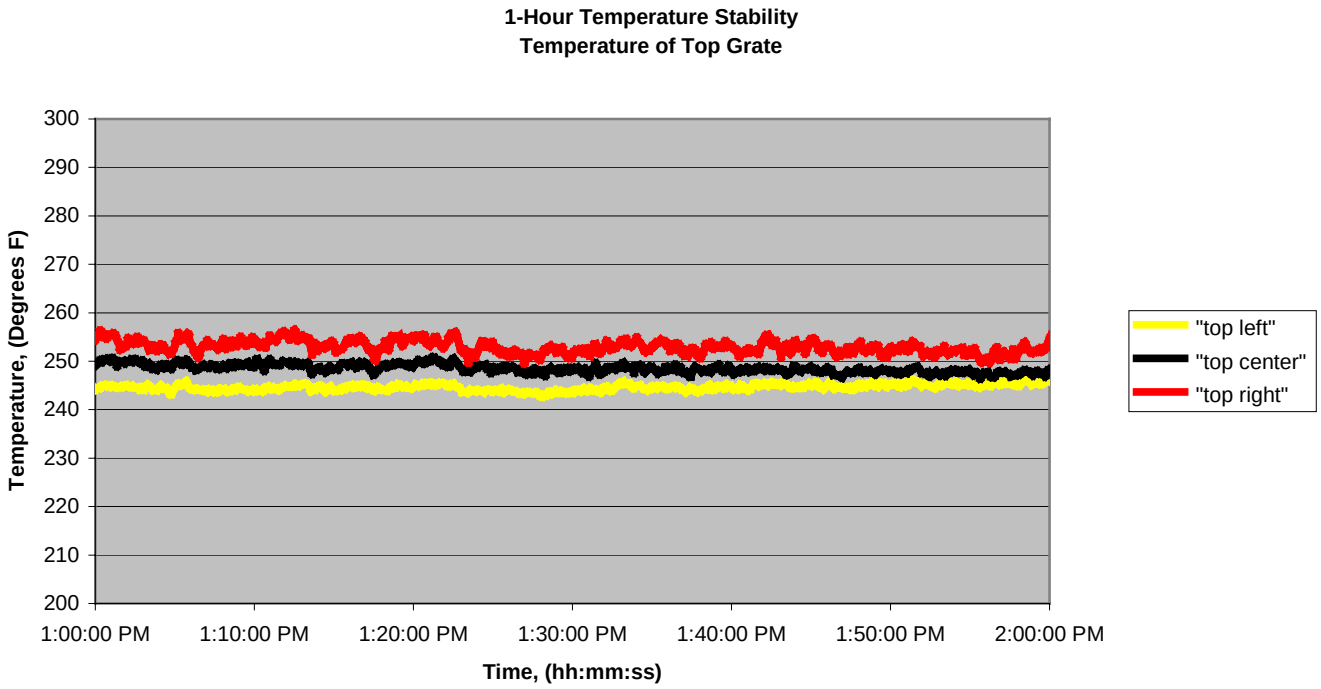

Figure 6. Temperature distribution across top grate.

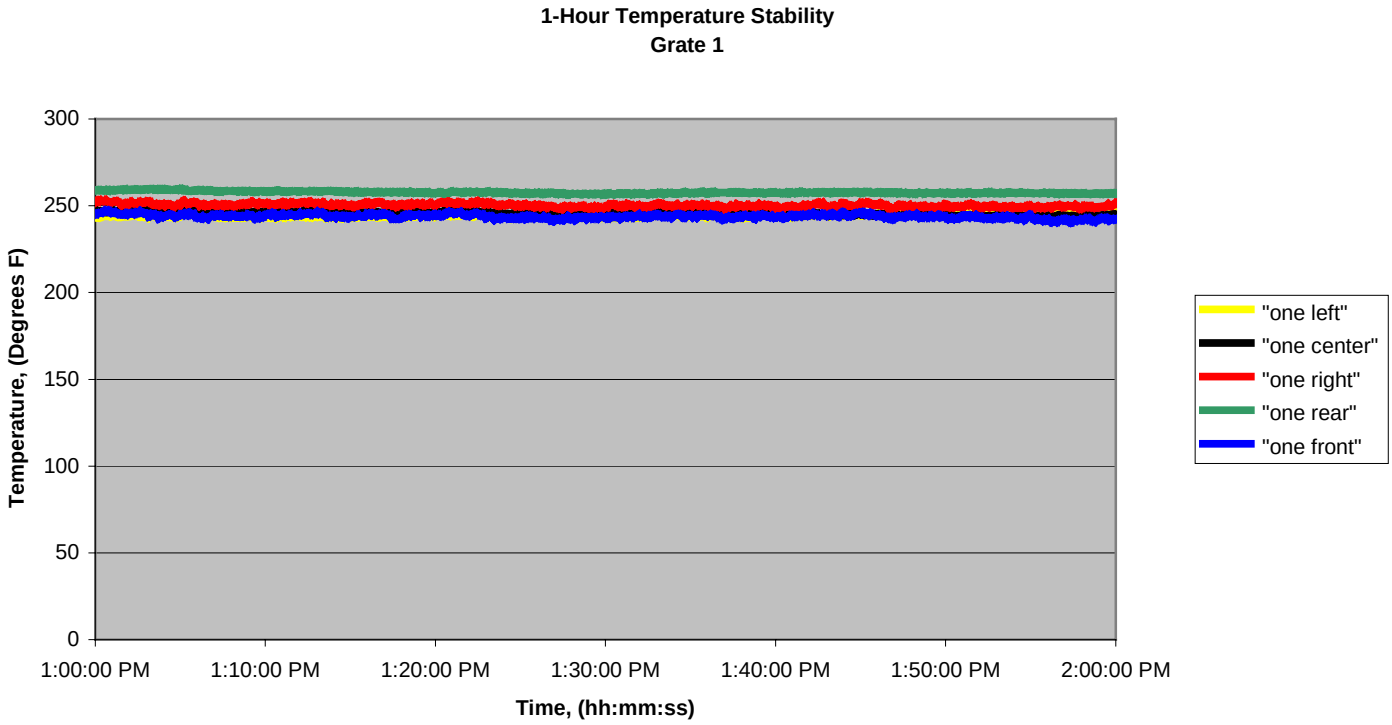

Figure 7. Temperature distribution across grate 1.

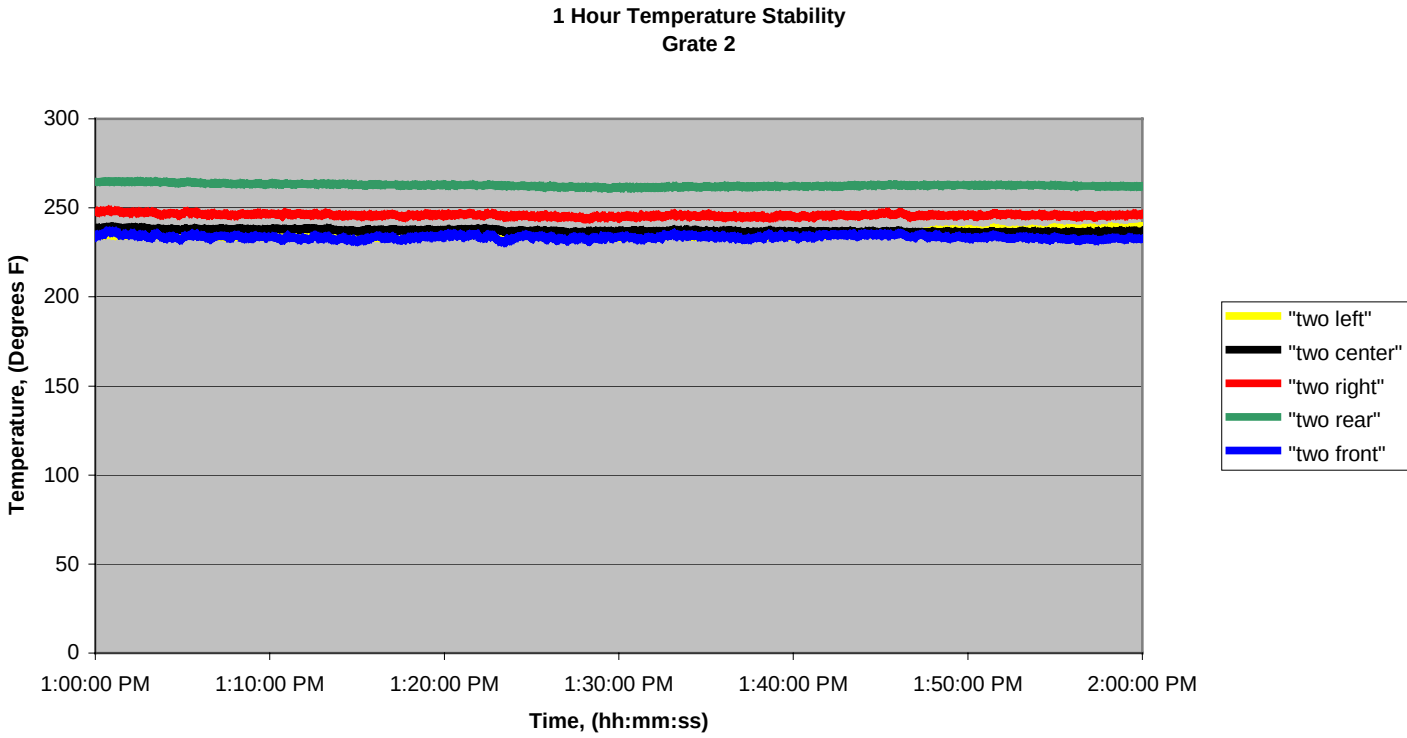

Figure 8. Temperature distribution across grate 2.

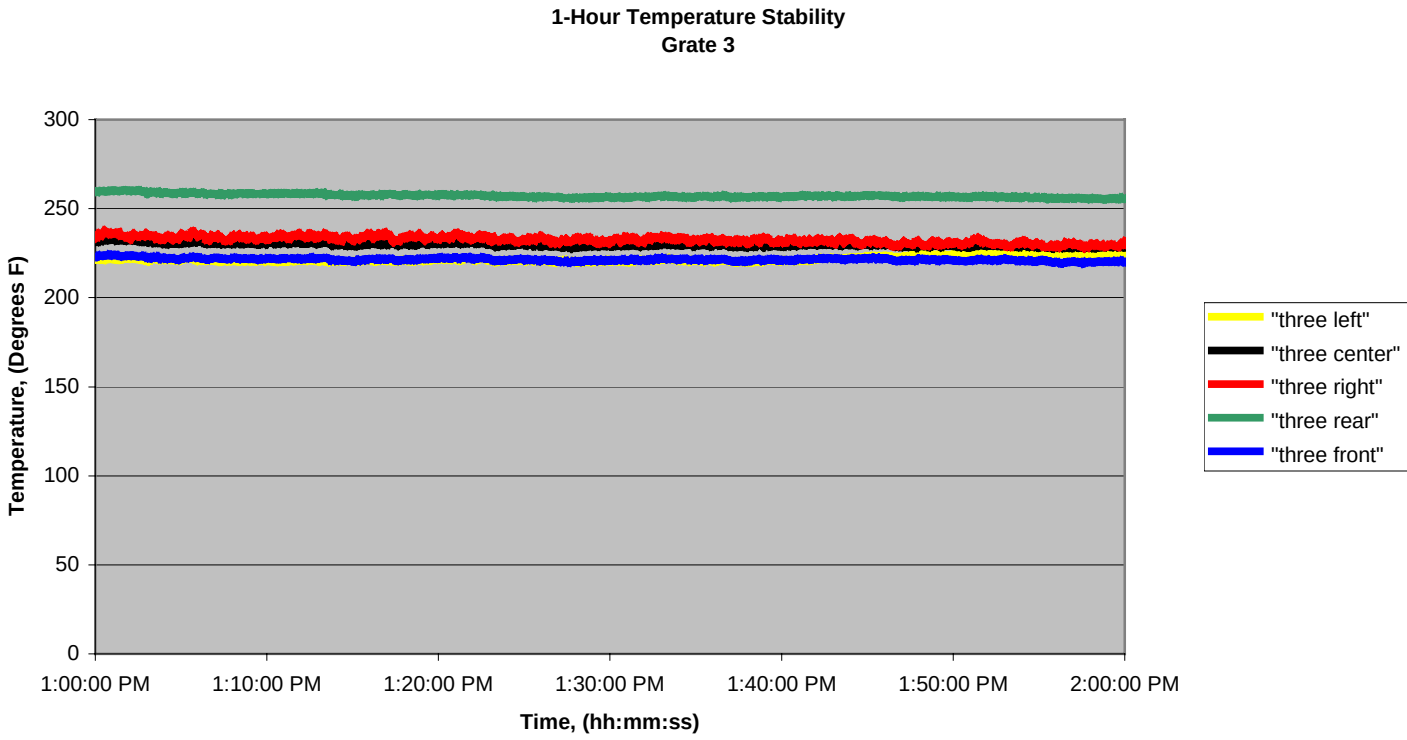

Figure 9. Temperature distribution across grate 3.

- Temperature stability over a 1-hour period for all grates has been demonstrated to within 2 degrees of the target temperature.

5. Temperature Response

Response of the smoking chamber temperatures to actions typically conducted during normal use was explored. The first type of action was achieved through manipulation of the damper valve. This is representative of an intentional action to raise or lower the smoking temperature, without making adjustments to the fire or firebox. The second type of action was achieved by opening the lid on the smoking chamber. This represents an undesired change that would occur when opening the lid to check the cooking progress of the food. The results of each are summarized below, and shown in Figure 10.

a. Response of damper adjustments

For a small temperature adjustment (approximately 10-20 degrees F) the following results were achieved.

- Small temperature adjustments, either to increase or decrease smoker temperature, were easily achieved with small adjustments of the damper valve. For example, a nominal temperature rise of 10 degrees is shown in Figure 10. In this example, the 10 degree rise was obtained in under 1 minute. For a nominal decrease in temperature of 20 degrees, a slightly longer response was observed, taking about 6 minutes to achieve the final temperature (also shown in Figure 10).

Larger temperature increases (40 degrees and higher) were achieved with larger damper adjustments, with temperature rises achieved within about 7 minutes.

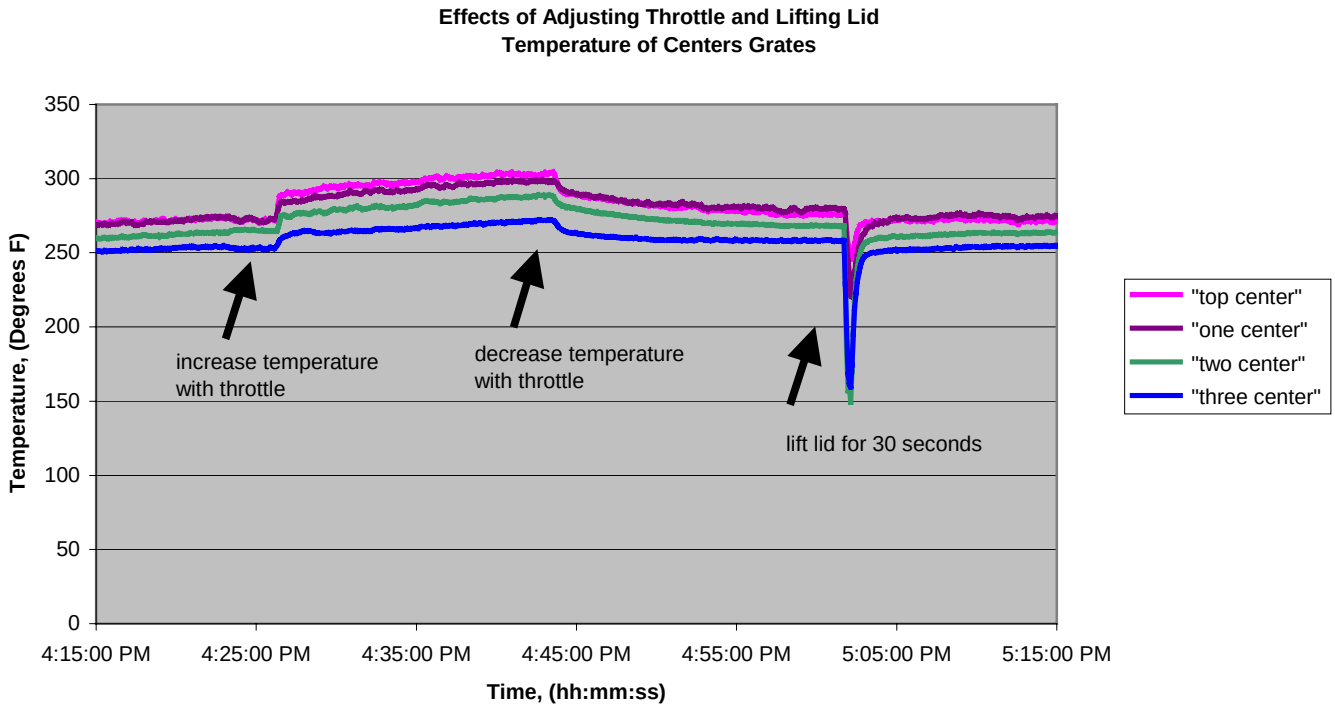

Figure 10. Temperature recovery during damper adjustments and opening of lid.

b. Recovery of temperatures when opening lid

- With the smoker at about 270 degrees F, the lid was opened fully for 30 seconds. The temperature dipped to around 150F, and recovered to within about 7 degrees of original in about 3 minutes (see Figure 10).

This temperature level is very stable, and a slight bump of the damper would easily restore the full temperature level.

6. Charcoal Burn Performance

Three tests (Tests number 2-4) were conducted in which a maximum burn time could be established. All three tests started with 30 pounds of lump charcoal started by one chimney load of lit coals. The maximum burn time was considered to be the time in which a stable cooking temperature was obtained in the smoking chamber. The lengths of time it took to start the fire and obtain stable temperatures, and the time it took to die down was excluded from the calculation of maximum burn time. Table 5 summarizes the maximum burn times achieved in each test.

The average burn rate of charcoal was calculated using the maximum burn time. Thus, while a fire may have burned for longer than the maximum (stable) time, burn rates were calculated on the maximum time indicated in Table 5. Thus, the burn rate is actually lower than that calculated, but that value is not practical for use in estimating the amount of charcoal necessary for a particular length cook.

Test	**Maximum burn time**	**Average burn rate of charcoal (pounds per hour)**
2	8 hours	Approximately 3.75 lbs/hr
3	9 hours	Approximately 3.3 lbs/hr
4	8 hours	Approximately 3.75 lbs/hr

Table 5. Maximum burn times.

The average maximum burn time for 30 pounds of lump charcoal was between 8 and 9 hours. The average burn rate of charcoal during the stable cooking time was about 3-1/2 lbs/hr.

7. Firebox temperatures

The temperature of the firebox was measured during Test 3. The temperature measurement was made at the center of the cooking grate in the firebox. On average, the temperatures were very high. With the cover closed, the temperatures ranged from 750 to 850 F. This is highly dependent on the amount of coals present at any given time, their proximity to the temperature probe, and the position of the damper valve. With the cover opened, the temperatures averaged 600 F. These temperatures are approximate, as they exhibit large

variation, especially when the cover is open. This is due to the additional effects of wind on the open grill surface.

8. Thermometer check

The standard dial thermometer provided with the smoker was calibrated against the temperatures of the center of grate #1, during several tests. It was found that, although the thermometer measures temperatures at the upper left side of the smoking chamber, it can be used to estimate the temperature of the center of grate #1. Results show the thermometer will read approximately 20 degrees higher than the center temperature of grate #1.

The accuracy of the dial type thermometer, and factors affecting its performance can be found in the previously released reports on the Marshal and Open Range models.

9. Summary

Several tests have been conducted to examine the performance of the Rodeo Model smoker. Tests examined the temperature stability of the smoker, the distributions of temperature throughout the smoking chamber, the ability of the smoker to change and recover temperature, temperatures of the firebox and grill, and the accuracy of the thermometer supplied with the unit.

The following results and conclusions from the test program can be identified.

- Lateral temperatures differences in the smoking chamber were very small, averaging between 6 and 12 degrees. This difference is sensitive to the lateral location of the burning embers in the firebox.
- Temperature stability with time indicates variations in temperature of about 2 degrees over 1 hour *without any adjustments being made,* and about 7 degrees over 4 hours, *with only small adjustments to the damper being made.*
- Small increases in smoking chamber temperatures (10 degrees for example) can be achieved within a minute, larger (40F or more) can be achieving within 3 minutes.
- Small decreases in smoking chamber temperatures (20 degrees for example) can be achieved within 3 minutes.
- Temperature recovery following opening the smoking chamber lid during a typical food check of 30 seconds can be achieved in 3 minutes. Temperatures recover to within approximately 7 degrees of original temperature. *A fine tune of the damper may be necessary to achieve complete recovery.*
- Maximum stable burn times for 30 pounds of charcoal are between 8 and 9 hours. This correlates to a charcoal burn rate of about 3-1/2 pounds per hour.
- Firebox temperatures at grate level ranged from 750-850 F when the lid is closed, and approximately 600 F when open.
- Front to rear temperature variations are larger than lateral variations due to the proximity to the heat source (firebox and damper valve). In general, temperatures at

the front of the grates are cooler than those at the rear. This difference ranges from 14 degrees for grate #1, to 35 degrees for grate #3.

- Vertical temperature differences were measured, with the top grate being the hottest. The top grate was 2-4 degrees hotter than grate #1, grate #2 was 8-9 degrees cooler than grate #1, and grate 3 was 14 to 16 degrees cooler than grate #1.
- The use of water in the bottom of the smoking chamber tends to reduce the vertical temperature variations, especially at the lower grates.
- The dial thermometer reads about 20 degrees hotter than the temperatures at grate #1.

10. Recommendations

Based on the results of this testing, the following recommendations can be made. These are essentially the same as those mentioned in the previous report for the Marshall model.

- To minimize vertical temperature variations, a reverse flow system should be explored. This would allow the exhaust from the smoke chamber to be pulled from the bottom, instead of venting out the top. Chimneys ported out the lower sides of the smoke chamber, with the top vents closed, is one configuration that should be explored.
- Because this model has achieved burn times of 9 hours with one 30 pound load of charcoal, the addition of a temperature controlled damper could make the enable the user to leave it unattended for up to nine hours.
- Additional thermometers should be installed slightly below each grate. Long stem thermometers should be used. The dials should be enclosed on the outside of the smoker, to shield from the outside air. This will give a good indication of the temperatures at each grate in the smoking chamber.
- Due to its large lateral span, this smoker would benefit from having one additional thermometer, located opposite the present thermometer location, but at the same height. This would indicate if the fire was burning unevenly.
- Increased fuel burn times, and reduced charcoal use can be achieved if the firebox were insulated. There are many ways to do this, either with a double wall or by using high temperature insulation under a thin sheet metal jacket.
- The smoke chamber should be fitted with additional shelving slots in between the four already in place. It seems that a 7-10 pound pork butt never really fits well between the shelves (too tall), and an additional ½ space of vertical clearance would be welcomed when necessary.
- The firebox, when used for direct grilling, should have the ability to raise and lower the grates, with additional brackets welded inside the firebox.
- The firebox grate should be stainless steel. Temperatures are so high in the firebox that there is no real way to season the plain steel grate that is supplied, and so it rusts very quickly and easily. This makes preparation for grilling time consuming.