LNG Research Study

Gas Range

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Results Summary

Results obtained from all tests conducted with oven door closed revealed that:

- There were no operational, ignition, safety, flame stability, flame lifting, flashback or yellow tipping problems.
- The temperature of the surface above pilot peaked at 866˚F with Gas 3 during the 12% Overfired Tests - Tuned w/ Base Gas.
- Tuning the unit with Gas 8 did not create any significant safety, emissions, performance or operational problems.
- Most of the emissions and temperatures monitored during the test were more stable when the unit was tuned with Gas 8.
- Highest CO emissions (787 ppm) were generated with Gas 3 during the decrease inlet pressure test.

All emissions reported during the two tests with the oven door open are uncorrected because the high percentage of O_2 in the sample.

Results obtained from oven door open tests revealed that:

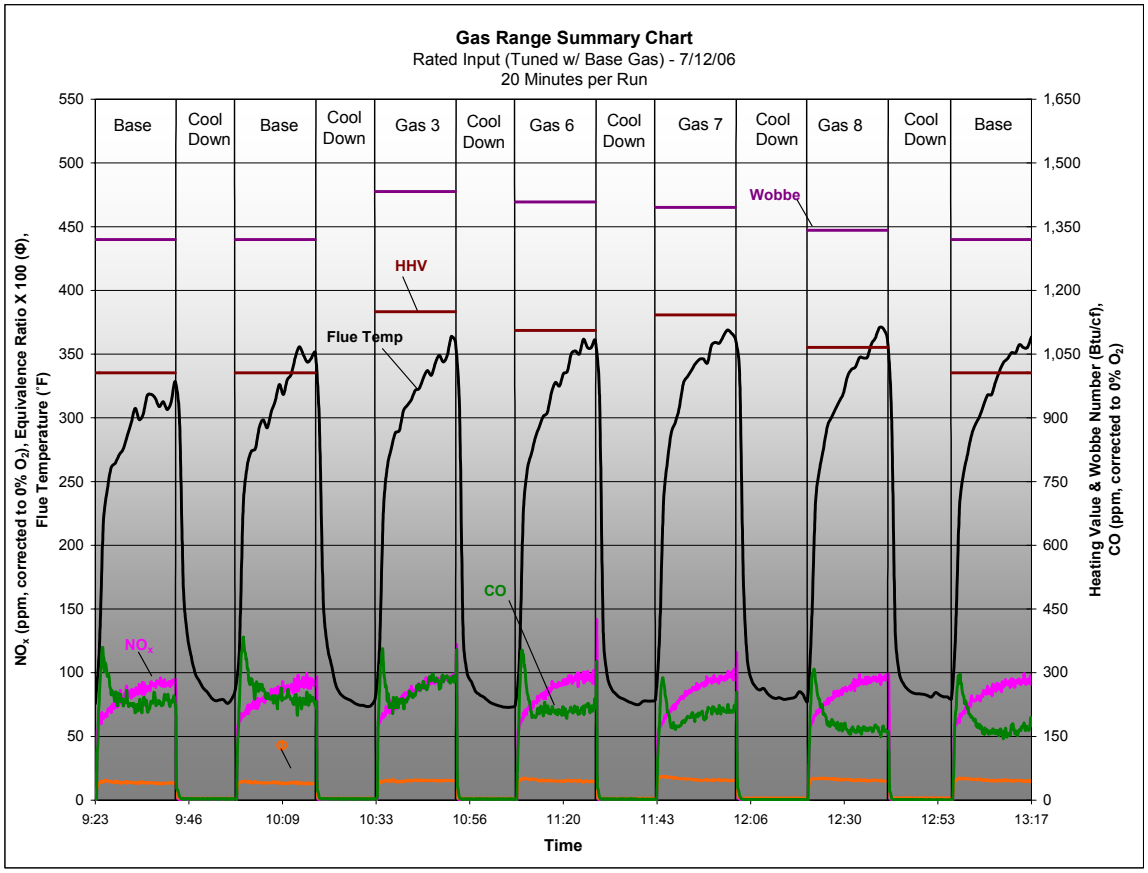
- Top Burners Hood — average CO emissions were lowest with Gas 3 at 7 ppm and highest with Base Gas at 9 ppm. Average NO_X emission were lowest with Base Gas at 13 ppm and highest with Gas 3 at 15 ppm. The NO_2 emission were not more than 10% of total NO_X in any of the NO_X measurements.
- Oven Hood — CO emissions were highest with Base Gas, averaging 27 ppm (first run), 20 ppm (second run) and 21 ppm (third run). Gas 7 and Gas 3 generated lower emissions (17 ppm and 18 ppm). Average NO_X emissions were lowest with Base Gas (second run) at 1 ppm and highest with Gas 3 at 3 ppm.

Results obtained during the Hand Held Emissions test with the oven door open revealed that:

- The emissions concentrations typically decreased as the probe was moved away from the appliance
- The highest CO emissions were 35 ppm with Base Gas (Middle at 6 in.). The highest NO_X emissions were 4 ppm and it occurred with all the test gases — Base Gas (Left at 6 in.), Gas 7 (Middle at 6 and 12 in.), and Gas 3 (Right 12 in.).
- The NO_2 emissions were not more than 50% of total NO_X in any of the NO_X measurements

Rated Input Test (Tuned w/ Base Gas)

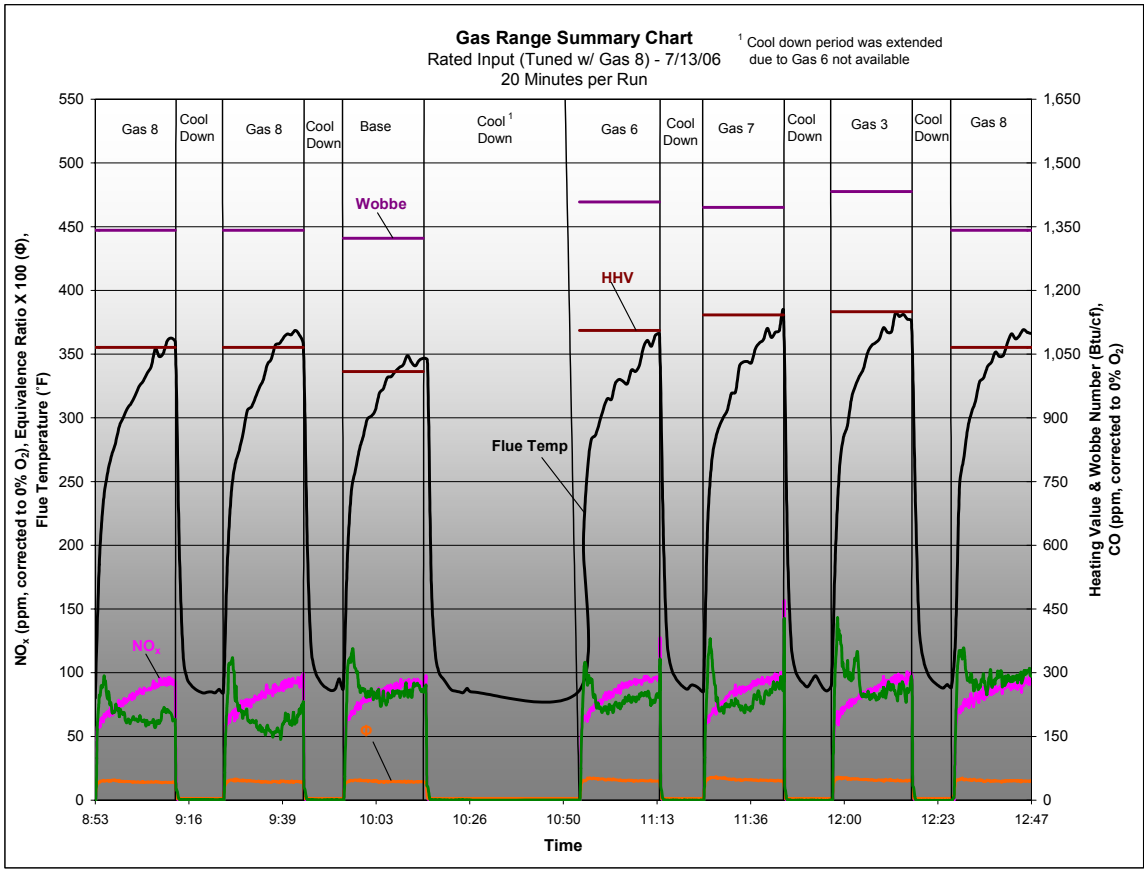
Average NO_X emissions increased from 83 ppm (Base Gas- second run) to 86 ppm (Gas 6) and CO emissions increased from 182 ppm (Base Gas-final run) to 263 ppm (Gas 3). CO emissions for Gas 3 and Gas 7 increased with respect to time, which is opposite to how CO reacted with the other test gases. Flue temperatures increased slightly with the richer gases.



NOTE: Emission test results are for information purposes, they were not the result of certified tests.

Rated Input Test (Tuned w/ Gas 8)

When tuned with Gas 8 the average NO_X emissions were slightly lower than when tuned with Base Gas. Average NO_X emissions were lowest with Gas 8 (81 ppm) and highest with Gas 7 (85 ppm). Average CO emissions were the lowest during the second run with Gas 8 (198 ppm) and were highest during the last run with Gas 8 (285 ppm). Flue temperatures increased slightly with the richer gases.

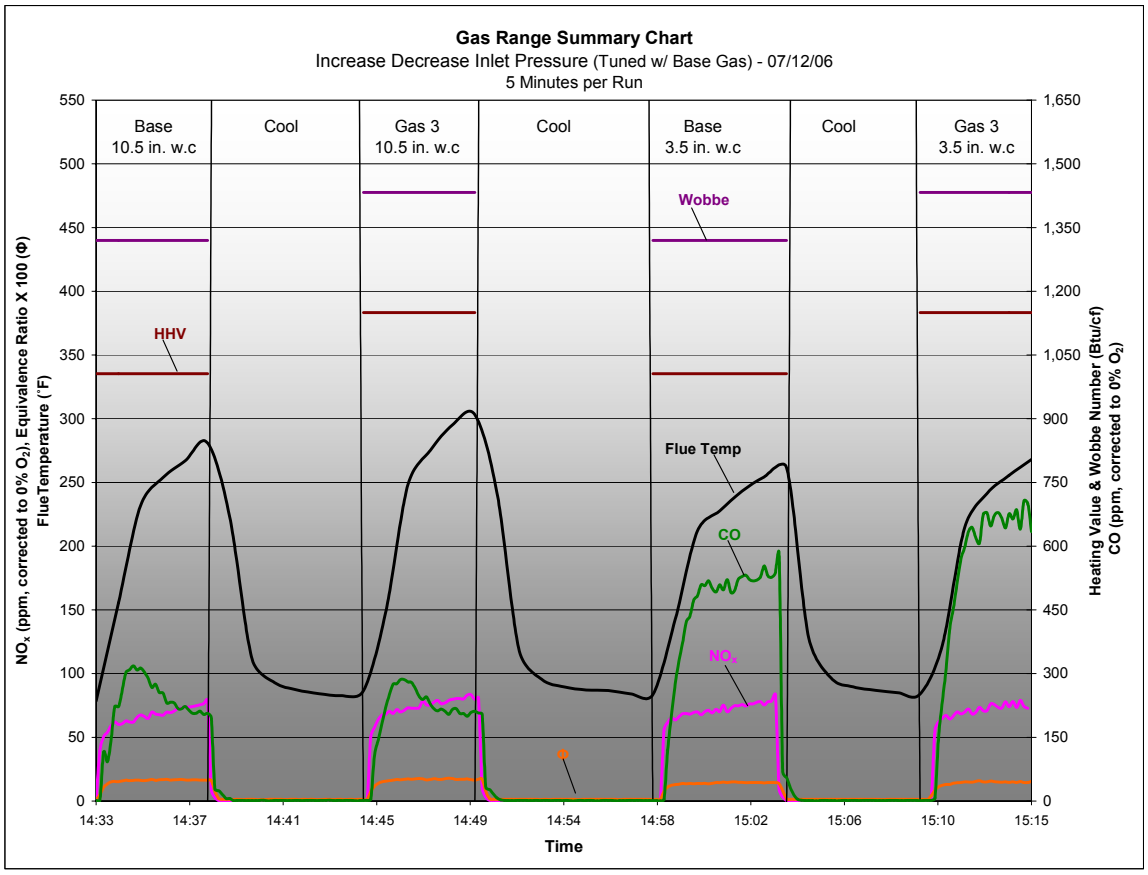


NOTE: Emission test results are for information purposes, they were not the result of certified tests.

Increased Decrease Inlet Pressure Tests - (Tuned w/ Base Gas)

With a reduced inlet pressure, average CO emissions substantially increased compared to an increased inlet pressure. Average CO emissions increased from 498 ppm (Base Gas) to 627 ppm (Gas 3). Average flue temperature was lowest with Gas 3 (198˚F).

With an increased inlet pressure, average CO emissions decreased from 250 ppm (Base Gas) to 236 (Gas 3). Average NO_X emissions were highest with Gas 3 (75 ppm) and lowest with Base Gas (68 ppm). Average flue temperatures increased with an increased inlet pressure; Gas 3 was highest at 226˚F.

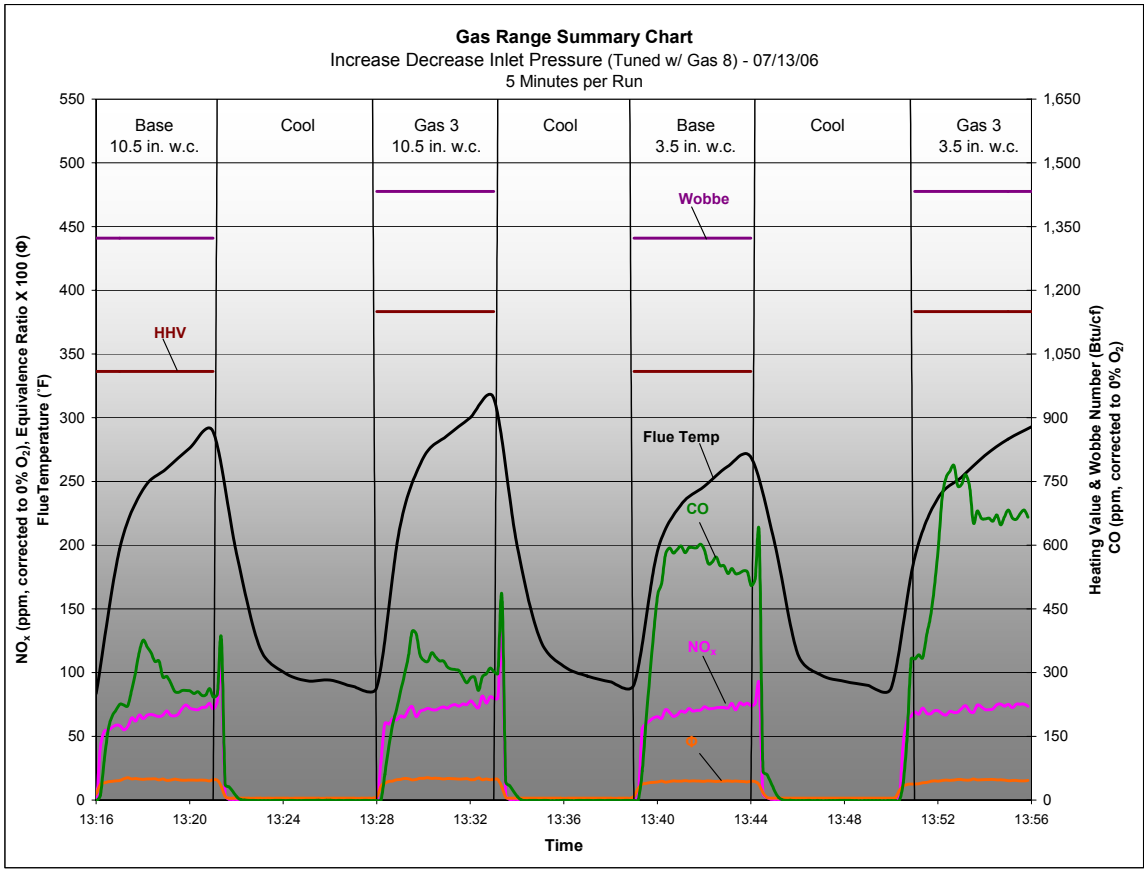


NOTE: Emission test results are for information purposes, they were not the result of certified tests.

Increased Decrease Inlet Pressure Tests - (Tuned w/ Gas 8)

With a reduced inlet pressure, average CO emissions substantially increased compared to the emission at increased inlet pressure. Average CO emissions increased from 556 ppm (Base Gas) to 685 ppm (Gas 3), and reached a peak of 787 ppm. NO_X emissions at a reduced inlet pressure averaged 71 ppm (Base Gas) and 72 ppm (Gas 3).

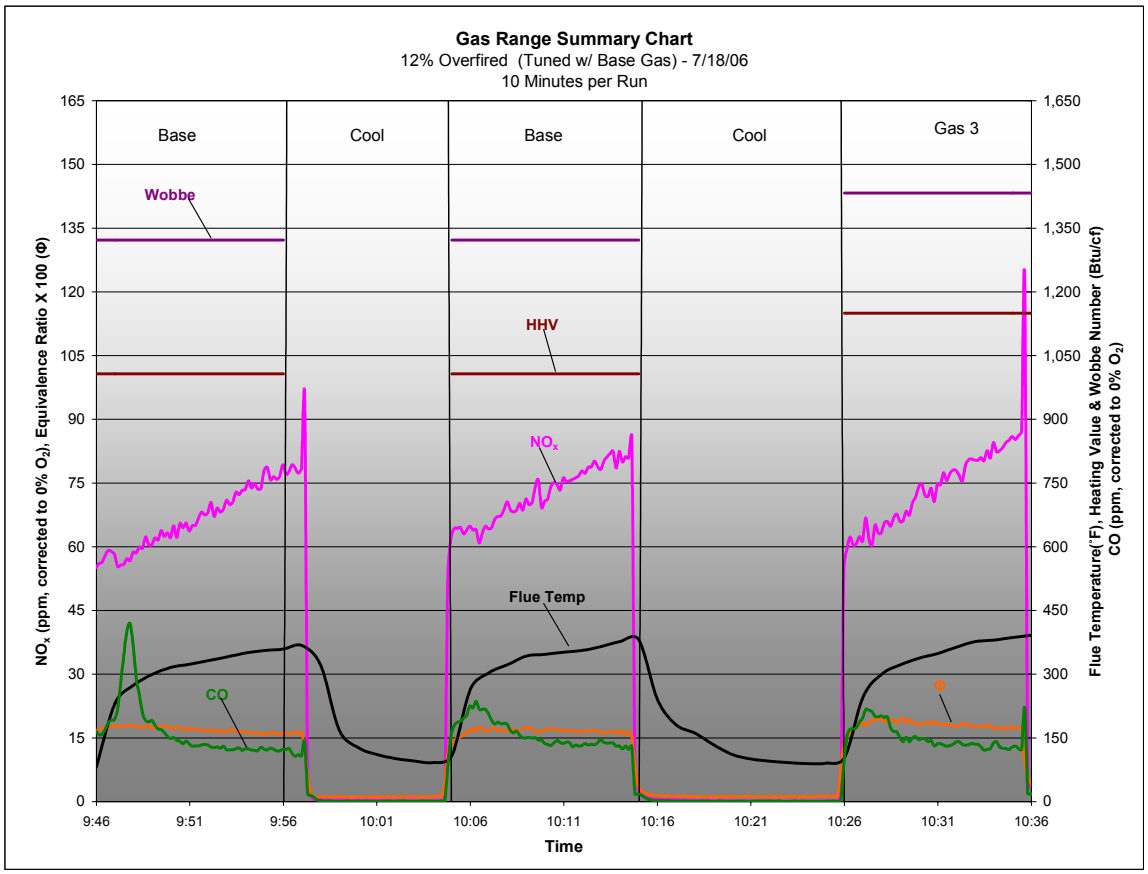
With an increased inlet pressure, average CO values increased from 277 ppm (Base Gas) to 310 (Gas 3). Average NO_X emissions decreased from 72 ppm (Gas 3) to 67 ppm (Base Gas). Flue temperature increased with an increased inlet pressure, with a maximum temperature of 277˚F with Gas 3.



NOTE: Emission test results are for information purposes, they were not the result of certified tests.

12% Overfired Tests - (Tuned w/ Base Gas)

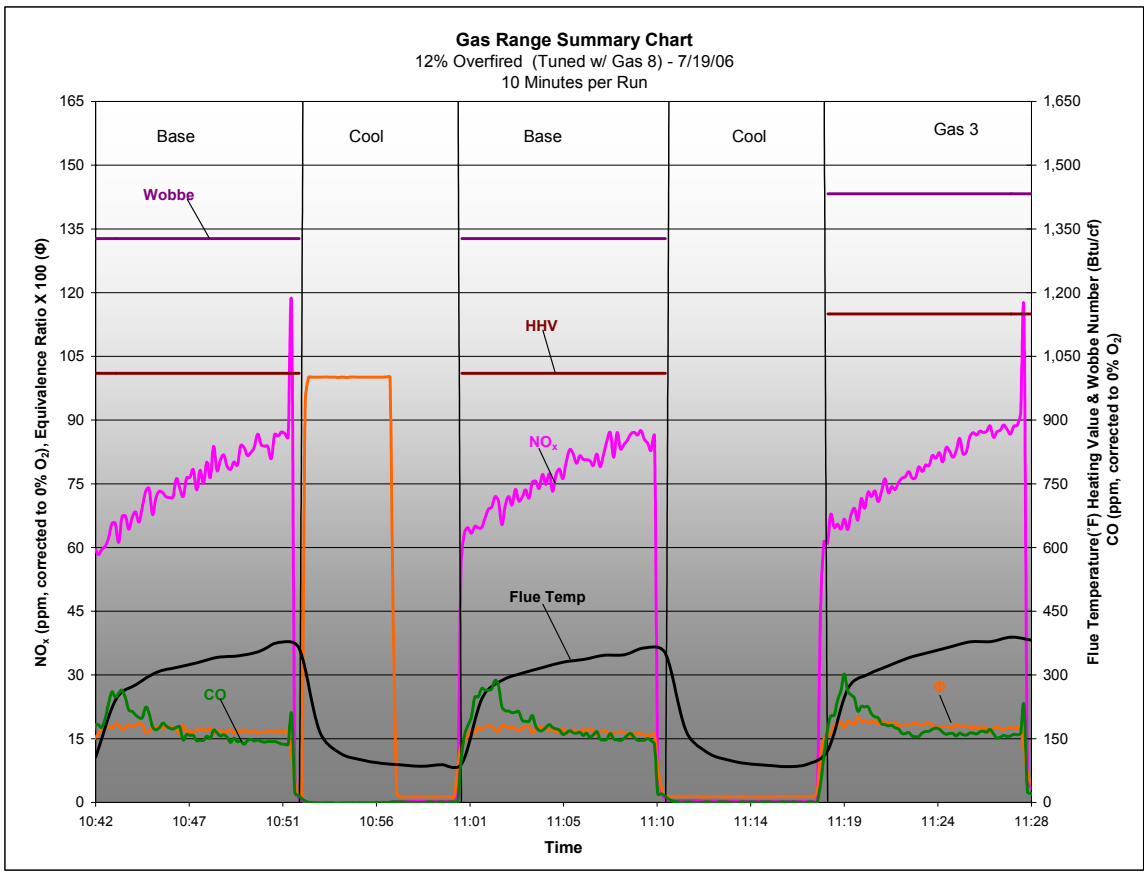
Average NO_X emissions were highest with Gas 3 (71 ppm). CO emissions decreased from 152 ppm (Base Gas) to 145 ppm (Gas 3). Average flue temperature was at its highest with Gas 3 (356 °F).



NOTE: Emission test results are for information purposes, they were not the result of certified tests.

12% Overfired Tests - (Tuned w/ Gas 8)

Average CO and NO_X emissions were highest with Gas 3, with average values of 175 ppm and 76 ppm, respectively. Maximum average flue temperature was 357°F with Gas 3, which is very similar to the flue temperature recorded during the 12% Overfired Test – (Tuned with Base Gas).



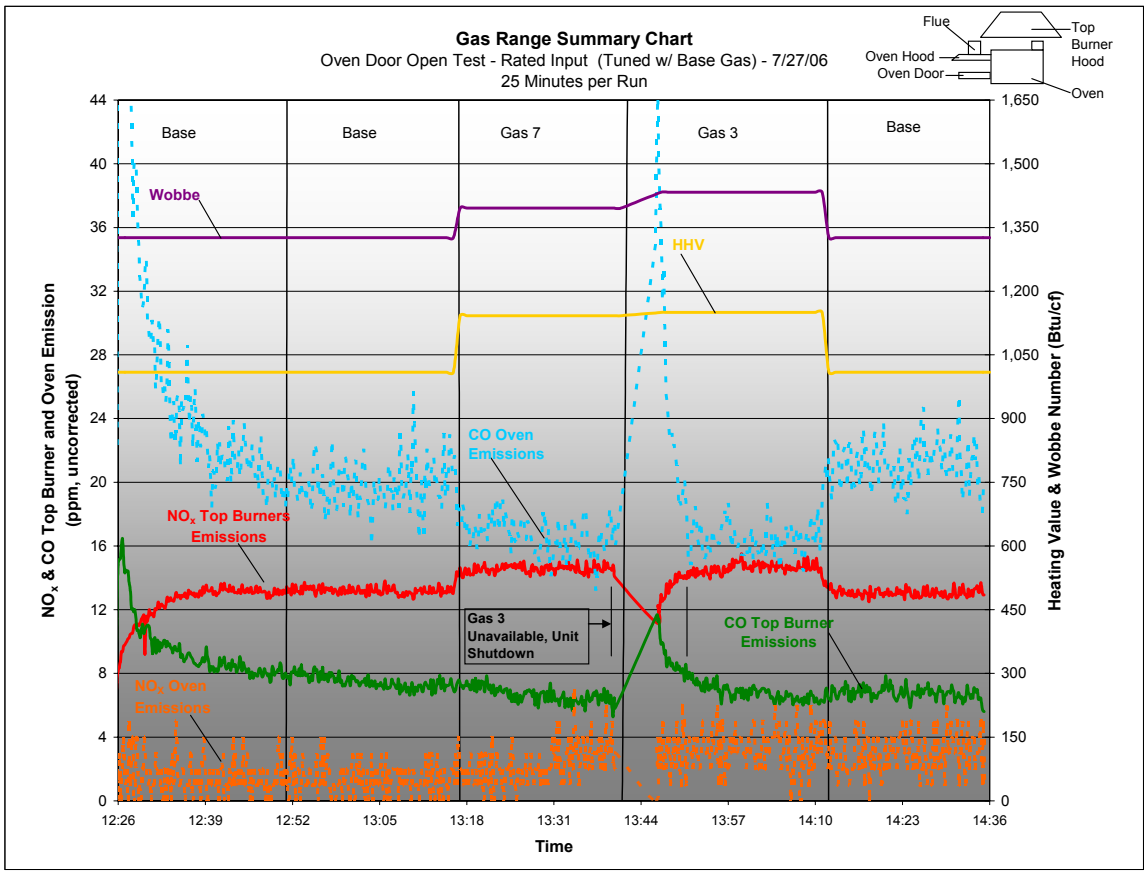
NOTE: Emission test results are for information purposes, they were not the result of certified tests.

Oven Door Open Tests – Rated Input (Tuned w/ Base Gas)

All emissions reported during the oven door open tests are uncorrected because of the high percentage of O_2 in the sample.

Top Burners Hood — average CO emissions were lowest with Gas 3 at 7 ppm and highest with Base Gas at 9 ppm. Average NO_X emission were lowest with Base Gas at 13 ppm and highest with Gas 3 at 15 ppm. The NO_2 emission were not more than 10% of total NO_X in any of the NO_X measurements.

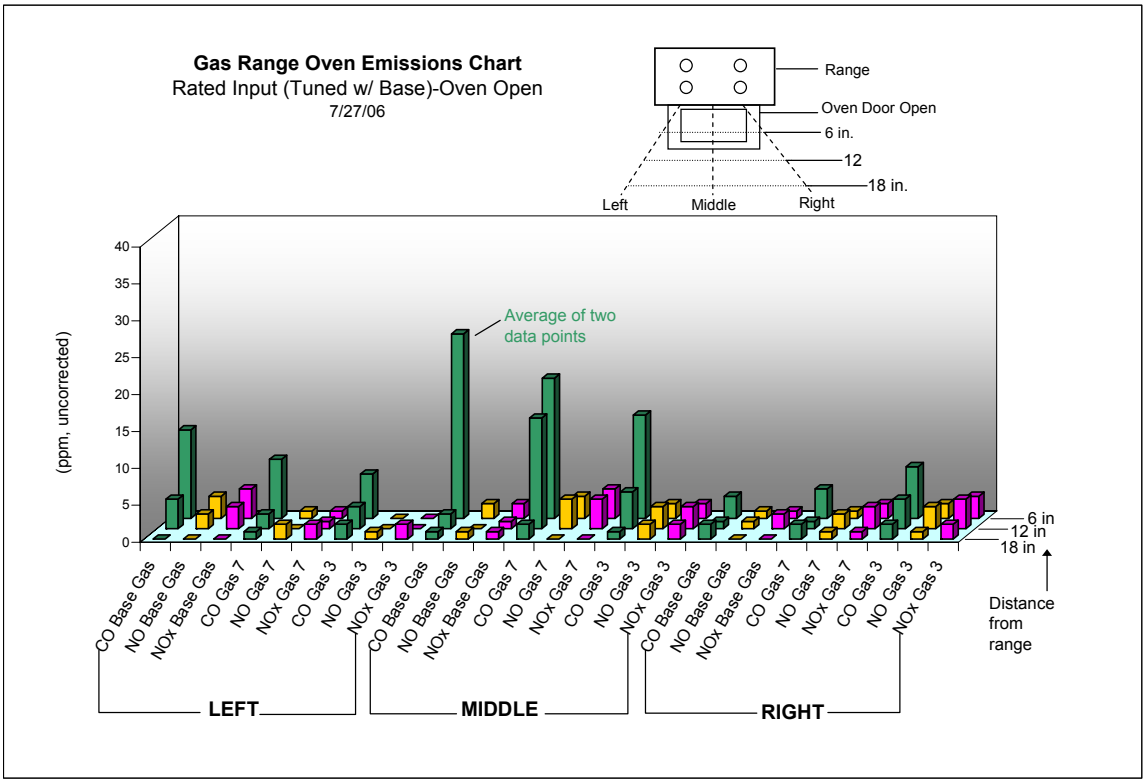
Oven Hood — CO emissions were highest with Base Gas, averaging 27 ppm (first run), 20 ppm (second run) and 21 ppm (third run). Gas 7 and Gas 3 generated lower emissions (17 ppm and 18 ppm). Average NO_X emissions from the oven hood were highest at 3 ppm with Gas 3 and the final Base Gas run.



NOTE: Emission test results are for information purposes, they were not the result of certified tests.

Hand held emissions Test with Oven Door Open – Rated Input (Tuned w/ Base Gas)

In general, as the distance from the range increased, all emission concentrations decreased. The highest CO emissions were 35 ppm with Base Gas (Middle at 6 in.). The highest NO_X emissions were 4 ppm and it occurred with all the gases — with Base Gas (Left at 6 in.), Gas 7 (Middle at 6 and 12 in.), and Gas 3 (Right 12 in.). The NO_2 were not more than 50% of total NO_X in any of the NO_X measurements. Emissions values reported are uncorrected



NOTE: Emission test results are for information purposes, they were not the result of certified tests.

Equipment Selection Criteria

This type of residential freestanding range, with a standing pilot, was selected to investigate concerns by industry experts related to indoor air pollution. Since these units are not directly vented outside the house, the industry experts were concerned about generating higher CO, NO, and NOx emissions when operating on richer gases. In addition, this unit was selected because: (a) there are a large number of pilot operated units in the field and (b) this particular unit uses an uncommon automatic shut off system for the oven that is incorporated with the thermostat.

Equipment Specification

Description	Residential Gas Range
Burners	Top Burners: Four atmospheric 2"ϕ burners Oven Burner: One ribbon burner
Input Rate	Total: 54,400 Btu/hr Top Burners: Four at 9,100 btu/hr Oven Burner: One at 18,000 btu/hr
Type of fuel	Natural Gas
Required gas supply pressure	4.5 – 10.5 in. w.c.

Standards

A detailed description of the protocol used to develop the test procedures is included in appendix A. The test protocol was developed based on the following test standards:

ANSI Z21.1-2000 **ANSI Z21.1a-2003**	Household Cooking Gas Appliances Addenda
SCAQMD **Method 100.1**	Instrumental analyzer procedure for continuous gaseous emissions

Installation

Instrumentation was installed following the cited test standards and input from industry experts. The gas range was installed in an area within a test laboratory. Thermocouples were installed to measure ambient, gas, flue, oven, average internal oven surface, surface above pilot, broiler, and average knobs temperatures. Pressure transducers were installed to measure manifold and gas delivery system pressures. A gas meter was used to measure the gas flow and an emissions probe was built and placed in the flue vents of the installed hoods.

Test Gases

The following gases have been specifically formulated to cover the range of gas compositions and calorific values of natural gases that could be delivered in the Southern California Gas Company territory by current natural gas suppliers and future LNG suppliers. Composition details are specified in Appendix C.

Gas	**Wobbe Number** (Btu/cf)	**Heating Value** (Btu/cf)
Base	1,322 (Low Wobbe)	1,008 (Low heat content)
3	1,433 (Highest Wobbe)	1,150 (Highest heat content)
6	1,408 (High Wobbe)	1,106 (High heat content)
7	1,395 (High Wobbe)	1,142 (Highest heat content)
8	1,342 (Medium Wobbe)	1,066 (Medium heat content)

Test Procedure

Base on the above standard, the test procedures were developed. However, due to time limitations and variations between the cited test standards, with input from consultants and information obtained from previous studies, test procedures were simplified.

A brick and metal flange were placed inside the oven and an additional brick was place in the broiler, to simulate a load.

Before every test the following steps were performed:

- All emissions analyzers were calibrated and checked for linearity.
- Data logger was enabled to verify temperature, pressure and gas flow readings.
- Before each test, four (4) flat-bottom test utensils, containing 5 pounds of water, were place on each of the top burners. Per protocol, two of these utensils were placed over a cast iron griddle.
- Emissions hood was lower to a pre-determined height of 2 inch from top of range to underside of hood.

- The oven surface temperature was cooled to a pre-determined temperature of 100˚F in between runs, to establish a baseline start period.
- All top burners were set to high and broiler was turned ON.

After every test the following steps were performed:

- Test data was downloaded.
- Linearity and drift inspections were performed on all emissions analyzers.

Rated Input Test (Tuned w/ Base Gas)

Using Base Gas, the manifold pressure and supply were adjusted to operate at the rated input. Once readings stabilized, data was collected and the test gases were ran in the following order:

Base Gas for 20 minutes.

Base Gas for 20 minutes.

Gas 3 for 20 minutes.

Gas 6 for 20 minutes.

Gas 7 for 20 minutes.

Gas 8 for 20 minutes.

Conclude testing with Base Gas for 20 minutes.

Reduced & Increased Inlet Pressure Test (Tuned w/ Base Gas)

For the reduced and increased Inlet Pressure Tests, the supply pressure was adjusted to 3.5” w.c. and 10.5” w.c., respectively. Once readings stabilized, data was collected and the test gases were ran in the following order:

Base Gas for 5 minutes.

Gas 3 for 5 minutes.

Adjustment to Increased Inlet Pressure settings

Base Gas for 5 minutes.

Gas 3 for 5 minutes.

Rated Input Test (Tuned w/ Gas 8)

Using Gas 8, the manifold pressure was adjusted to operate at the rated input. Once readings stabilized, data was collected and the test gases were ran in the following order:

Gas 8 for 20 minutes.

Gas 8 for 20 minutes.

Base Gas for 20 minutes.

Gas 6 for 20 minutes.

Gas 7 for 20 minutes.

Gas 3 for 20 minutes.

Conclude testing with Gas 8 for 20 minutes.

Reduced & Increased Inlet Pressure Test (Tuned w/ Gas 8)

For the reduced and increased Inlet Pressure Tests, the supply pressure was adjusted to 3.5" w.c. and 10.5" w.c., respectively. Once readings stabilized, data was collected and the test gases were ran in the following order:

Base Gas for 5 minutes.

Gas 3 for 5 minutes.

Adjustment to Increased Inlet Pressure settings

Base Gas for 5 minutes.

Gas 3 for 5 minutes.

12% Over-Fired Input (Tuned w/ Base Gas)

Using Base gas, the manifold pressure was adjusted to operate at 12% over rated input. Once readings stabilized, data was collected and the test gases were ran in the following order:

Base Gas for 10 minutes.

Base Gas for 10 minutes.

Gas 3 for 10 minutes.

12% Over-Fired Input (Tuned w/ Gas 8)

Using Base gas, the manifold pressure was adjusted to operate at 12% over rated input. Once readings stabilized, data was collected and the test gases were ran in the following order:

Base Gas for 10 minutes.

Base Gas for 10 minutes.

Gas 3 for 10 minutes.

Oven door Open Test - Rated Input (Tuned w/ Base Gas)

Using Base Gas, the manifold pressure and supply were adjusted to operate at the rated input. Four top burners were operated with no flat-bottom utensils. Before start of test, oven door was opened. Once readings stabilized, data was collected and the test gases were ran in the following order:

Base Gas for 25 minutes.

Base Gas for 25 minutes.

Gas 7 for 25 minutes.

Gas 3 for 25 minutes.

Conclude testing with Base Gas for 25 minutes.

Oven door Open Test (Hand held spot check) - Rated Input (Tuned w/ Base Gas)

Using Base Gas, the manifold and supply pressures were adjusted to operate at the rated input. Four top burners were operated with no flat-bottom utensils. Before start of test, oven door was opened. During this test, with a hand held probe, emissions values were measured at 6, 12, and 18 inches from front of oven, at three positions (left, center, right), for a total of nine readings per gas. Once readings stabilize, data was collected and the test gases were ran in the following order:

Base Gas, nine readings (left, middle, right @ 6, 12, 18 inches for each)

Gas 7, nine readings (left, middle, right @ 6, 12, 18 inches for each)

Gas 3, nine readings (left, middle, right @ 6, 12, 18 inches for each)

Cold Ignition Test

With the unit tuned with each setup gas. At ambient temperature, three ignition tests will be conducted following the protocol detailed in §7.1 & §7.2 of Appendix A.

Hot Ignition Test

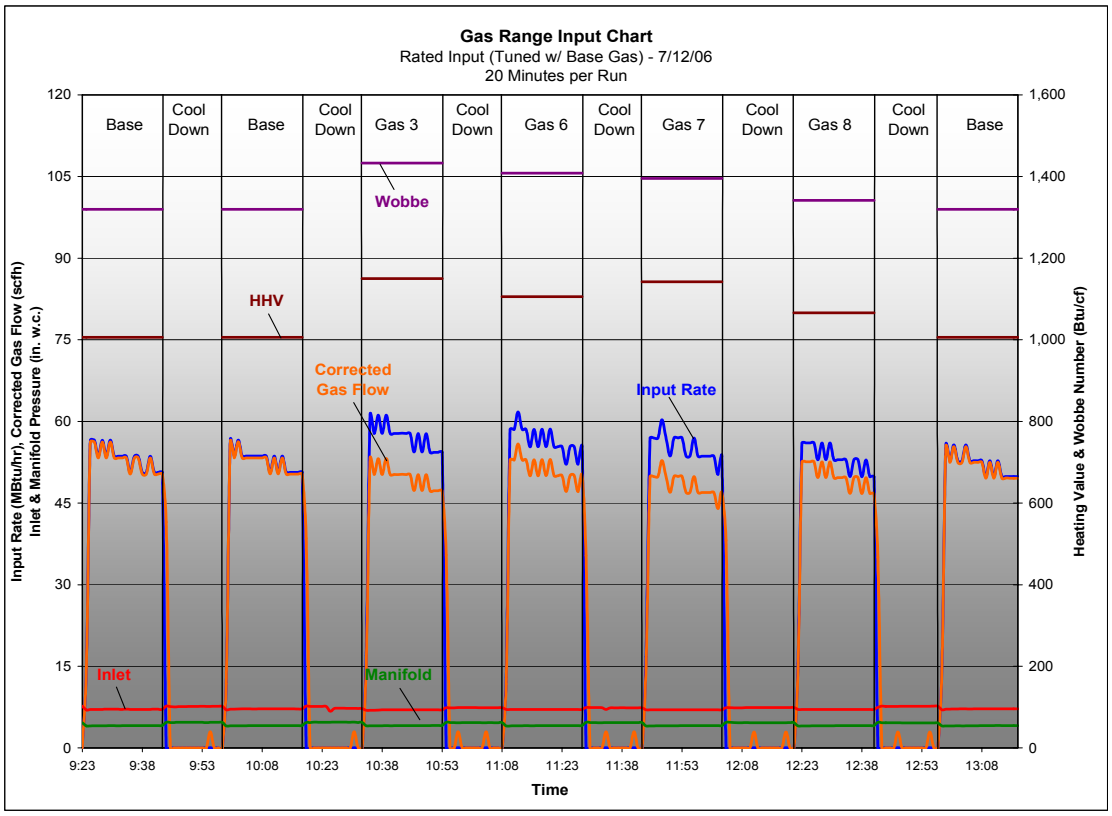
With the unit tuned with each setup gas. After steady-state operating conditions are achieved, three ignition tests will be conducted following the protocol detailed in §7.3 & §7.4 of Appendix A.

Results[1,2,3]

Rated Input Test (Tuned w/ Base Gas)

Input

The average minimum and maximum input rates were 51,975 Btu/hr (Base Gas – last run) and 57,008 Btu/hr (Gas 3). The corrected gas flow ranged from 48 scfh (Gas 7) to 52 scfh (Base Gas - second run). Inlet and manifold pressures remained stable throughout the course of the test.



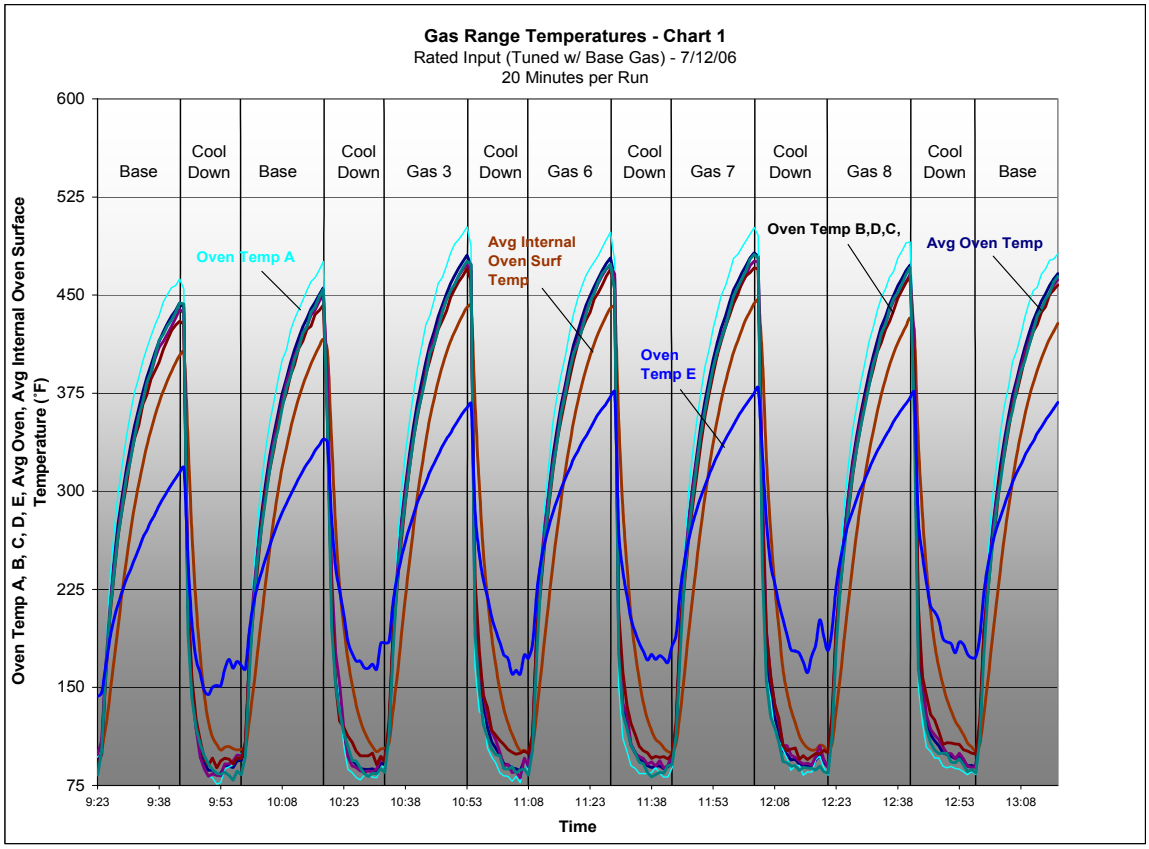
[1] All emissions, temperature and input values mentioned throughout the results section are average values.

[2] Emissions values are corrected to 0% O_2.

[3] When either Base Gas or Gas 8 is used as the set-up gas, the values reported for the set-up gas are the average values of all runs for that gas during each test.

Temperatures (Chart 1)

Results reveal that average oven temperature ranged from 353°F (Base gas - first run) to 388°F (Gas 7). Average internal oven surface temperature was highest with Gas 7 and Gas 3 both at 328°F and lowest with Base Gas (first run) at 297°F. Oven temperature E was low due to the thermocouple being directly between a brick and a metal flange, which were utilized for load simulation purposes. Oven temperatures A through D varied uniformly, as a group, depending on the test gas — the richer gases generated higher temperatures.

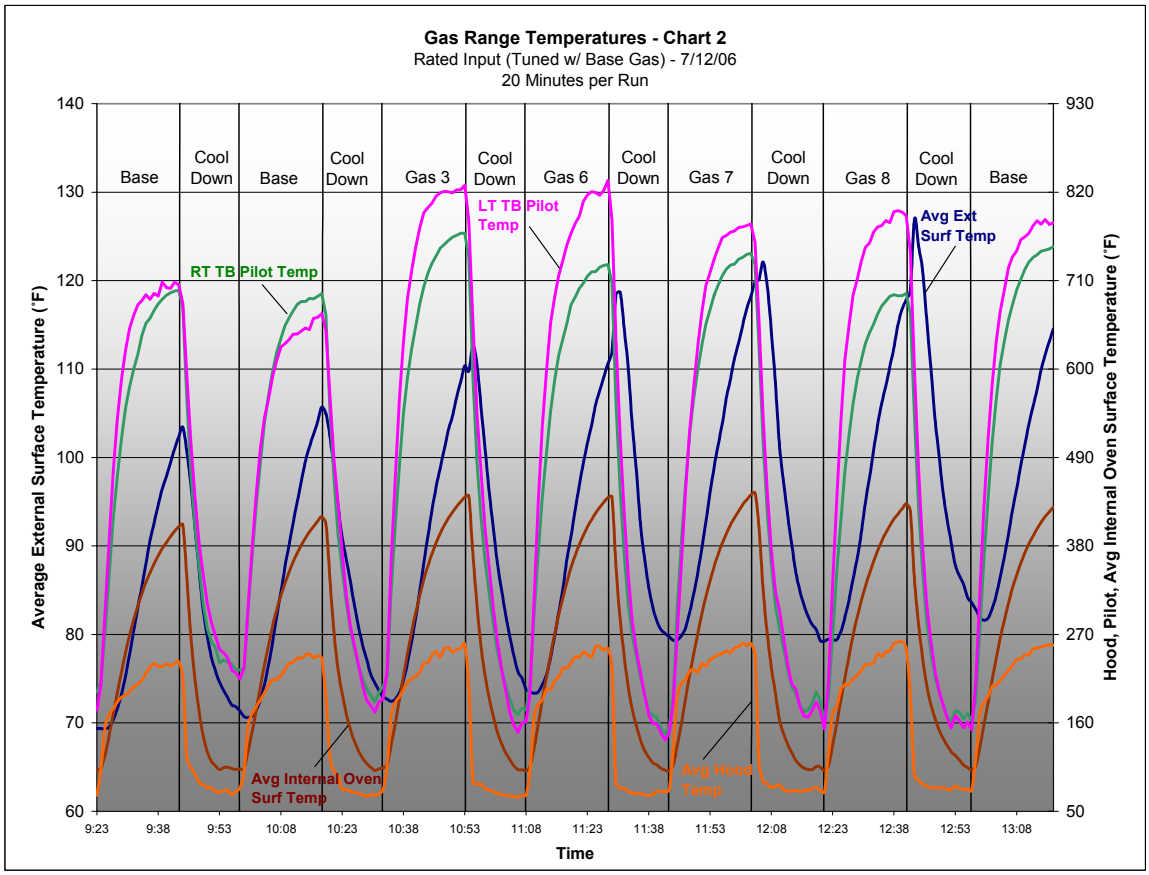


Temperatures (Chart 2)

Surface above pilot — left top burner pilot (LT TB Pilot) average temperatures were highest with Gas 3 (733°F) and lowest with Base Gas (582°F - second run).

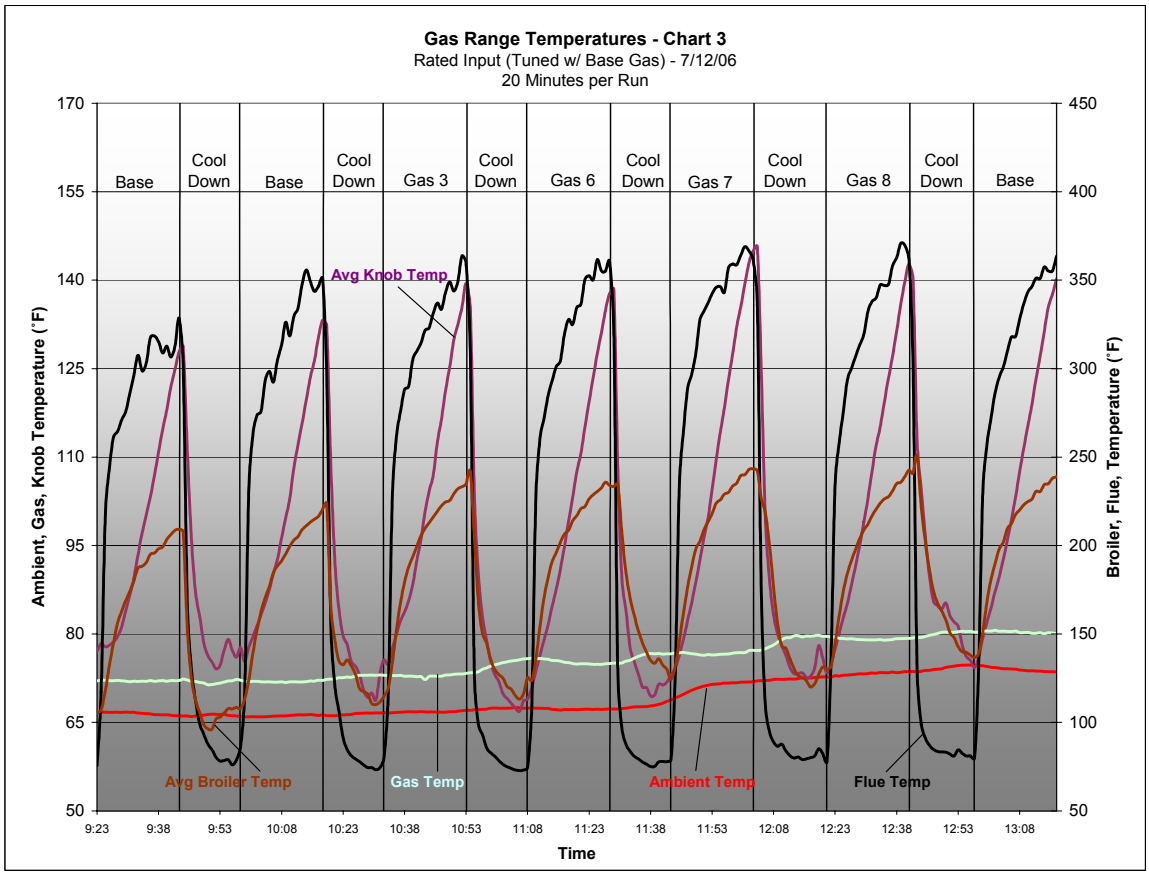
Surface above pilot — right top burner pilot (RT TB pilot) highest average temperature was 660°F with Gas 3 and 587 °F with Base Gas (first run).

External surface temperatures were comprised of an average of four thermocouples, resulting with an average low temperature of 85°F with Base Gas, and a high of 98°F with Gas 7. Average Hood Temperatures ranged from 210°F (Base Gas - first run) to 237 °F (Gas 7).



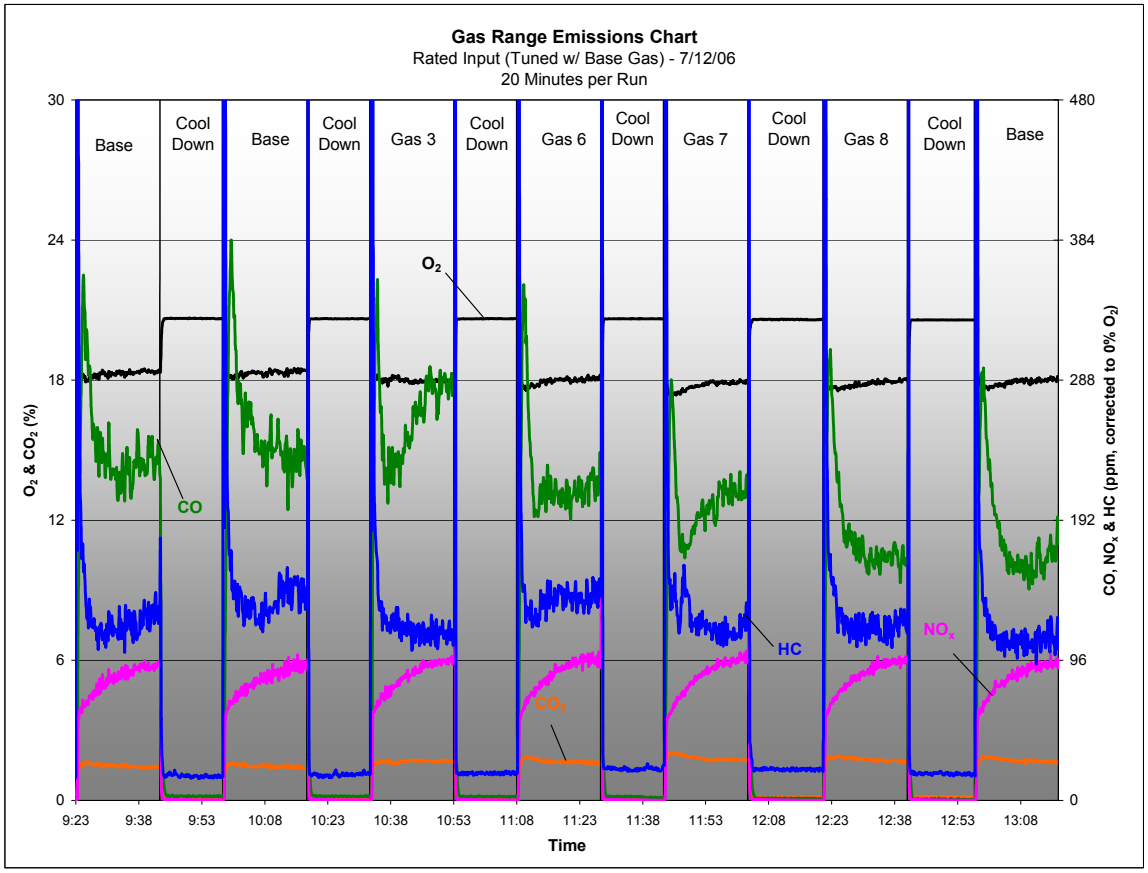
Temperatures (Chart 3)

When tuned with Base Gas, Average Knob and Average broiler temperatures were lowest with Base Gas (first run), averaging 99°F and 180°F, respectively. Highest average knob (110°F) and broiler (213°F) temperatures were recorded with Gas 7. Ambient and Gas Temperature had a slow steady increase throughout the duration of the test.



Emissions

Average NO_X emissions increased from 83 ppm (Base Gas - second run) to 86 ppm (Gas 6), average CO emissions increased from 182 ppm (Base Gas - third run) to 263 ppm (Gas 3), and average HC emissions increased from 125 ppm (Gas 8) to 141 ppm (Base Gas - second run). CO emissions with Gas 3 & 7 increased with respect to time, which is opposite to how CO reacted with the other test gases. Changes in CO_2 & O_2 were negligible throughout the test.

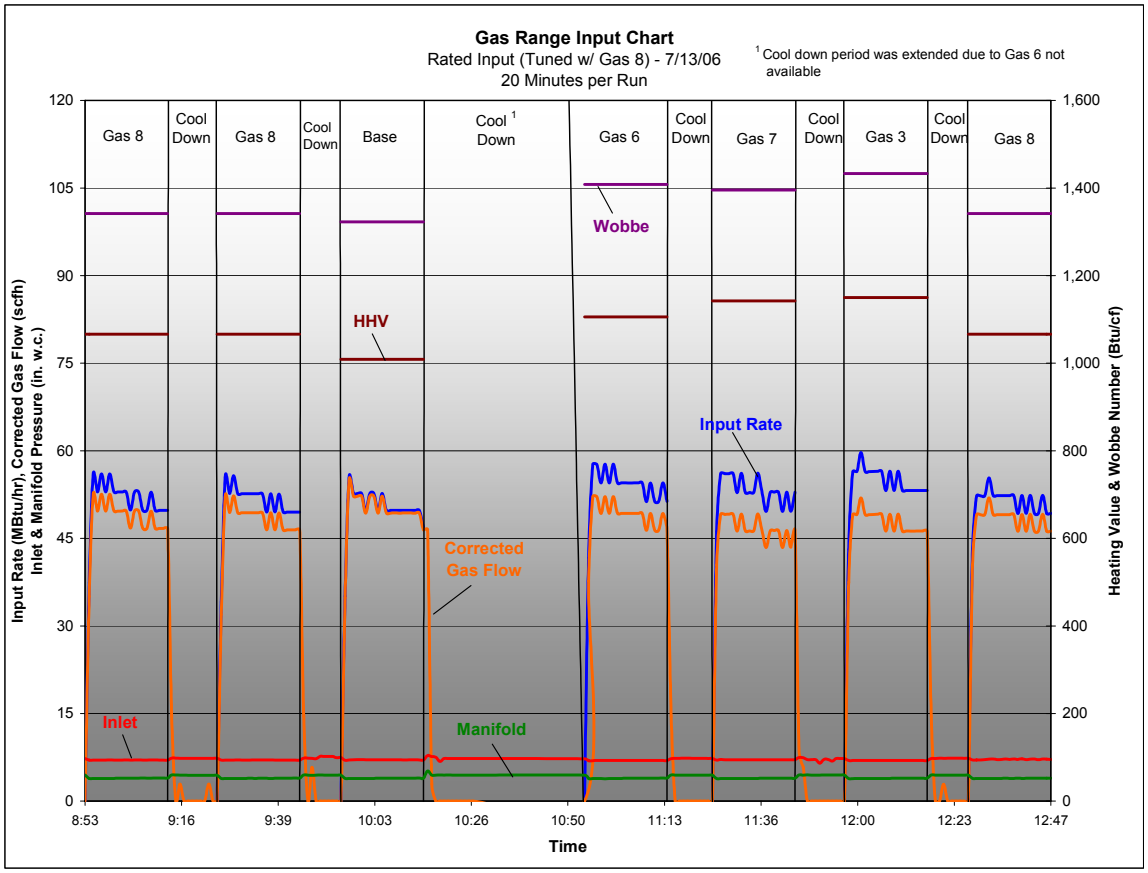


NOTE: Emission test results are for information purposes, they were not the result of certified tests.

Rated Input Test (Tuned w/ Gas 8)

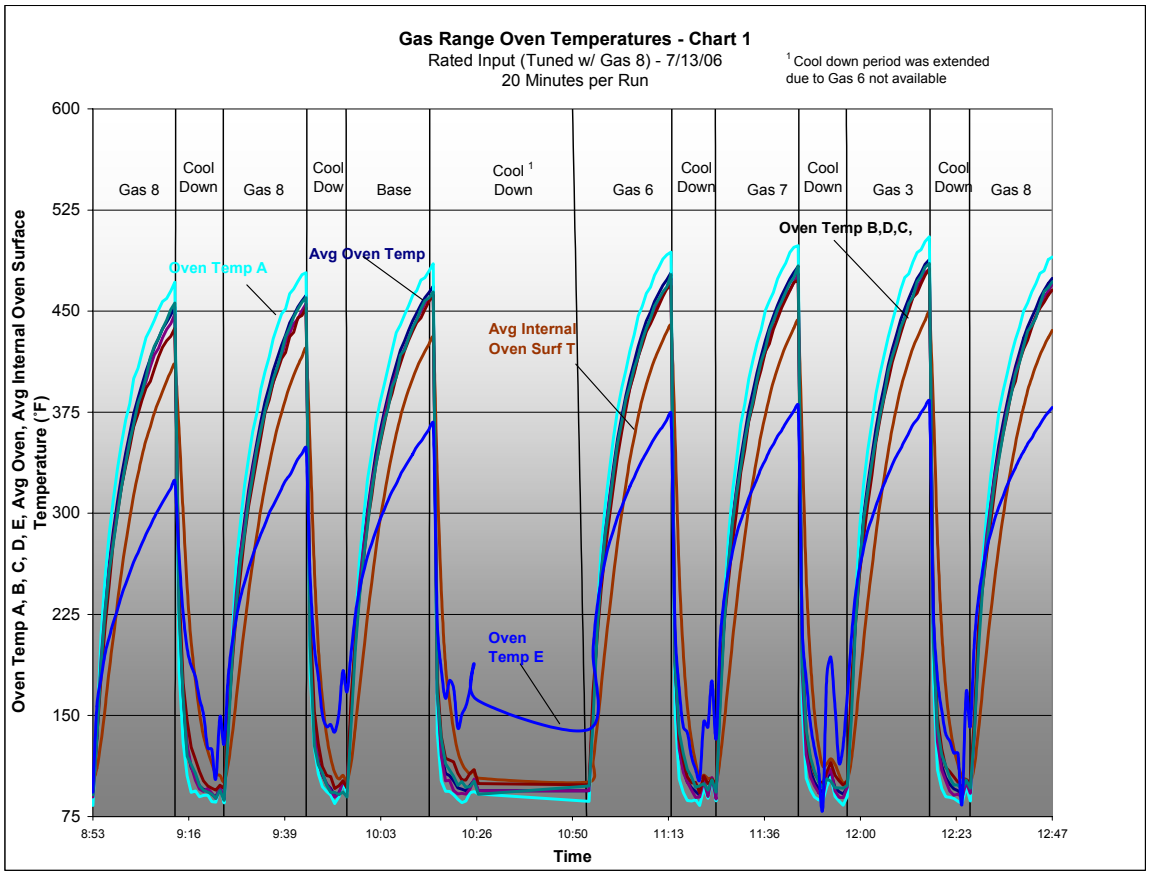
Input

The minimum and maximum input rates were 50,850 Btu/hr (Base Gas) and 55,089 Btu/hr (Gas 3). The corrected gas flow ranged from 47 scfh (Gas 7) to 50 scfh (Base Gas). Inlet and manifold pressures remained stable throughout the course of the test.



Temperatures (Chart 1)

Results revealed that average oven temperature ranged from 364°F (Gas 8 - first run) to 400°F (Gas 3). Average internal oven surface temperature ranged from 338°F (Gas 3) to 306°F (Gas 8 - first run). Oven temperatures A through D varied uniformly, as a group, depending on the test gas—the richer gases generated higher temperatures.

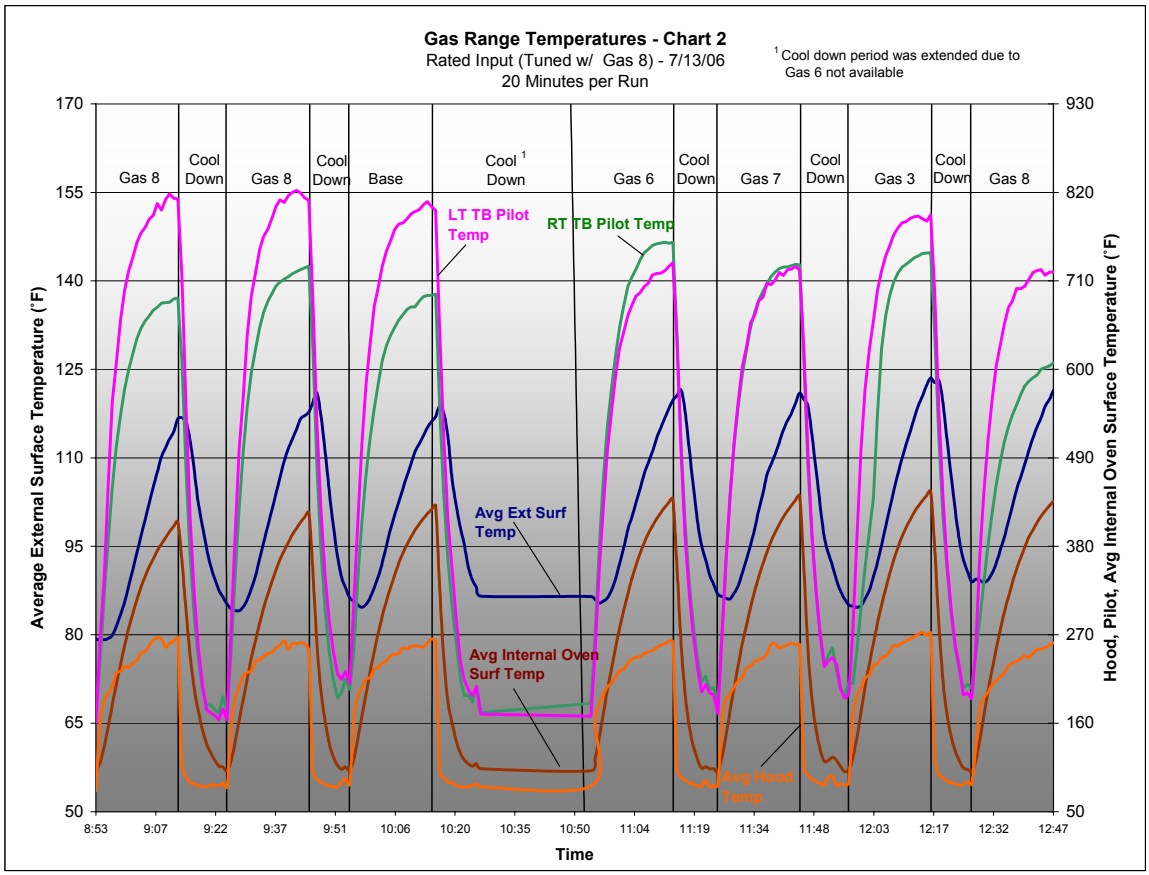


Temperatures (Chart 2)

Surface above pilot — left top burner pilot (LT TB Pilot) average temperatures were the highest with Gas 8 (732°F - second run) and the lowest with Gas 6 (641°F).

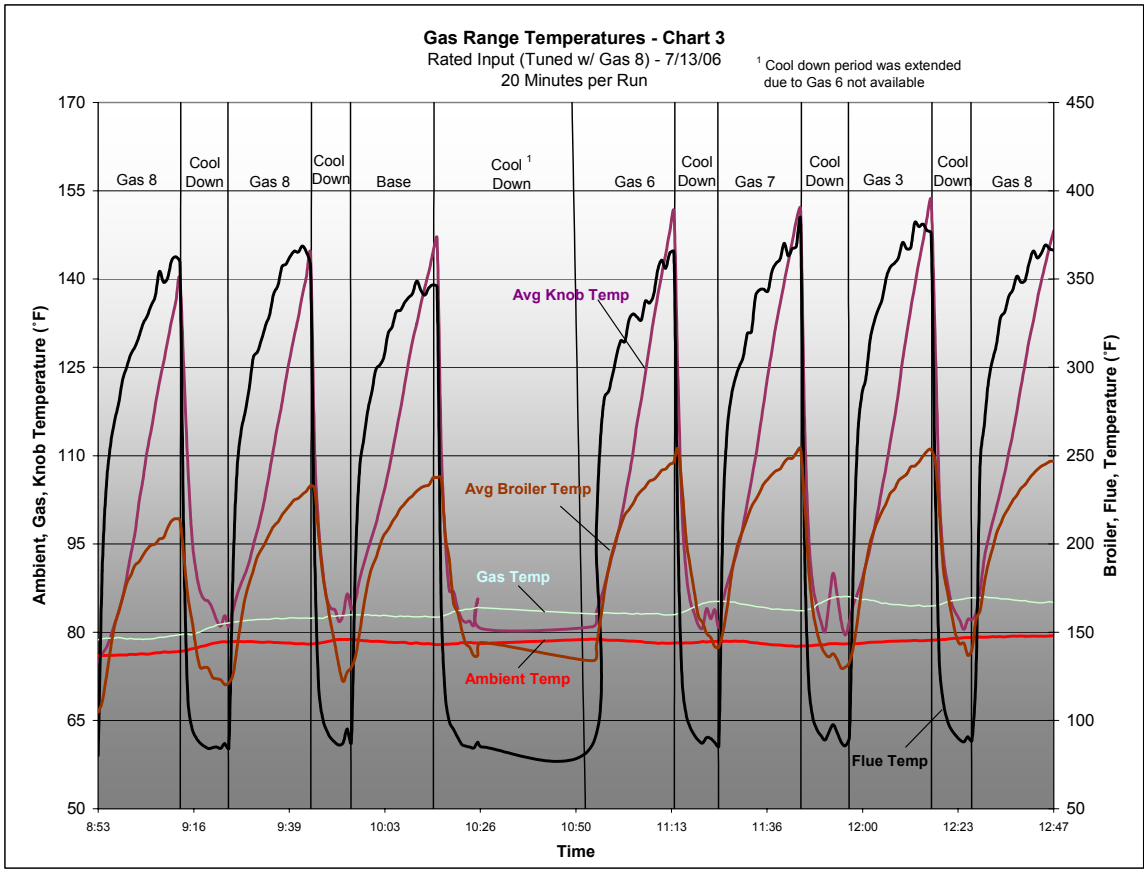
Surface above pilot — right top burner pilot (RT TB pilot) reached the highest average temperature with Gas 6 (674°F) and the lowest with Gas 8 (518°F - third run).

Average External surface temperature was the lowest (97°F) with Gas 8 - first run and a highest (104°F) also with Gas 8 - third run. Average Hood Temperatures ranged from 231°F (Gas 8 - third run) to 247°F (Gas 3).



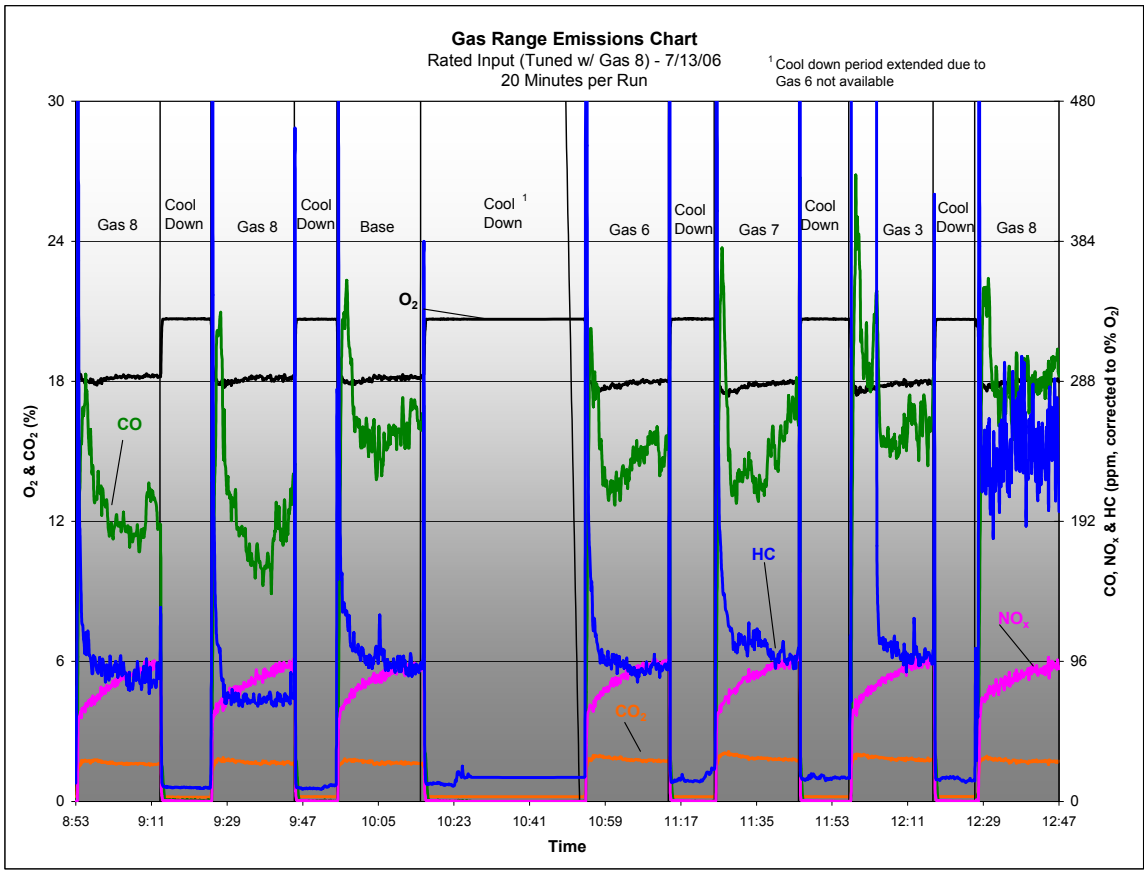
Temperatures (Chart 3)

When tuned with Gas 8, Average Knob and Average broiler temperatures were the lowest with Gas 8 - first run, 107°F and 186°F, respectively. Both temperatures were the highest with Gas 7, 119°F and 225°F. Ambient and Gas temperature had a slow steady increase throughout the duration of the test.



Emissions

Average NO_X emissions increased from 81 ppm (Gas 8 - first run) to 85 ppm (Gas 7), CO emissions increased from 198 ppm (Gas 8 - second run) to 285 ppm (Gas 8 - third run) and HC emissions increased from 75 ppm (Gas 8) to 327 ppm (Gas 3). Changes in CO_2 & O_2 remained negligible throughout the test.

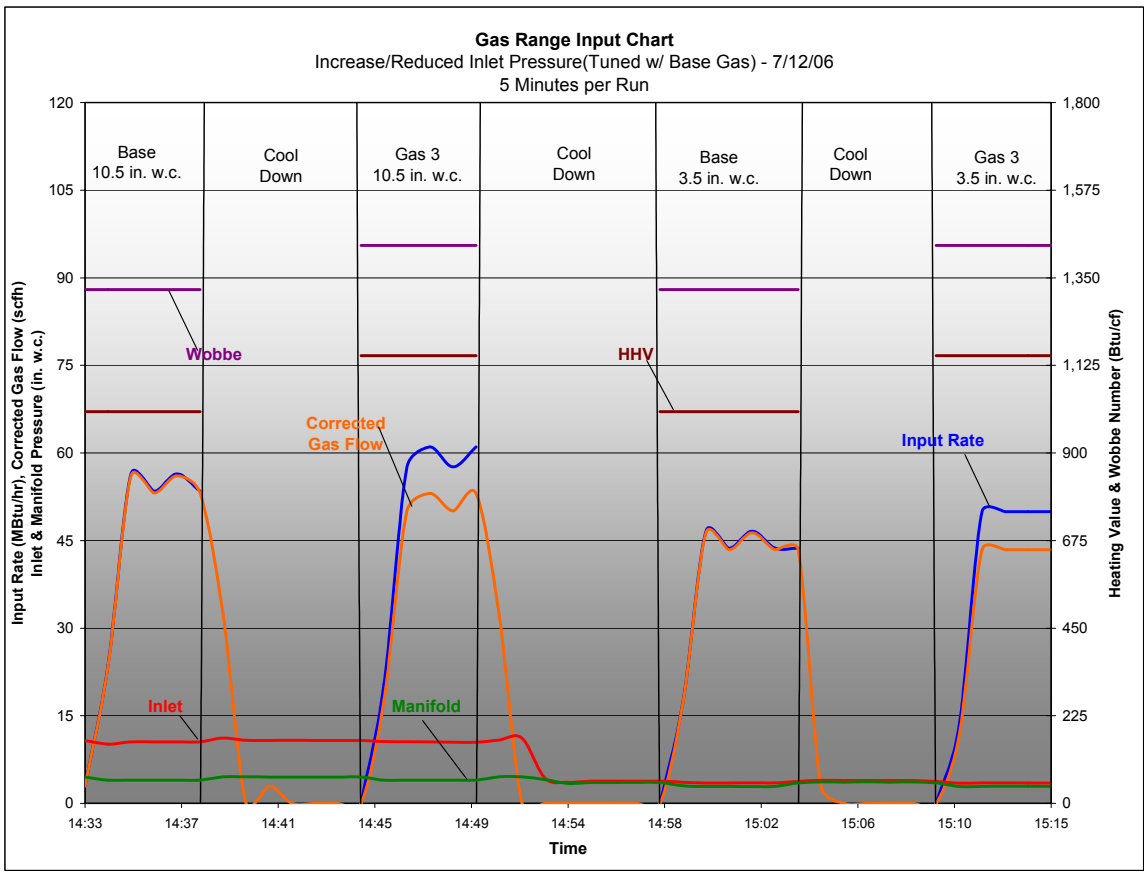


NOTE: Emission test results are for information purposes, they were not the result of certified tests.

Increased Decrease Inlet Pressure Tests - (Tuned w/ Base Gas)

Input

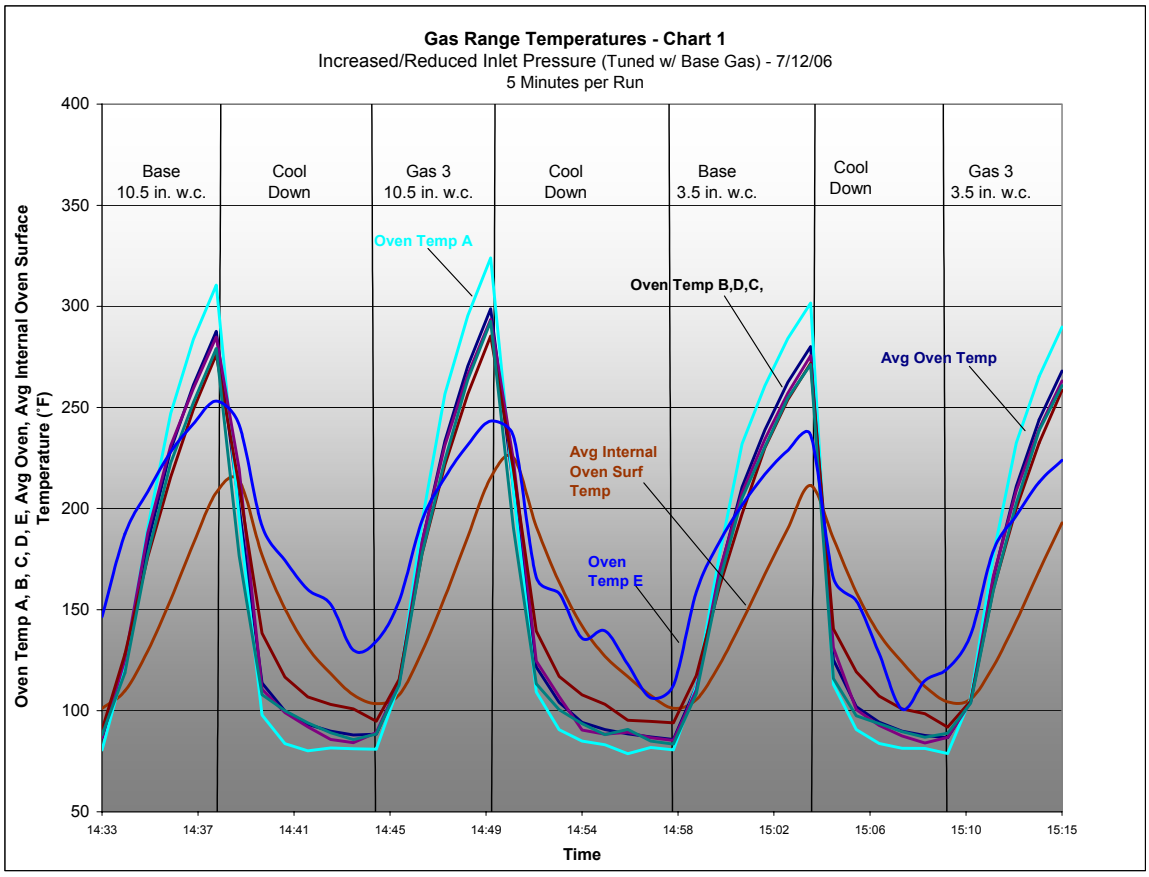
With an increased inlet pressure, the input rate reached a high of 59,334 btu/hr with Gas 3, and decreased to 49,936 Btu/hr with a reduced inlet pressure. The corrected gas flow with increased inlet pressure was 55 scfh (Base Gas) and 52 scfh (Gas 3). With a reduced inlet pressure, the corrected gas flow averaged 45 scfh for Base Gas and 43 scfh for Gas 3. Manifold pressure during the increase inlet pressure test was 4.1" w.c. and 3.0" w.c. during the reduced inlet pressure test.



Temperatures (Chart 1)

With an increase in inlet pressure, average oven temperature ranged from 195°F (Base Gas) to 198°F (Gas 3). Average internal oven surface temperature ranged from 150°F (Gas 3) to 148°F (Base Gas).

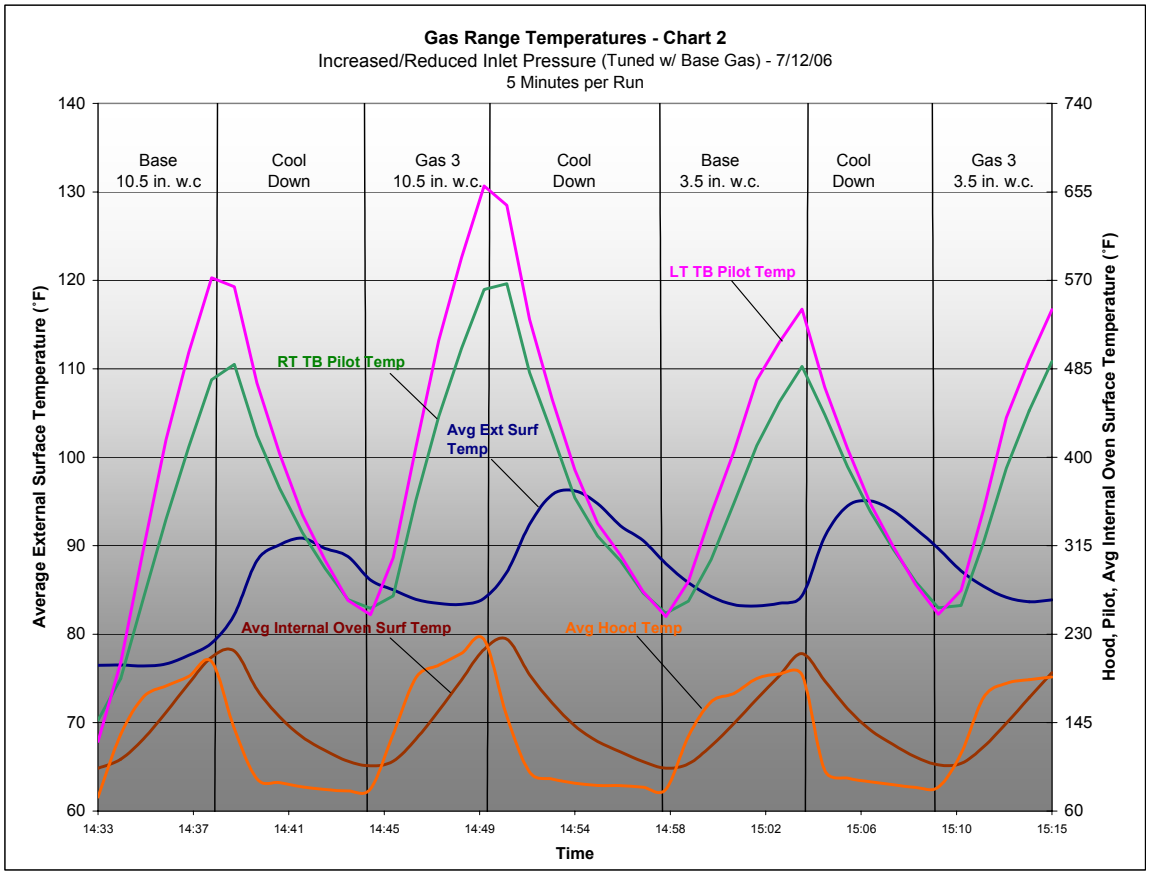
For reduced inlet pressure, average oven temperature ranged from 180°F (Base Gas) to 180°F (Gas 3). Average internal oven surface temperature ranged from 140°F (Gas 3) and 139°F (Base Gas).



Temperatures (Chart 2)

At an increased inlet pressure, the Surface above pilot — left top burner pilot (LT TB Pilot) temperature averaged 355°F (Base Gas) and 455°F (Gas 3), while RT TB pilot temperature averaged 304°F (Base Gas) and 398°F (Gas 3). Average external surface temperature ranged from 77°F (Base Gas) to 84°F (Gas 3).

At reduced inlet pressure, the Surface above pilot — (LT TB Pilot) temperature averaged 377°F (Base Gas) and 391°F (Gas 3), while RT TB pilot temperature averaged 339°F (Base Gas) and 360°F (Gas 3). Average external surface temperature ranged from 85°F (Base Gas) to 86°F (Gas 3).

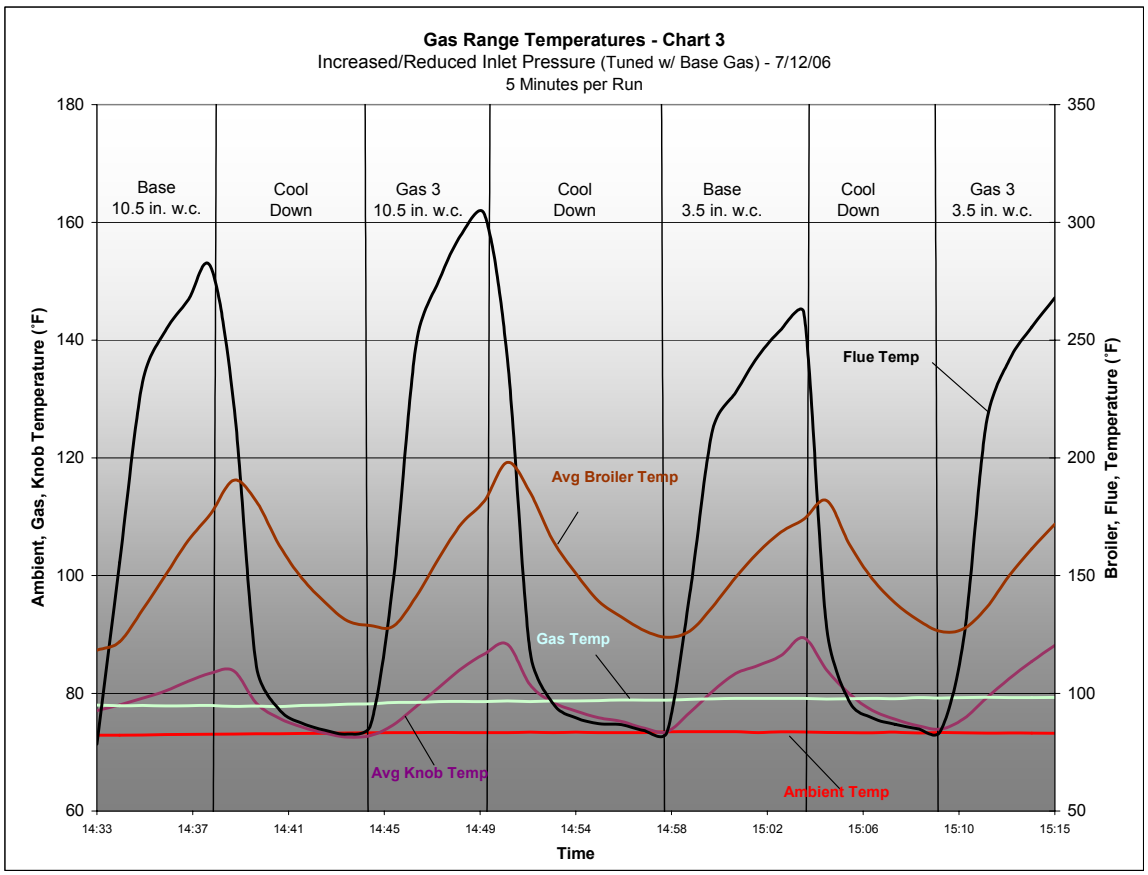


Temperatures (Chart 3)

At increase inlet pressure, when Gas 3 was introduced, Knob, Broiler and Flue temperatures reached their peak, even though the average temperatures may indicate different.

At a reduced inlet pressure, Knob, Broiler and Flue temperatures decreased and when Gas 3 was introduced, none of the temperatures had any considerable changes.

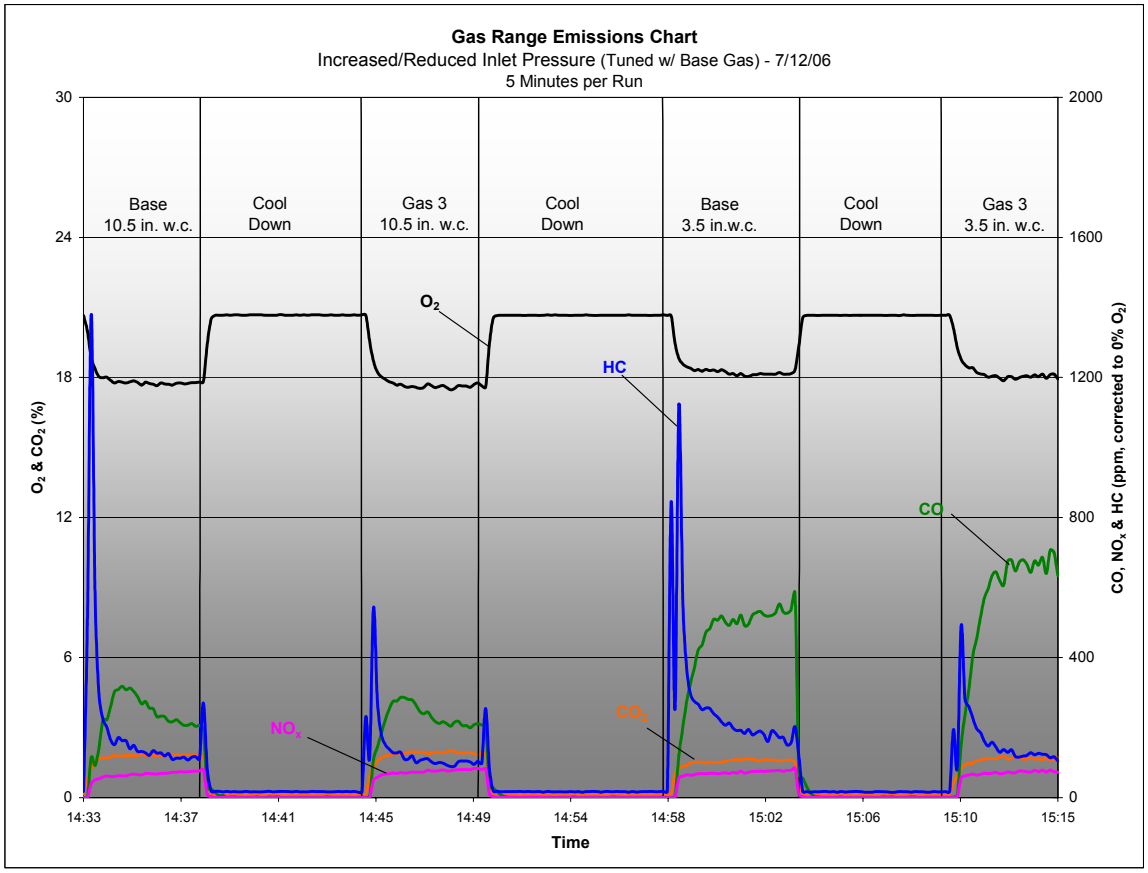
Ambient and Gas temperature slightly increased during the duration of the test.



Emissions

During the increased inlet pressure test, average NO_X emissions increased from 68 ppm (Base Gas) to 75 ppm (Gas 3), CO emissions decreased from 250 ppm (Base Gas) to 236 ppm (Gas 3) and HC emissions decreased from 137 ppm (Base Gas) to 109 ppm (Gas 3).

During the reduced inlet pressure test, average NO_X emissions decreased from 73 ppm (Base Gas) to 72 ppm (Gas 3), CO emissions increased from 498 ppm (Base Gas) to 627 ppm (Gas 3) and HC emission decreased from 207 ppm (Base Gas) to 139 ppm (Gas 3).

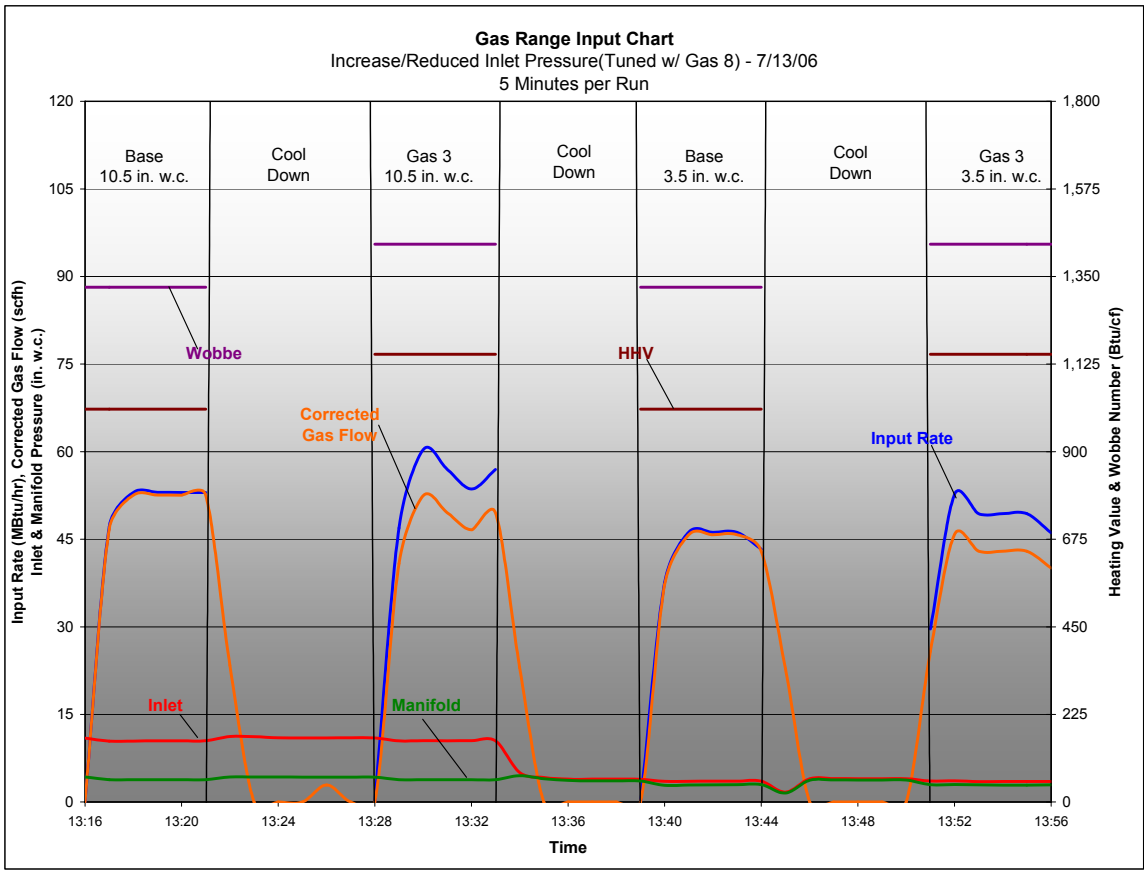


NOTE: Emission test results are for information purposes, they were not the result of certified tests.

Increased Decreased Inlet Pressure Tests - (Tuned w/ Gas 8)

Input

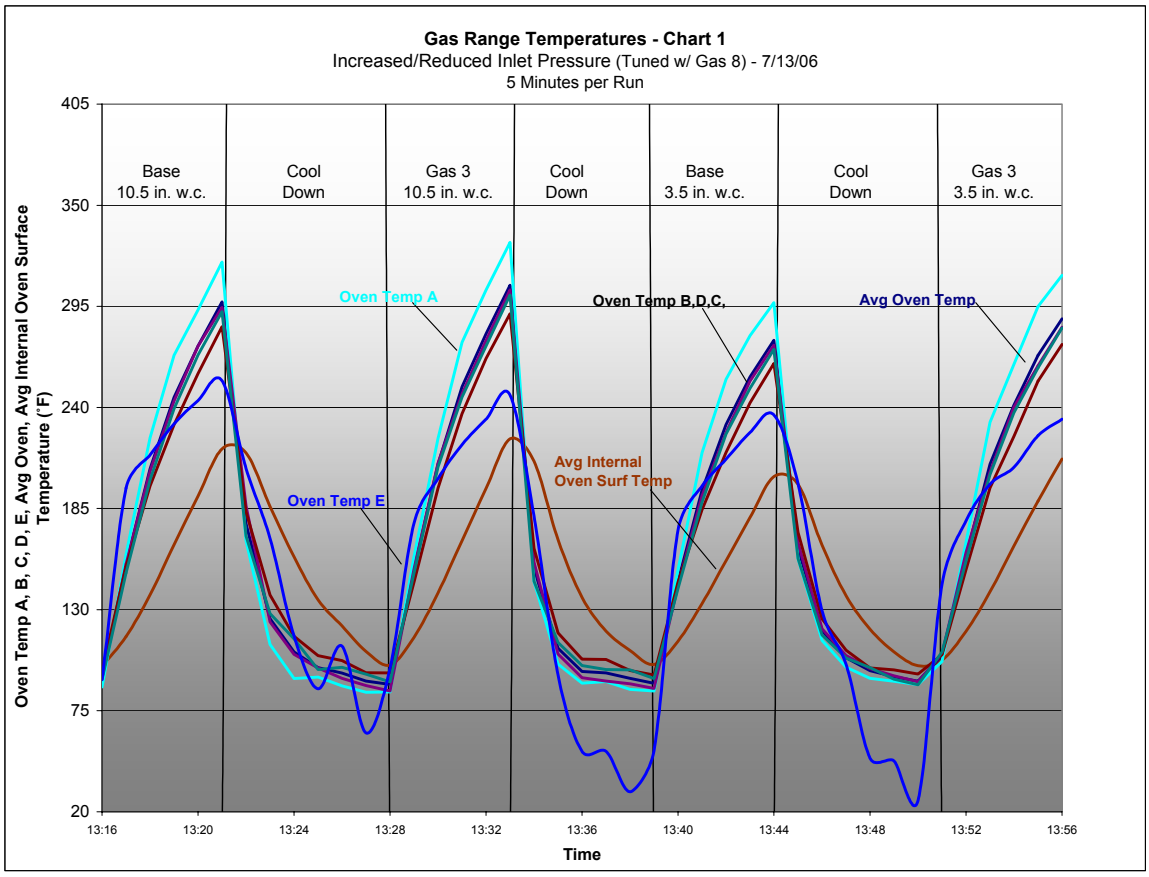
Input rate averages were higher with Gas 3, both at increased inlet pressure (54,965 Btu/hr) and at reduced inlet pressure (49,386 Btu/hr). The corrected gas flow was 51 scfh (Base Gas) and 48 scfh (Gas 3) for increased inlet pressure, while average flows for the reduced inlet pressure ranged from 44 scfh (Base Gas) to 43 scfh (Gas 3). Manifold pressure during the increase inlet pressure test was 3.9" w.c. and 2.9" w.c. during the reduced inlet pressure test.



Temperatures (Chart 1)

When tuned with Gas 8, at increase in inlet pressure, average oven temperature increased from 236°F (Base Gas) to 240°F (Gas 3). Average internal oven surface temperature decreased from 168°F (Gas 3) to 166°F (Base Gas).

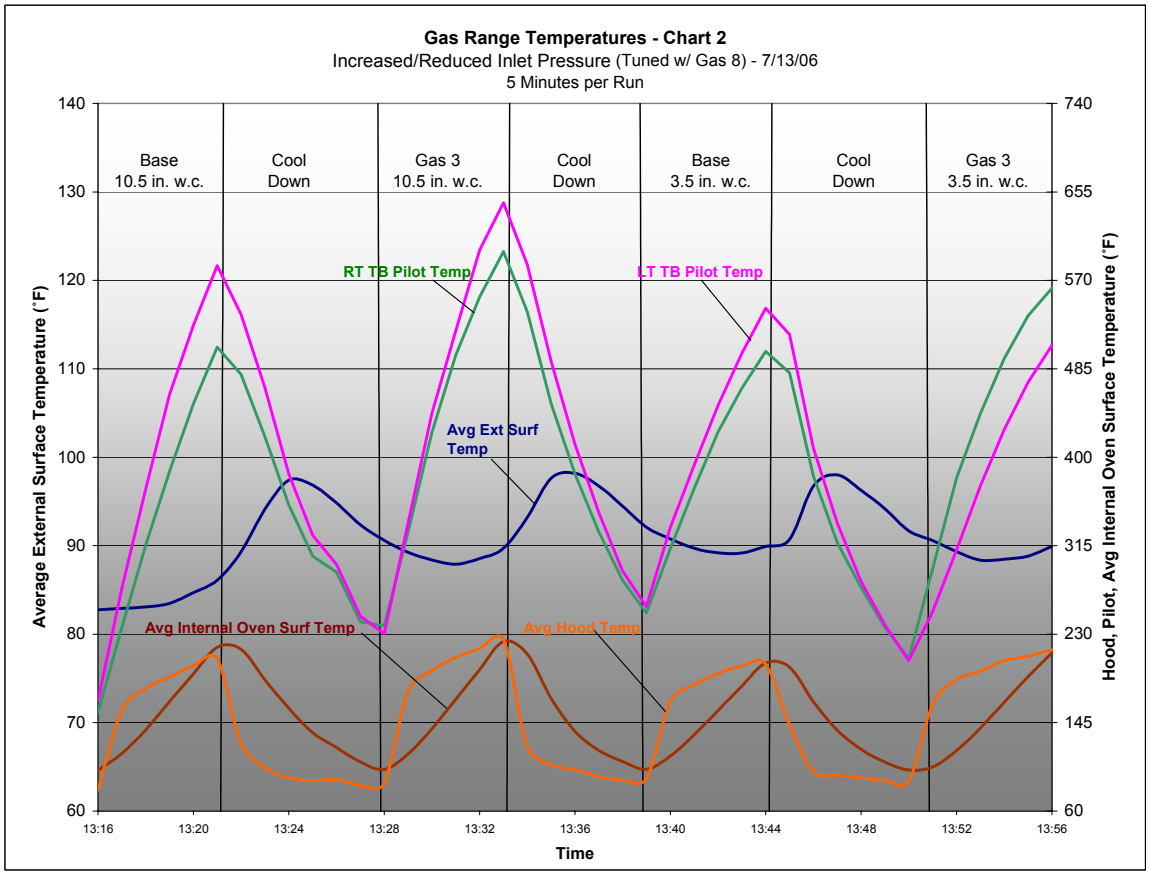
For reduced inlet pressure, average oven temperature increased from 221°F (Base Gas) to 233°F (Gas 3). Average internal oven surface temperature decreased from 165°F (Gas 3) and 157 °F (Base Gas).



Temperatures (Chart 2)

At an increased inlet pressure, the Surface above pilot — left top burner pilot (LT TB Pilot) temperature averaged 443°F (Base Gas) and 509°F (Gas 3), while RT TB pilot temperature averaged 379°F (Base Gas) and 480°F (Gas 3). Average external surface temperature ranged from 84°F (Base Gas) to 89°F (Gas 3).

At reduced inlet pressure, the Surface above pilot — (LT TB Pilot) temperature averaged 444°F (Base Gas) and 418°F (Gas 3), while RT TB pilot temperature averaged 415°F (Base Gas) and 483°F (Gas 3). Average External surface temperature ranged from 89°F (Gas 3) to 90°F (Base Gas).

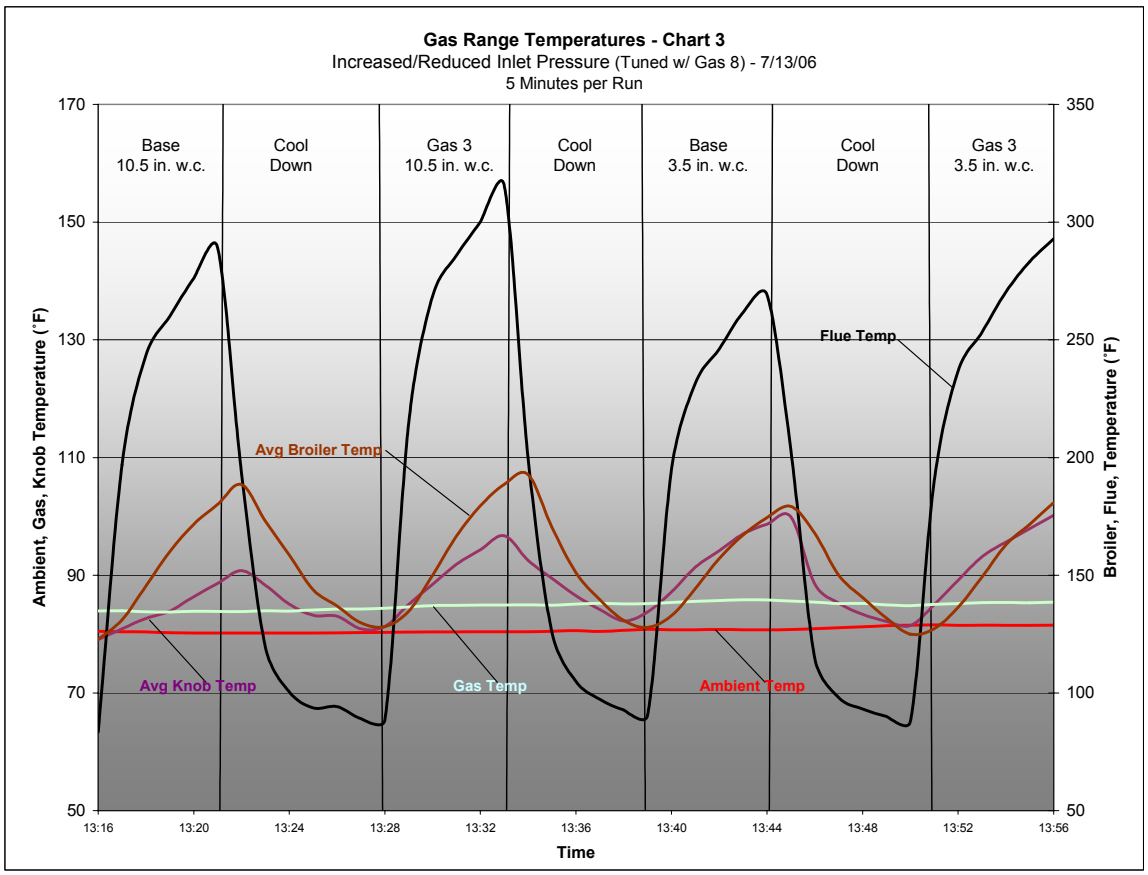


Temperatures (Chart 3)

At increase inlet pressure, when Gas 3 was introduced, Knob, Broiler and Flue temperatures reached their peak, even though the average temperatures may indicate different.

At a reduced inlet pressure, Knob, Broiler and Flue temperatures decreased compared to the increased inlet pressure run. When Gas 3 was introduced, none of the temperatures had any considerable changes, except for an increase in flue temperature.

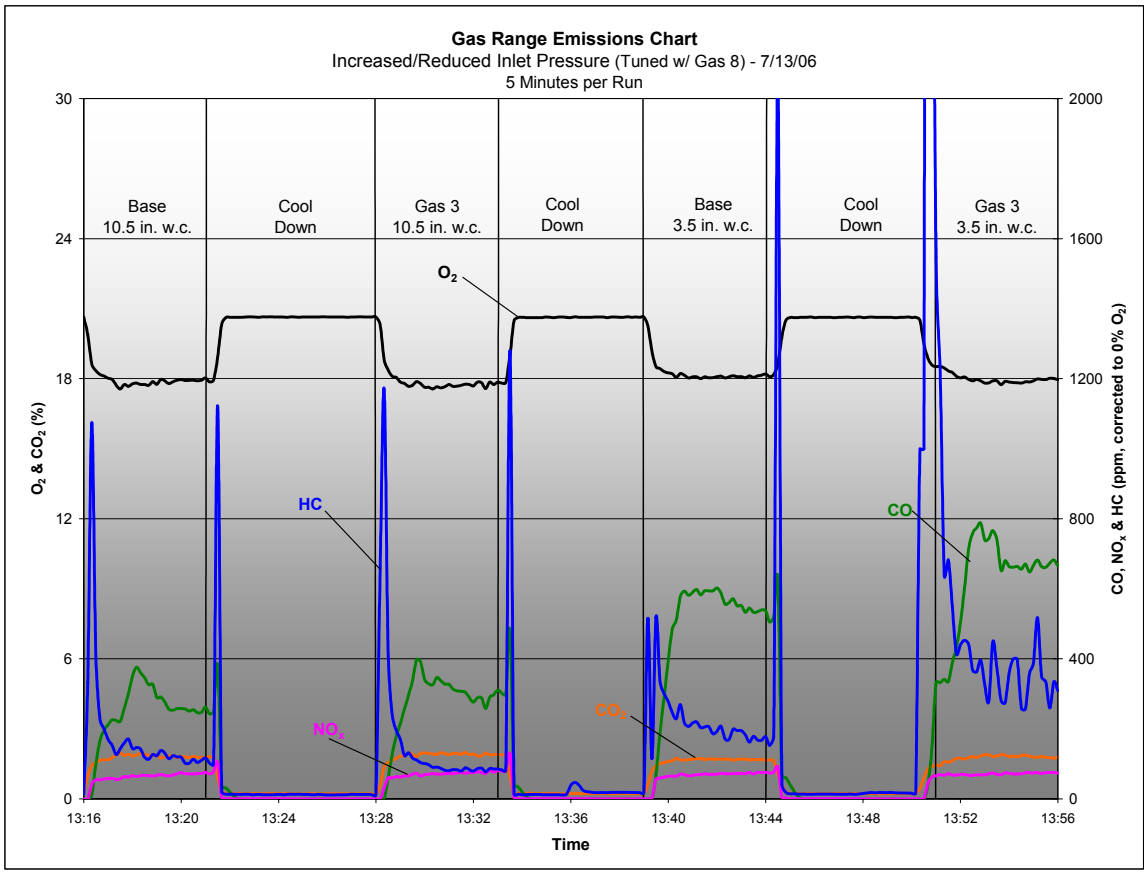
Ambient and Gas temperature slightly increased during the duration of the test.



Emissions

During the increased inlet pressure test, average NO_X emissions increased from 67 ppm (Base Gas) to 72 ppm (Gas 3), CO emissions increased from 277 ppm (Base Gas) to 310 ppm (Gas 3) and HC emissions decreased from 129 ppm (Base Gas) to 96 ppm (Gas 3).

During the reduced inlet pressure test, average NO_X emissions increased from 71 ppm (Base Gas) to 72 ppm (Gas 3), CO emissions increased from 563 ppm (Base Gas) to 685 ppm (Gas 3) and HC emission increased from 199 ppm (Base Gas) to 359 ppm (Gas 3). CO emissions reached a peak of 787 ppm with Gas 3.

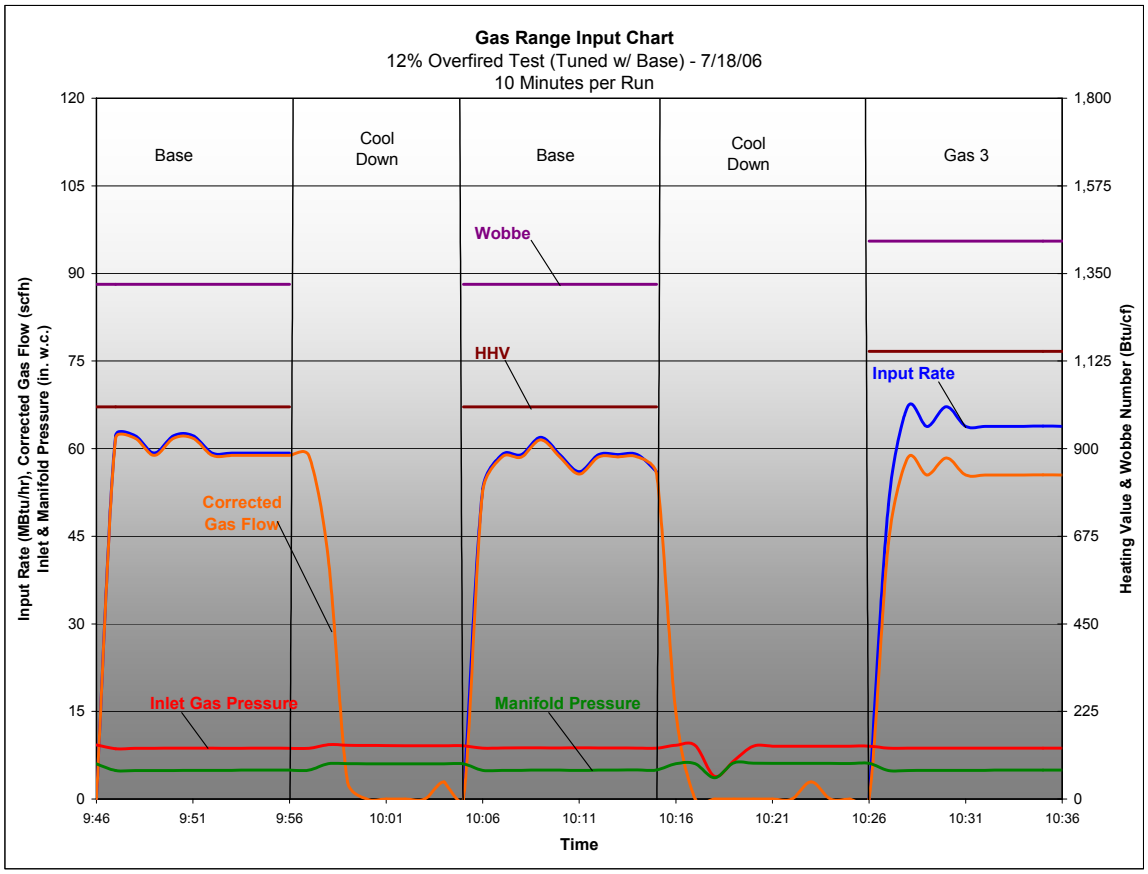


NOTE: Emission test results are for information purposes, they were not the result of certified tests.

12% Overfired Tests - (Tuned w/ Base Gas)

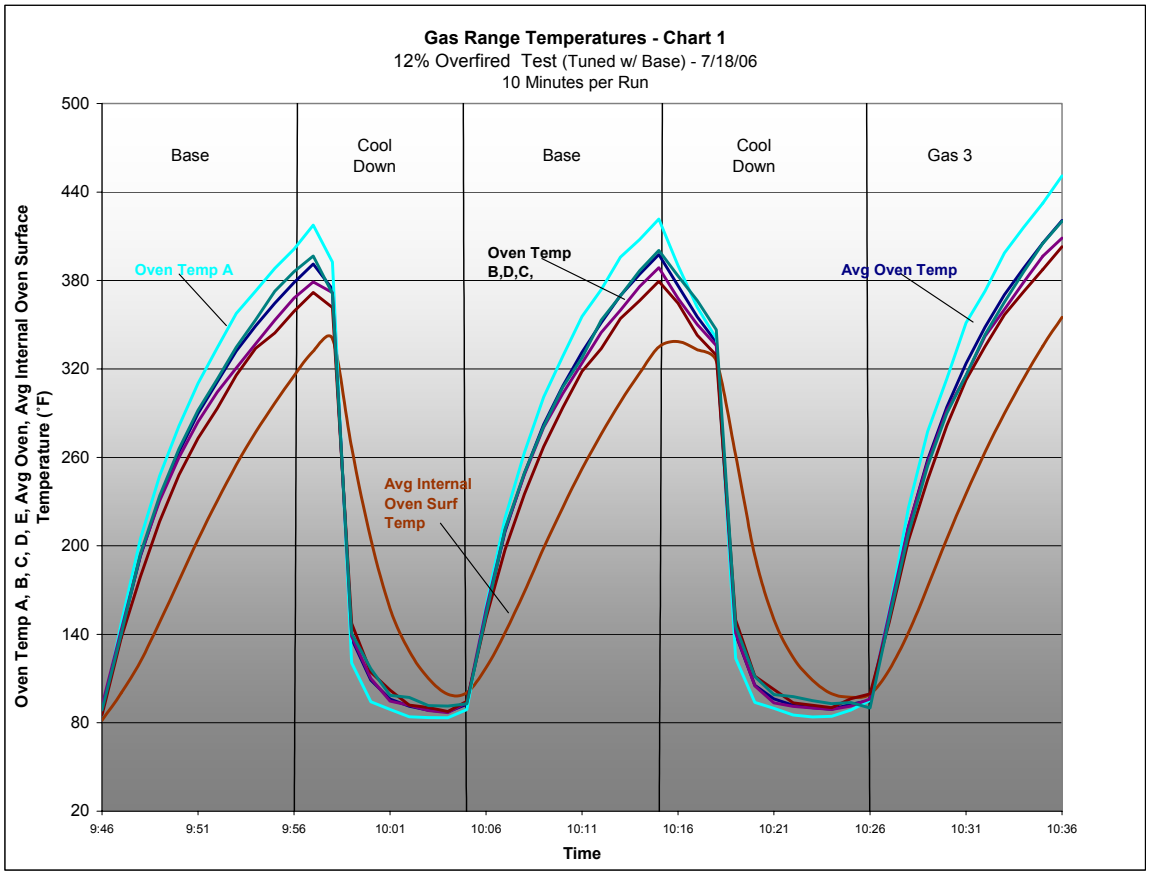
Input

The average minimum and maximum input rate was 58,667 Btu/hr (Base Gas- second run) and 64,566 Btu/hr (Gas 3). The corrected gas flow was 56 scfh (Gas 3) and 60 scfh (Base Gas - first run). Inlet and manifold pressures remained stable throughout the course of the test.



Temperatures (Chart 1)

Average oven temperature was 302°F (Base Gas) and 336°F (Gas 3). Average internal oven surface temperature had averages of 257°F (Gas 3) and 225°F (Base Gas). Average oven temperatures A through D varied uniformly, as a group, depending on the test gas—the richer gases generated higher temperatures.

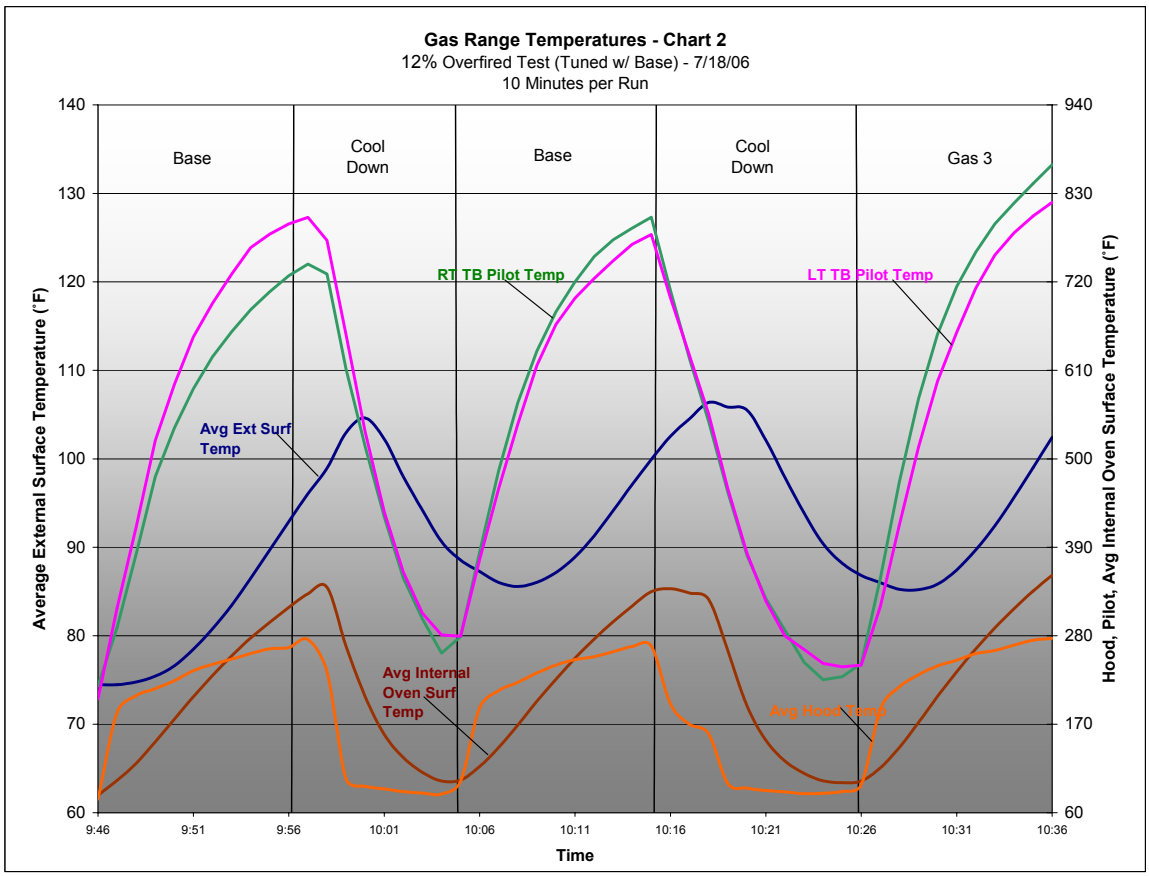


Temperatures (Chart 2)

Surface above pilot — left top burner pilot (LT TB Pilot) average temperature was highest with Gas 3 (673°F) and lowest with Base Gas (660°F).

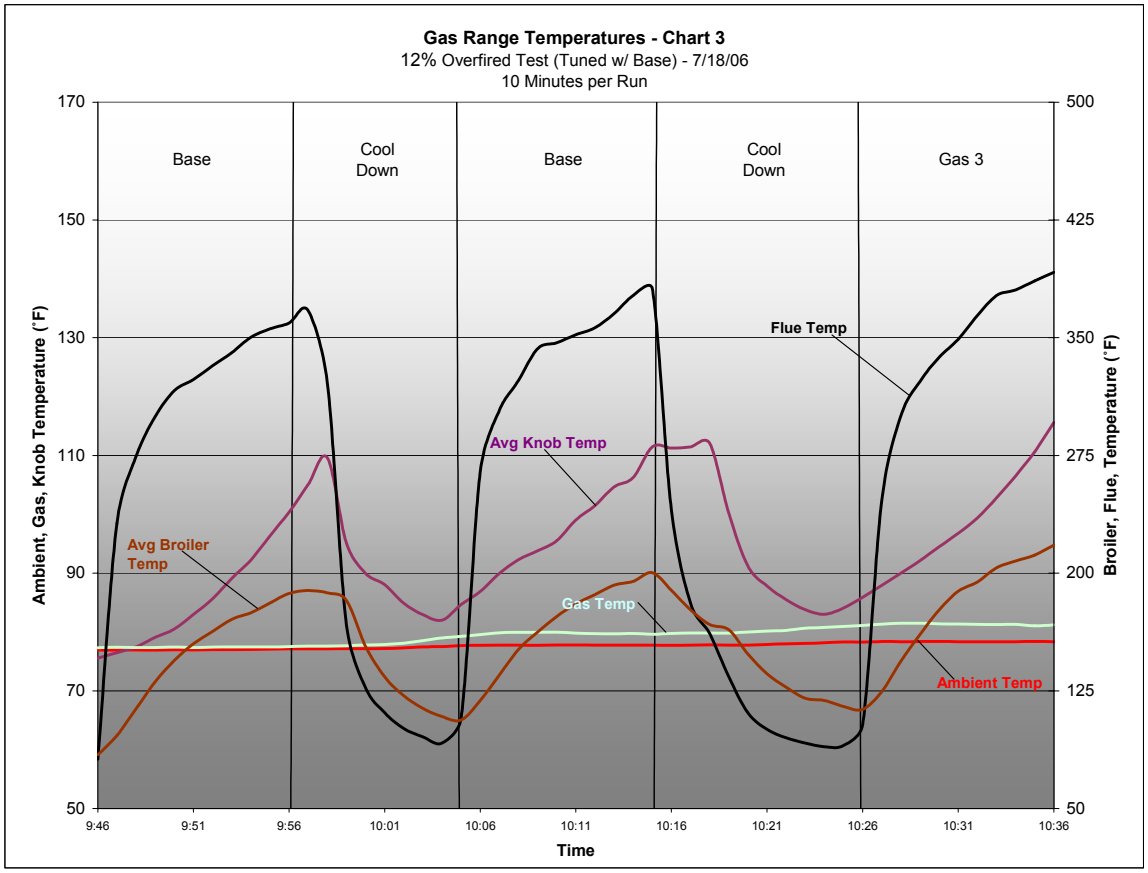
Surface above pilot — right top burner pilot (RT TB pilot) highest average temperature was 721°F (Gas 3) and lowest was 599°F (Base Gas).

Average External surface temperatures ranged from 82°F (Base Gas- first run) to 91°F (Gas 3).



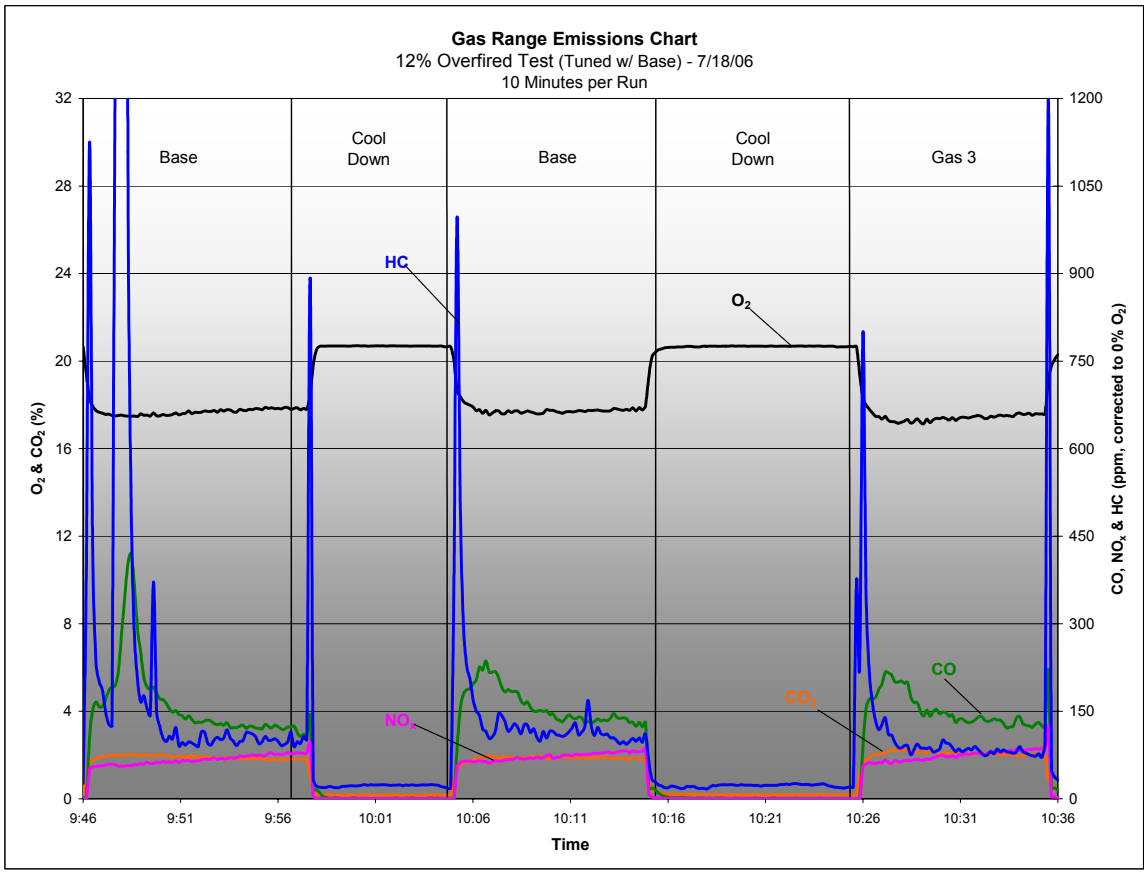
Temperatures (Chart 3)

When tuned with Base Gas, Average Knob and Average broiler temperatures were both highest with Gas 3, with temperatures of 101°F and 189°F, respectively. Flue temperature was 328°F (Base Gas) and 356°F (Gas 3). Ambient and Gas temperature had a steady increase throughout the duration of the test.



Emissions

Average NO_X emissions ranged from 66 ppm (Base Gas- first run) to 71 ppm (Gas 3), CO emissions ranged from 145 ppm (Gas 3) to 166 ppm (Base Gas- first run) and HC emissions ranged from 123 ppm (Gas 3) to 282 ppm (Base Gas- first run). Changes in CO_2 & O_2 remained negligible throughout the test.

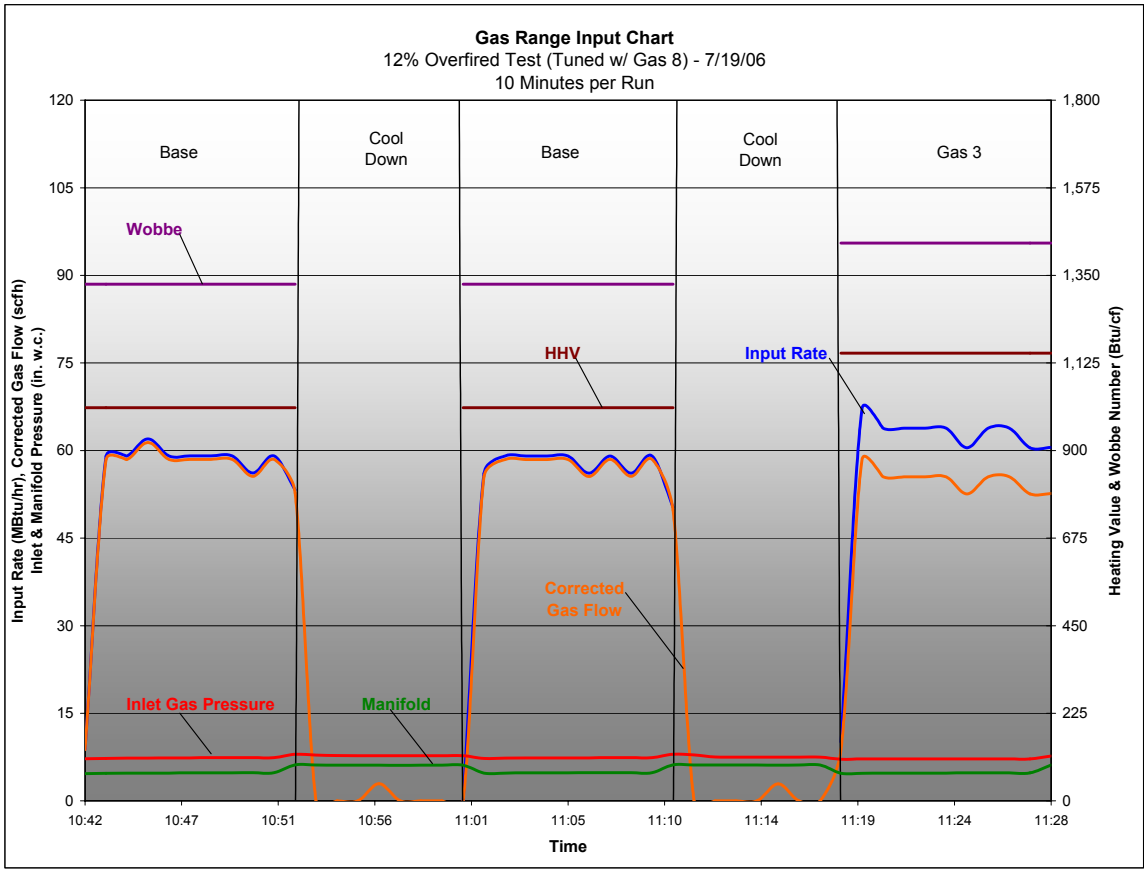


NOTE: Emission test results are for information purposes, they were not the result of certified tests.

12% Overfired Tests - (Tuned w/ Gas 8)

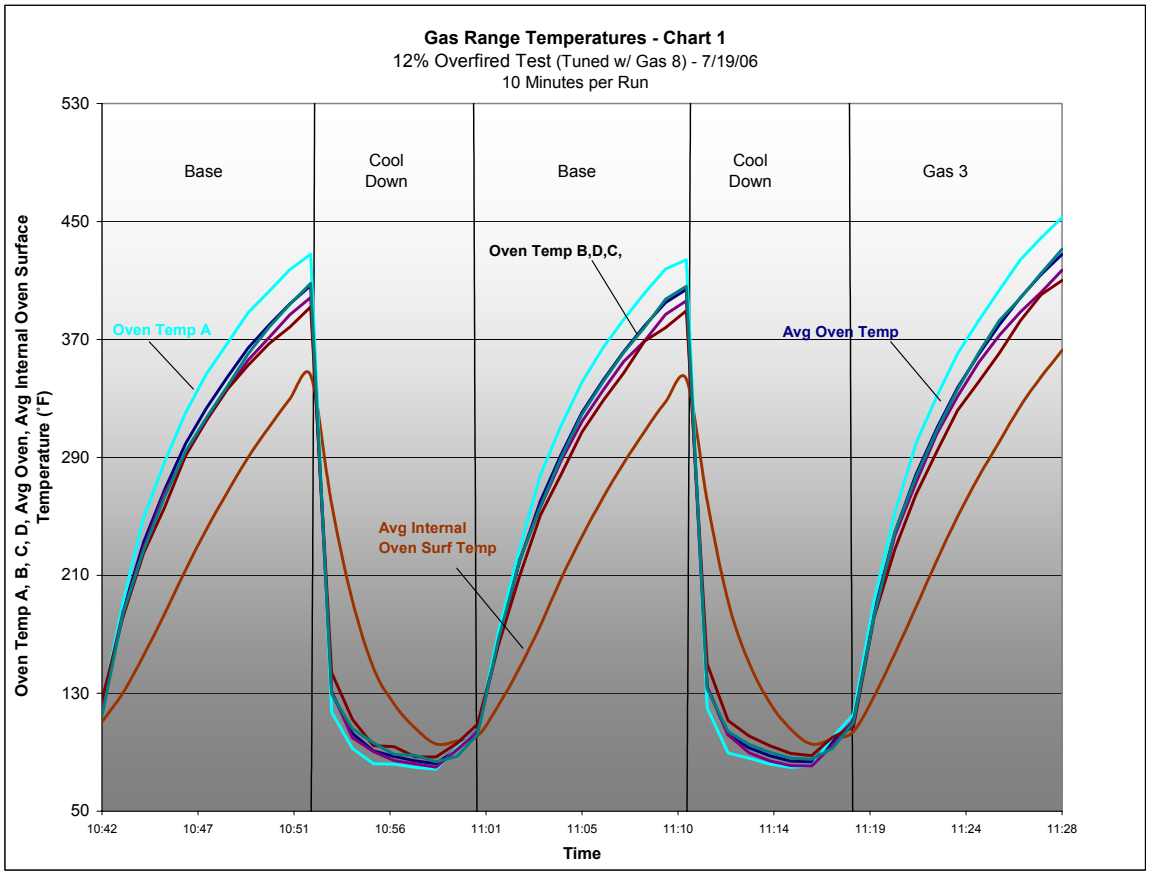
Input

The average minimum and maximum input rate was 57,432 Btu/hr (Base Gas- second run) and 62,716 Btu/hr (Gas 3). The corrected gas flow was 55 scfh (Gas 3) and 60 scfh (Base Gas - first run). Inlet and manifold pressures remained stable throughout the course of the test.



Temperatures (Chart 1)

Average oven temperature was 331°F (Base Gas) and 349°F (Gas 3). Average internal oven surface temperature had averages of 269°F (Gas 3) and 255°F (Base Gas). Average oven temperatures A through D varied uniformly, as a group, depending on the test gas—the richer gases generated higher temperatures.

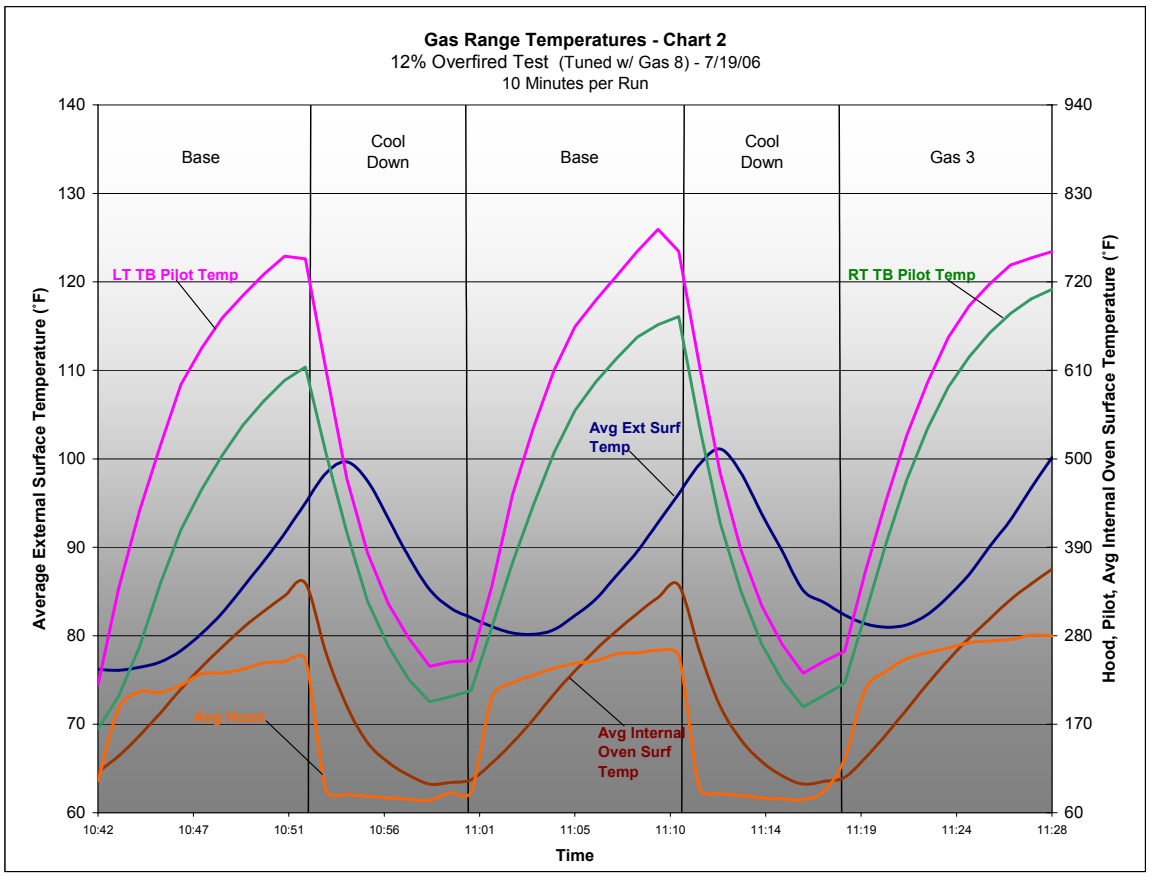


Temperatures (Chart 2)

Surface above pilot — left top burner pilot (LT TB Pilot) highest average temperature was 666°F (Base Gas).

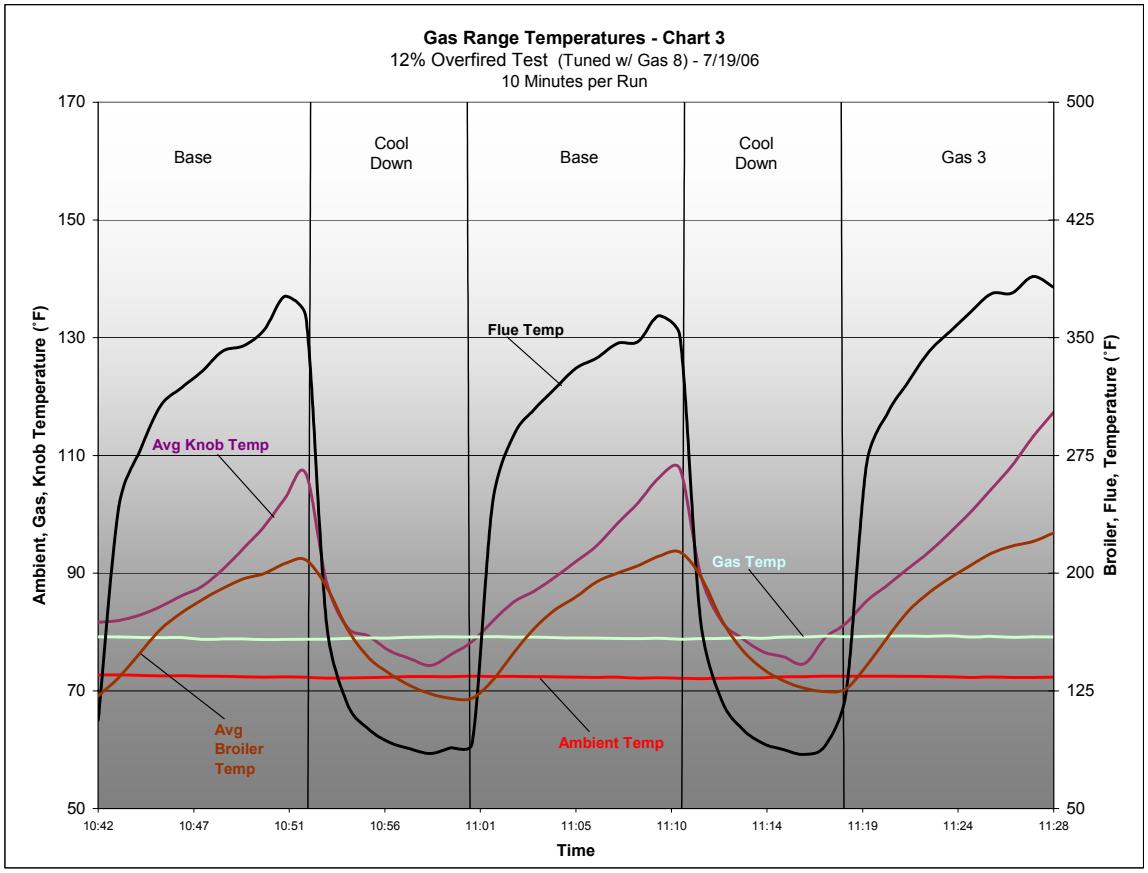
Surface above pilot — right top burner pilot (RT TB pilot) highest average temperature was 597°F (Gas 3).

Average External surface temperatures increased from 84°F (Base Gas- first run) to 88°F (Gas 3).



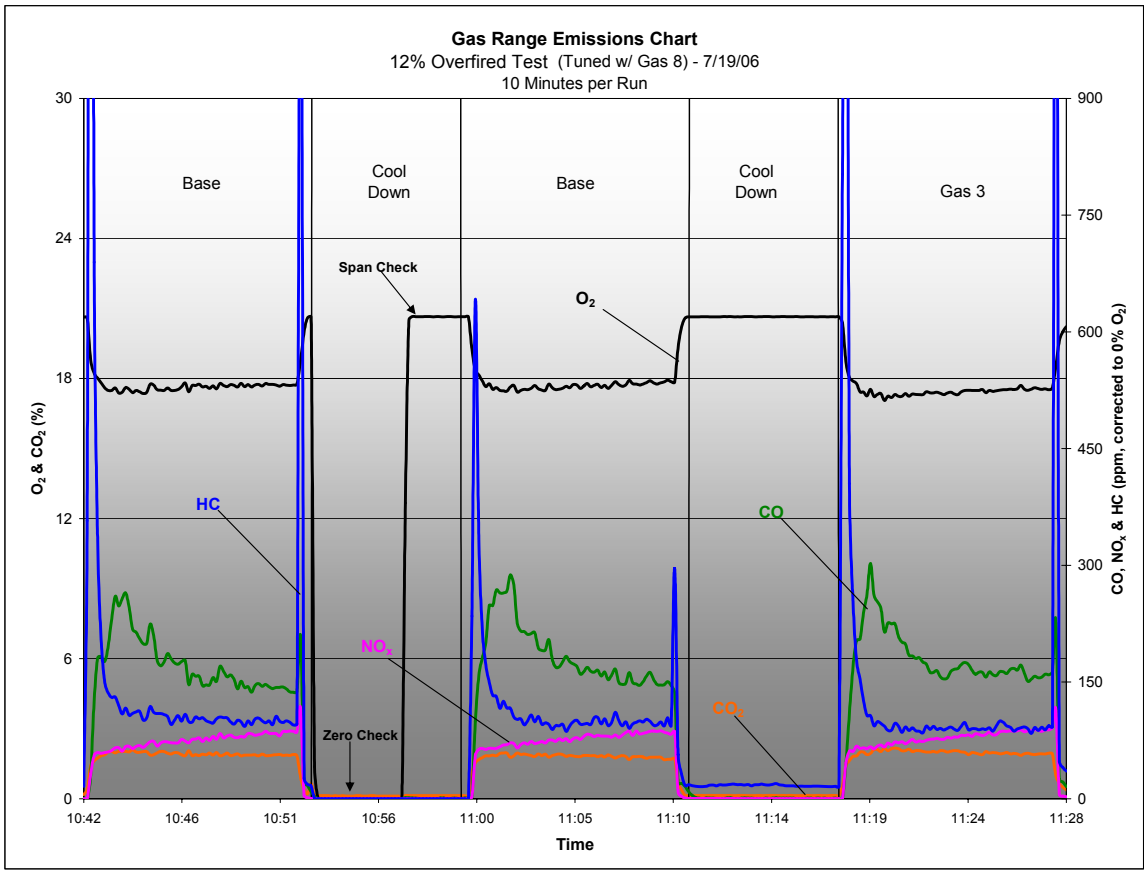
Temperatures (Chart 3)

When tuned with Gas 8, Average Knob and Average broiler temperatures were both highest with Gas 3, with temperatures of 101°F and 200°F, respectively. Maximum average flue temperature was 357°F with Gas 3.



Emissions

Average NO_X emissions increased from 72 ppm (Base Gas- second run) to 76 ppm (Gas 3), CO emissions increased from 166 ppm (Base Gas- first run) to 175 ppm (Gas 3) and HC emissions increased from 107 ppm (Base Gas- second run) to 123 ppm (Base Gas- first run).

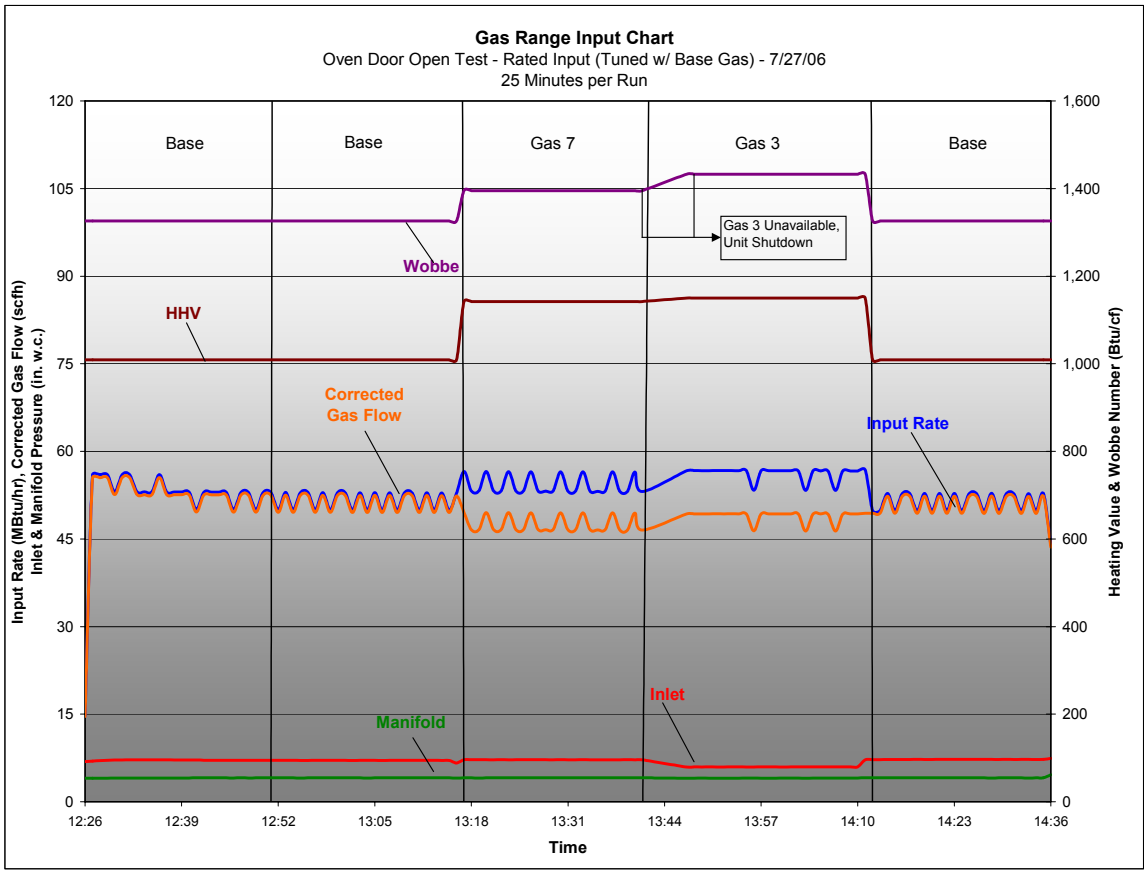


NOTE: Emission test results are for information purposes, they were not the result of certified tests.

Oven Door Open Tests - (Tuned w/ Base Gas)

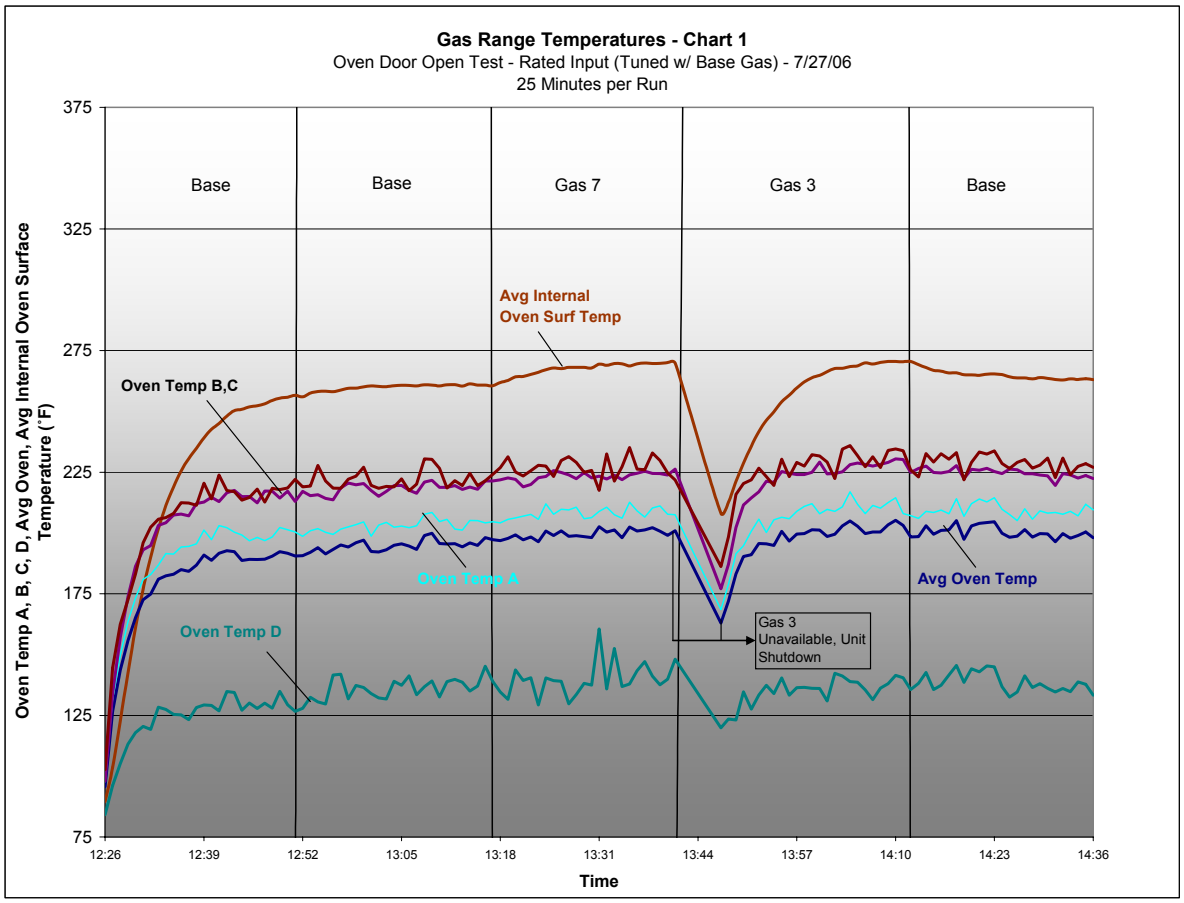
Input

The average minimum and maximum input rate was 51,726 Btu/hr (Base Gas- second run) and 56,227 Btu/hr (Gas 3). The corrected gas flow ranged from 48 scfh (Gas 7) to 53 scfh (Base Gas - first run). Inlet and manifold pressures remained stable throughout the course of the test.



Temperatures (Chart 1)

Average oven temperature increased from 185°F (Base Gas) to 200°F (Gas 7). Average internal oven surface temperature decreased from 268°F (Gas 7) to 228°F (Base Gas). Overall, the richer gases generated slightly higher temperatures.

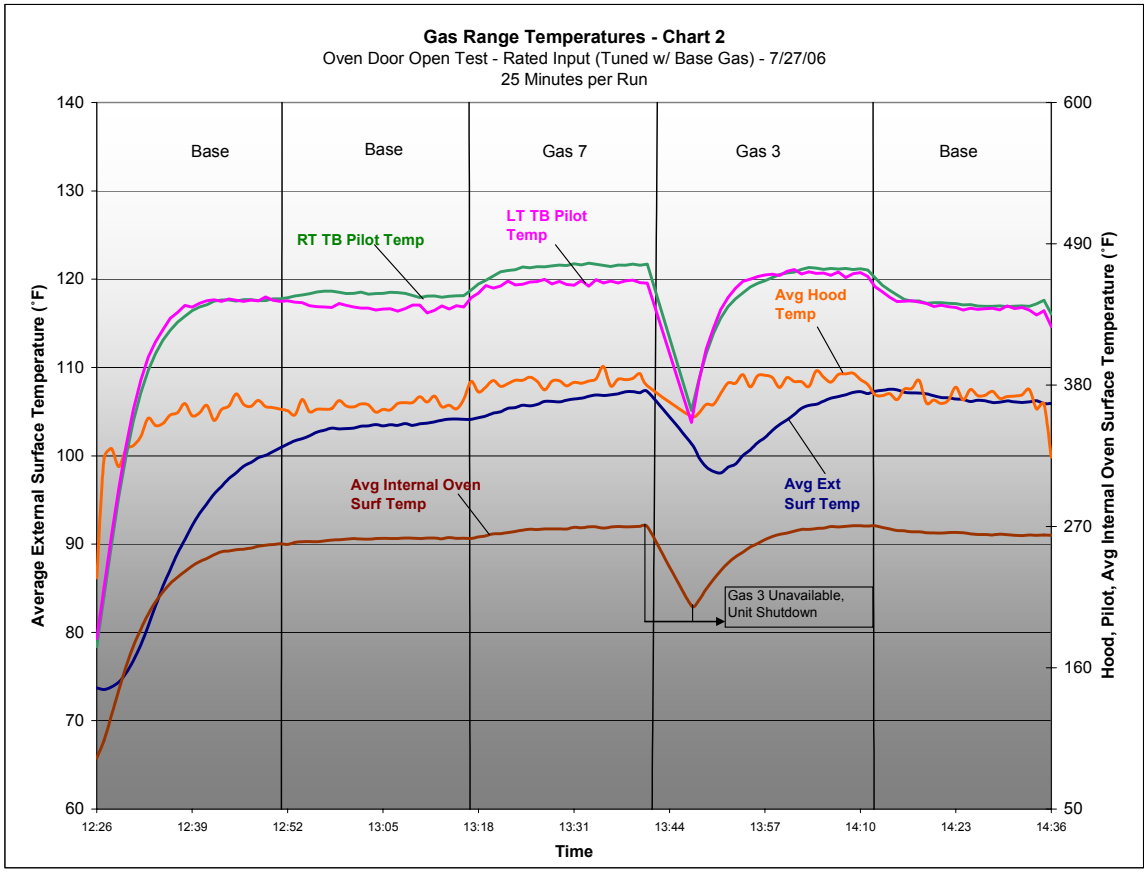


Temperatures (Chart 2)

Surface above pilot — left top burner pilot (LT TB Pilot) average temperature ranged from 462°F (Gas 3) to 423°F (Base Gas).

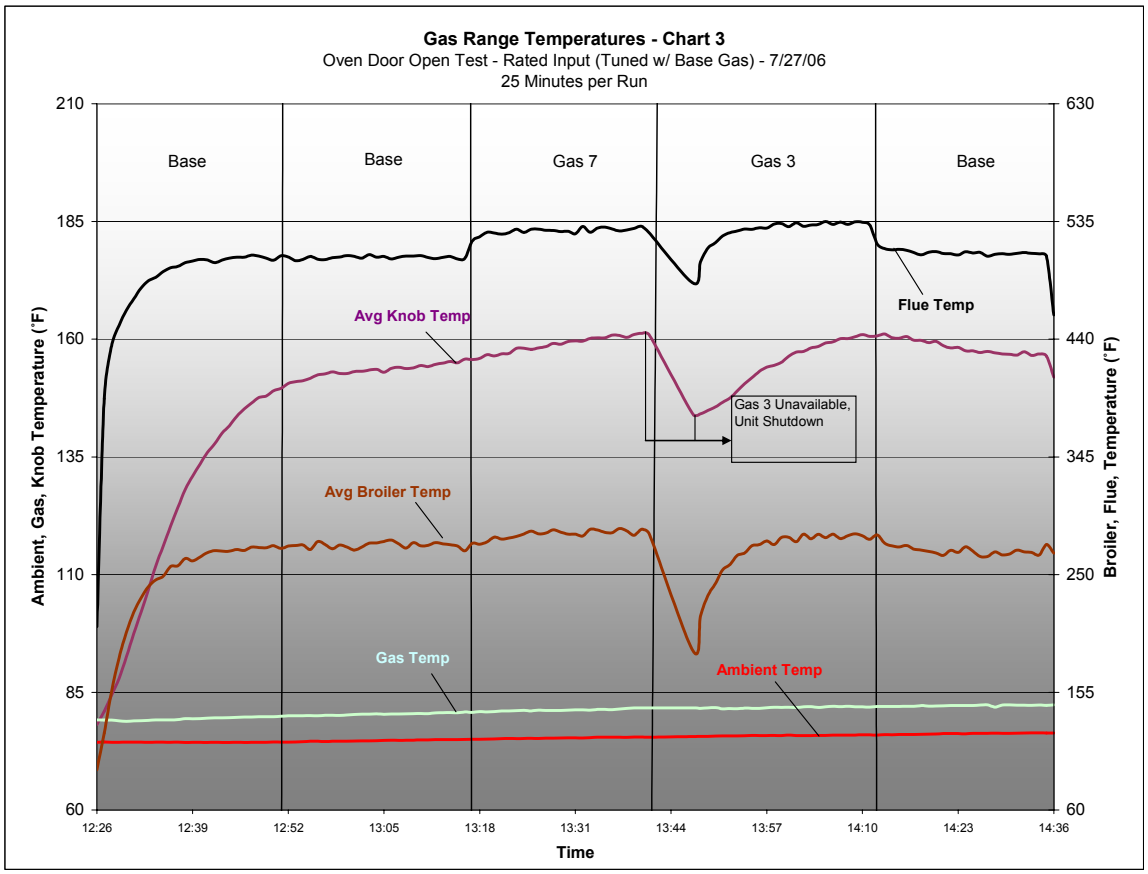
Surface above pilot — right top burner pilot (RT TB pilot) average temperature ranged from 418°F (Base Gas) to 472°F (Gas 7).

Average external surface temperatures ranged from 91°F (Base Gas) to 106°F (Gas 7).



Temperatures (Chart 3)

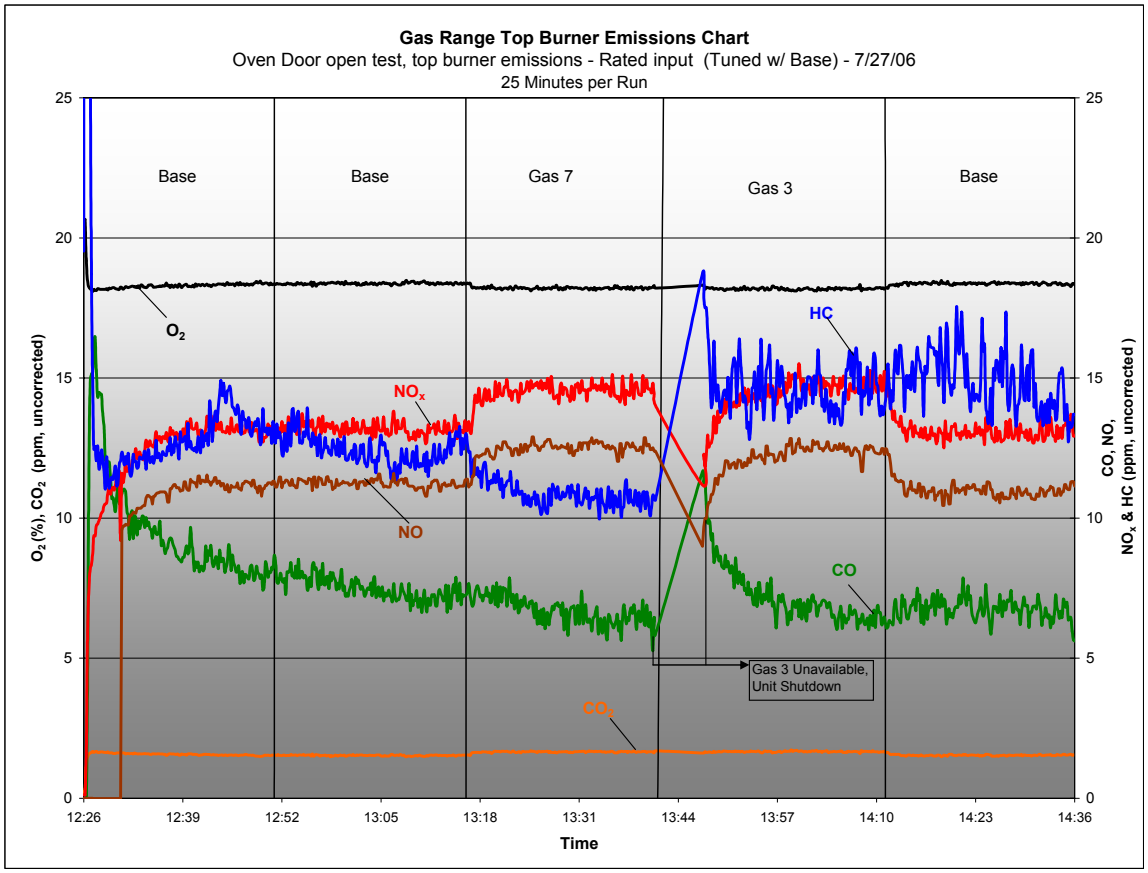
Gas 7 generate the highest average knob (159°F) and average broiler (283°F) temperatures. The richer gases produced slightly higher flue temperatures.



Emissions (Top Burners Hood)

All emissions reported are uncorrected because of the high percentage of O_2 in the sample.

Average NO_X emissions increased from 13 ppm (Base Gas - first run) to 15 ppm (Gas 7 & 3). CO emissions increased from 7 ppm (Gas 7) to 9 ppm (Base Gas- first run), and HC emissions increased from 11ppm (Gas 7) to 15 ppm (Base Gas - third run). NO emissions increased from 11 ppm (Base Gas - third run) to 13 (Gas 7). Changes in CO_2 & O_2 remained negligible throughout the test.

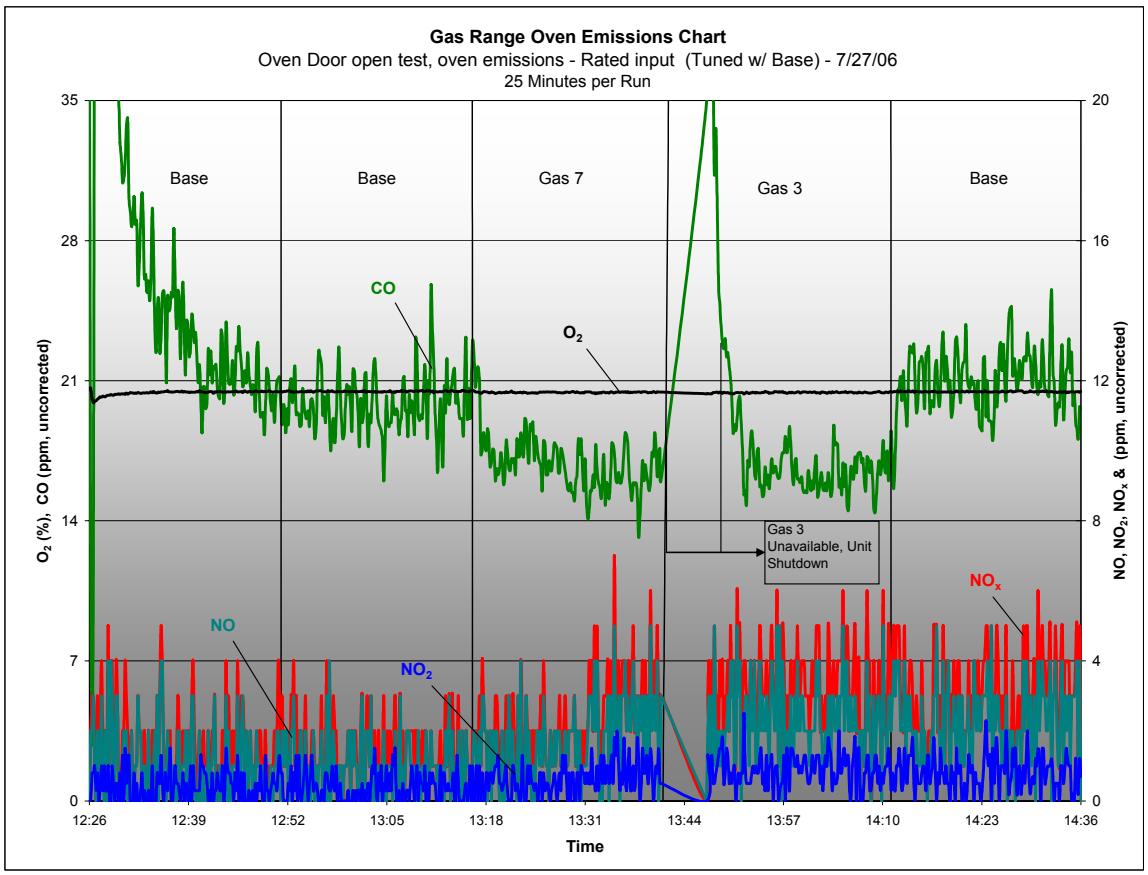


NOTE: Emission test results are for information purposes, they were not the result of certified tests.

Emissions (Oven Hood)

All emissions reported are uncorrected because of the high percentage of O_2 in the sample.

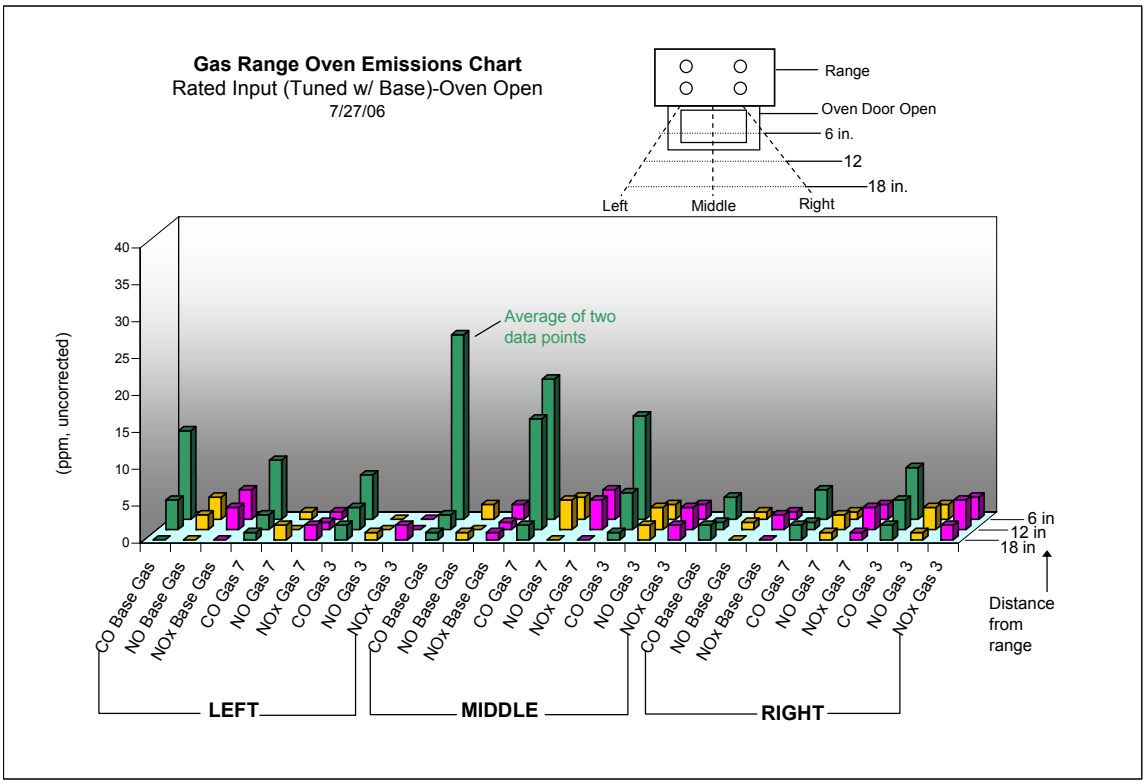
Average NO_X emissions increased from 1 ppm (Base Gas - second run) to 3 ppm (Gas 3). Average CO emissions increased from 17 ppm (Gas 7) to 27 ppm (Base Gas – first run) and average NO emissions increased from 1 ppm (First & Second Base Gas run) to 2 ppm (Last Base Gas Run, Gas 7 & 3). NO_2 emissions ranged from 0 ppm (Base Gas) to 1 ppm (Gas 7 & 3). Changes in O_2 were negligible throughout the test.



NOTE: Emission test results are for information purposes, they were not the result of certified tests.

Hand held emissions Test with Oven Door Open – Rated Input (Tuned w/ Base Gas)

In general, as the distance from the range increased, all emission concentrations decreased. The highest CO emissions were 35 ppm with Base Gas (Middle at 6 in.). Since this CO reading was higher than all the other readings two measurements were made to corroborate it. The highest NO_X emissions were 4 ppm and it occurred with all the test gases — with Base Gas (Left at 6 in.), Gas 7 (Middle at 6 and 12 in.), and Gas 3 (Right 12 in.). The NO_2 were not more than 50% of total NO_X in any of the NO_X measurements. Emissions values reported are uncorrected.



NOTE: Emission test results are for information purposes, they were not the result of certified tests.

Cold Ignition Test

For each set-up gas (Base Gas and Gas 8), the appliance was turned “on” without any problems during all the ignition tests with Base Gas and Gas 3. After ignition, flames were stable and there was not flame lifting, flashback or yellow tipping.

Rated Input Test (Tuned w/ Base Gas)		
Gas	Start-Up #	Comment & Observation
Base	1	Normal and without delays
	2	Normal and without delays
	3	Normal and without delays
3	1	Normal and without delays
	2	Normal and without delays
	3	Normal and without delays
Rated Input Test (Tuned w/ Gas 8)		
Gas	Start-Up #	Comment & Observation
Base	1	Normal and without delays
	2	Normal and without delays
	3	Normal and without delays
3	1	Normal and without delays
	2	Normal and without delays
	3	Normal and without delays

Hot Ignition Test

For each set-up gas (Base Gas and Gas 8), the appliance turned “on” without any problems during all ignition tests with Base Gas and Gas 3. After ignition, flames were stable and there was not flame lifting, flashback or yellow tipping.

Rated Input Test (Tuned w/ Base Gas)		
Gas	Start-Up #	Comment & Observation
Base	1	Normal and without delays
	2	Normal and without delays
	3	Normal and without delays
3	1	Normal and without delays
	2	Normal and without delays
	3	Normal and without delays
Rated Input Test (Tuned w/ Gas 8)		
Gas	Start-Up #	Comment & Observation
Base	1	Normal and without delays
	2	Normal and without delays
	3	Normal and without delays
3	1	Normal and without delays
	2	Normal and without delays
	3	Normal and without delays

Appendix A: Test Protocol

1. Standards

ANSI Z21.1-2000 **ANSI Z21.1a-2003**	Household Cooking Gas Appliances Addenda
SCAQMD Method 100.1	Instrumental analyzer procedure for continuous gaseous emissions

2. Gas Range Description

Description	Residential Gas Range
Burners	Top Burners: Four atmospheric 2"ϕ burners Oven Burner: One ribbon burner
Input Rate	Total: 54,400 Btu/hr Top Burners: Four at 9,100 btu/hr Oven Burner: One at 18,000 btu/hr
Type of fuel	Natural Gas
Required gas supply pressure	4.5 - 10.5 in. w.c.

3. Test Arrangement

The description of the test arrangement, contains sited material from referenced standards listed above.

3.1. Basic Setup

The range shall be installed with its back placed against a suitable test wall (as near as appliance construction will permit) and with the base of the appliance sealed to the floor for a vertical distance of ½ inch at the front and sides but not at the rear. Leg levelers, when provided, shall be removed. The back wall shall be black painted ¾" plywood. Installed appliance shall meet the minimum clearances specified by the manufacturer.

3.2. Oven and Broiler Load selection

In order to simulate a load, a brick and metal flange are to be placed inside the oven and a an additional brick in the broiler By adding the brick and metal flange, the broiler could remain "ON" longer without the thermostat reaching temperature set-point.

4. Test Gases

All test gases will adhere to the Southern California Gas Company's Gas Quality Specification (Rule 30), which is approved by the California Public Utilities Commission (CPUC).

The following gases have been specifically formulated to cover the range of gas compositions and calorific values of natural gases that could be delivered in the Southern California Gas Company territory by current natural gas suppliers and future LNG suppliers. Composition details are specified in Appendix C.

Gas	**Wobbe Number** (Btu/cf)	**Heating Value** (Btu/cf)
Base	1,322 (Low Wobbe)	1,008 (Low heat content)
3	1,433 (Highest Wobbe)	1,150 (Highest heat content)
6	1,408 (High Wobbe)	1,106 (High heat content)
7	1,395 (High Wobbe)	1,142 (Highest heat content)
8	1,342 (Medium Wobbe)	1,066 (medium heat content)

5. Basic Operating Condition

Unless required otherwise by specific test requirements, the following are to apply:

5.1. Room temperature

A temperature between 67 – 87°F shall be maintained. The temperature shall be determined by means of 4 J-Type thermocouples, the junctions of which are shielded from radiation. The thermocouple leads shall be connected to a data logger, and room temperature shall be the average of the four individual temperature readings.

5.2. Oven Heating Capacity

Ovens and their controls shall be measured by a data logger and five parallel-connected thermocouples, one located at the center, and the other four equally spaced between the center and corners of the oven on the diagonals of a horizontal plane through the center of the oven. Ovens and their controls shall be designed so the oven temperature can be increased from room temperature to 400˚F within 10 minutes.

5.3. Combustion

An appliance shall not produce a concentration of carbon monoxide in excess of 0.08 percent in an air-free sample of the flue gases when the appliance is tested in a room having approximately a normal oxygen supply.

5.4. Test Pressures and Burner Adjustments

Unless otherwise stated, all tests will be conducted at an inlet pressure of

7.0 ± 0.8 in. w.c and at the rated input of the appliance (within ± 5%). When operated for 20 minutes (starting with all parts of the appliance at room temperature) the burner adjustments shall be within ± 5% of the manufacturer's specified hourly Btu input rating. Primary air shall be set to give a good flame at this adjustment and neither burner ratings nor primary air adjustments shall be changed during a series of tests with any one test gas. Any adjustments resulting in an appreciable deposit of carbon during any of the tests specified shall not be acceptable.

5.5. Burner Operating Characteristics

The gas from the main burners and ignition devices shall be effectively ignited without delayed ignition or flashback when turned on and off at an inlet pressure of 7.0 ± 0.8 in. w.c and at the rated input of the appliance (within ± 5%), either manually or by a thermostatically actuated control device. When ignition is made, the flames shall not flash outside the appliance. Burners shall ignite, operate and extinguish without any undue noise.

5.6. Thermostats

With the thermostat calibrated at 350˚F, dial settings from the lowest dial marking to 500˚F shall control oven temperature to within ±10˚F per 100˚F of difference in the dial setting from the 350˚F position.

5.7. Flue Gas Temperature

The average temperature of the flue gases from an oven, broiler, or combustion oven and broiler designed to be connected to a venting system shall not exceed 480˚F above room temperature.

5.8. Evaluation of Burn Hazard Potential of Exterior Surfaces

The temperatures of exterior surfaces of the appliance, when tested as specified in the following method of Test, shall not exceed the temperatures listed in table XII (of the referenced protocol), Maximum Surface Temperature.

5.9. Temperatures of Handles, Knobs and Touch pads

The temperatures on door handles, valve handles, thermostat knobs, and any other knobs, touch pads or handles employed during normal cooking operations shall not exceed those specified in table XIII, Maximum Handle and Knob Temperatures.

5.10. Wall, Floor, and Enclosed Temperatures

The temperature on the floor beneath a floor-supported unit shall not be more than 90˚F in excess of room temperature. The temperature at any point on a surface located directly above a storage compartment shall not be more than 232˚F in excess of room temperature of 70˚F.

5.11. Inlet and Manifold Pressures

Inlet pressure will be measured just before the boiler gas control and manifold pressure will be measured after the boiler gas control or at the supplied pressure taps.

5.12. Setup Gas Input Rate

The input rate is to be that combination of gas orifice size, inlet gas pressure and manifold pressure required to deliver the appliance input rate with the Setup Gas. Input rate, inlet gas pressure and manifold pressure are to be within the tolerances specified by testing standards and/or manufacturers specifications. The appliance input rate will be verified after the appliance has been operated for 15 minutes from a cold start (i.e. all parts of the appliance are at room temperature). With gases other than the Setup Gas, the firing rate generally will *not* be at rated input**.**

6. Testing

6.1. Rated Input — Tuned with Base Gas

Before commencement of each test, 4 flat-bottom test utensils, containing 5 pounds of water, are to be placed on each of the top burners. Per protocol, two of these utensils shall be placed over a cast iron griddle. Testing hood shall be lowered to a pre-determined height of two inches from top of range to underside of hood. Gas range shall be operated at an inlet pressure of 7.0 ± 0.8 in. w.c and at its appliance rated input (within ± 5%) with Base Gas. Data collection shall be initiated, and proper operations of all equipment shall be verified. Overall, run cycle for each gas shall be twenty minutes.

Continue steady state operation for an additional twenty minutes. Allow oven surface temperature to be cooled to 100˚F to establish a baseline start period. Re-fill flat-bottom test utensils between each run.

When testing is conducted with all test gases, shut down range and examine the flue collector for presence of soot by means of the swab technique. If soot is found, clean surfaces and repeat testing with suspect gas blend(s), selected on the basis of earlier yellow tipping observations, to establish which gas(es) deposited soot in the appliance.

6.2. Rated Input — Tuned with Gas 8

Tune the appliance with Gas 8 to achieve the same input rate and similar performance (including emissions, temperatures, etc.) as with Base Gas. Follow the same procedures as specified in §6.1

6.3. Reduced and Increased Pressure Test — Tuned with Base Gas & Gas 8

Based on the information from manufacturers, consultants and the requirements of the test standards, adjust the appliance to operate under and over the rated

input. For this range, the under rate input should be achieved by reducing the inlet pressure to 3.5 in. w.c. The over rate input should be achieved by increasing the inlet pressure to 10.5 in. w.c., since the manifold pressure remained unaffected by the change in inlet pressure, per ANZI protocol:

"When the manifold pressure at increased inlet test pressure is not greater than the manifold pressure at normal inlet test pressure, the tests at increased inlet test pressure need not be applied."

From a cold start, record input and combustion data (O_2, NO_X, CO, CO_2 and HC) and verify that the firing rates are under and over the rated input after 15 minutes. If the burner modulates, automatically continue the test at operating input.

During testing, observe flames and note yellow tipping and flame lifting or flashback phenomena or lack of the same. Record these observations. If significant yellow tipping was observed, inspect flue collector and vent connection area and swab with a white cloth to determine if soot has been deposited. If soot is found, clean surfaces and repeat testing with suspect gas blend(s), selected on the basis of earlier yellow tipping observations, to establish which gas(es) deposited soot in the appliance.

6.4. 12% Over- fired Input— Tuned with Bas Gas

Adjust the manifold pressure to achieve a 12% increase over rated input- tuned w/ Base Gas. Start collecting temperature, pressures and emissions data while verifying proper operation of all equipment and instrumentation. Overall run cycle shall be ten minutes. Follow the same procedures as specified in §6.1

6.5. 12% Over- fired Input— Tuned with Gas 8

Adjust the manifold pressure to achieve a 12% increase over rated input- tuned w/ Gas 8. Start collecting temperature, pressures and emissions data while verifying proper operation of all equipment and instrumentation. Overall run cycle shall be ten minutes. Follow the same procedures as specified in §6.2.

6.6. Oven Door Open Test – Rated

An additional hood was installed over the top of the oven's open door (See Appendix H) to collect oven emissions.

Operate the four top burners with no utensils, with broiler "ON" and with oven door open. Start collecting temperature, pressures and emissions data while verifying proper operation of all equipment and instrumentation. Overall run cycle shall be twenty five minutes.

6.7. Oven Door Open Test (Hand held spot check) – Rated Input (Tuned w Base Gas)

Operate the four top burners with no utensils, with broiler "ON" and with oven door open. During this test, with a hand held probe, record emissions values at 6, 12 and 18 inches from front of oven, at three positions (left, center, right), for a total of nine readings per gas.

7. Ignition Tests

Shortly after and during ignition, observe flames and note yellow tipping, flame lifting or flashback phenomena or lack of the same.

7.1. Cold Ignition Test (Tuned w/ Base Gas)

With the appliance at room temperature and at the maximum allowable input rate achieved during initial tuning with Base Gas, purge the gas delivery system with Base Gas. Using Base Gas, turn the appliance "ON" and document any combustion, ignition or flame irregularities. Allow the appliance to cool down to room temperature then repeat this procedure 2 more times.

Purge the gas delivery system with Gas 3. Using Gas 3, turn the appliance "ON" and document any combustion, ignition or flame irregularities. Allow the appliance to cool down to room temperature then repeat this procedure 2 more times.

7.2. Cold Ignition Test (Tuned w/ Gas 8)

Follow the same procedure as Cold Ignition Test (Tuned w/ Base Gas) but substitute Base Gas with Gas 8.

7.3. Hot Ignition Test (Tuned w/ Base Gas)

With the appliance at steady state temperatures and at the maximum allowable input rate achieved during initial tuning with Base Gas, purge the gas delivery system with Base Gas. Using Base Gas, turn the appliance "ON" and document any combustion, ignition or flame irregularities. Repeat this procedure 2 more times without allowing the appliance to cool down.

Purge the gas delivery system with Gas 3. Using Gas 3, turn the appliance "ON" and document any combustion, ignition or flame irregularities. Repeat this procedure 2 more times without allowing the appliance to cool down.

7.4. Hot Ignition Test (Tuned w/ Gas 8)

Follow the same procedure as Cold Ignition Test (Tuned w/ Base Gas) but substitute Base Gas with Gas 8.

8. Additional Testing

Conduct additional testing and/or testing with other gas blends, per the Phase II

protocol, when test results or observations indicate it is necessary.

If indicated additional testing is outside of the project scope, include appropriate comment in the test report.

Appendix B: Tables of Averages

Rated Input Test (Tuned w/ Base Gas)

Table of Averages Gas Range Rated Input (Tuned with Base Gas) 07/12/2006							
Gases	**Base**	**Base**	**3**	**6**	**7**	**8**	**Base**
HHV (Btu/cf)	1,006	1,006	1,150	1,106	1,142	1,066	1,006
Wobbe (Btu/cf)	1,320	1,320	1,433	1,408	1,396	1,342	1,320
Input Rate (Btu/hr)	53,107	52,631	57,008	55,946	55,097	53,112	51,975
Corrected Gas Flow (scfh)	52.8	52.3	49.6	51.0	48.2	49.8	51.7
Emissions (not from certified tests)							
O_2 (%)	18.3	18.3	18.0	18.0	17.8	17.8	17.9
CO_2 (%)	1.48	1.47	1.67	1.68	1.82	1.76	1.72
CO (ppm @ 0% O_2)	242.3	254.4	263.3	221.8	204.3	184.8	182.1
HC (ppm @ 0% O_2)	126.2	140.5	123.2	138.9	125.3	124.9	117.0
NO_X (ppm @ 0% O_2)	82.8	82.6	85.1	86.4	84.9	85.5	83.9
Ultimate CO_2 (%)	11.8	11.8	12.0	11.9	12.1	12.0	12.0
Equivalence Ratio (Φ)	0.14	0.14	0.15	0.15	0.16	0.16	0.16
Temperatures (°F)							
Gas Temp	72.0	71.9	72.9	75.2	76.7	79.1	80.3
Avg. Flue Temp	291.9	313.1	317.2	319.5	331.7	325.0	319.6
Avg. Broiler Temp	179.9	188.3	204.2	205.6	213.4	209.3	212.1
Avg. Hood Temp	209.5	217.8	228.2	226.2	237.0	228.7	228.7
RT TB Pilot	586.7	596.9	659.7	619.9	634.1	589.3	635.2
LT TB Pilot	625.3	582.3	733.4	711.5	661.8	699.3	686.2
Oven Temp A	374.6	384.8	409.7	405.7	409.4	400.3	416.9
OvenTemp B	348	358.9	381.6	381.7	382.7	375.2	371.4
Oven Temp C	341.8	353.5	376.6	375.5	378.1	370.7	367.3
Oven Temp D	348.0	355.8	378.7	378.4	381.8	372.5	367.8
Oven Temp E	256.7	283.1	306.5	316.1	318.5	316.5	312.7
Avg. Oven Temp	353.0	363.2	386.6	385.3	388.0	379.7	375.8
Avg. External Surface Temp	85.2	87.3	90.5	91.0	98.2	97.6	96.7
Avg. Knob Temp	98.7	102.4	105.8	104.1	110.1	108.2	108.5
Avg. Internal Oven Surface Temp	297.2	308.2	327.7	325.8	327.7	321.0	317.9
Pressures (in. w.c.)							
Inlet	7.1	7.2	7.0	7.1	7.0	7.1	7.2
Manifold	4.1	4.1	4.1	4.1	4.1	4.1	4.1

Rated Input Test (Tuned w/ Gas 8)

Table of Averages Gas Range Rated Input (Tuned with Gas 8) 07/13/2006							
Gases	**8**	**8**	**Base**	**6**	**7**	**3**	**8**
HHV (Btu/cf)	1,066	1,066	1,009	1,106	1,142	1,150	1,066
Wobbe (Btu/cf)	1,342	1,342	1,323	1,408	1,396	1,433	1,342
Input Rate (Btu/hr)	52,282	51,813	50,850	54,500	53,389	55,089	51,520
Corrected Gas Flow (scfh)	49.0	48.6	50.4	49.3	46.8	47.9	48.3
Emissions (not from certified tests)							
O_2 (%)	18.1	18.1	18.1	17.9	17.8	17.8	18.0
CO_2 (%)	1.65	1.69	1.68	1.81	1.88	1.85	1.74
CO (ppm @ 0% O_2)	204.8	197.9	262.6	239.0	245.2	276.4	284.8
HC (ppm @ 0% O_2)	92.8	74.8	101.5	100.1	112.8	326.5	244.8
NO_X (ppm @ 0% O_2)	81.0	81.9	83.5	84.8	85.4	84.7	83.8
Ultimate CO_2 (%)	12.5	12.5	12.5	12.5	12.7	12.6	12.5
Equivalence Ratio (Φ)	0.1	0.1	0.1	0.2	0.2	0.2	0.2
Temperatures (°F)							
Gas Temp	79.0	82.2	82.7	83.1	84.3	84.9	85.5
Avg. Flue Temp	317.5	328.5	316.7	325.8	336.1	346.3	335.1
Avg. Broiler Temp	186.0	202.5	209.0	219.0	225.3	223.5	221.0
Avg. Hood Temp	240.0	241.5	239.2	234.9	236.9	246.6	230.6
RT TB Pilot	599.8	642.2	606.4	674.3	647.9	611.1	517.5
LT TB Pilot	712.1	732.2	719.7	640.8	645.8	711.2	646.3
Oven Temp A	386.1	394.8	397.2	410.0	415.6	420.9	404.6
OvenTemp B	358	368.1	374.3	386.0	390.3	394.1	382.2
Oven Temp C	351.7	362.3	369.9	380.7	385.5	390.0	378.3
Oven Temp D	360.8	368.2	371.3	386.6	391.6	394.9	380.2
Oven Temp E	264.4	292.1	308.9	319.3	325.6	328.3	326.0
Avg. Oven Temp	364.3	373.3	378.2	390.8	395.8	400.0	386.4
Avg. External Surface Temp	96.8	100.9	99.8	101.9	103.0	103.7	104.1
Avg. Knob Temp	106.6	112.7	115.4	116.5	119.2	118.2	118.4
Avg. Internal Oven Surface Temp	305.7	314.3	321.1	331.0	334.0	337.5	327.1
Pressures (in. w.c.)							
Inlet	7.0	7.0	7.1	6.9	7.1	7.0	7.2
Manifold	3.9	3.9	3.9	3.9	3.9	3.9	3.9

Increased & Reduced Inlet Pressure Tests (Tuned w/ Base Gas)

Table of Averages Gas Range Increase/Reduced Inlet Pressure (Tuned with Base Gas) July 12, 2006				
Gases	**Base**	**3**	**Base**	**3**
HHV (Btu/cf)	1,006	1,150	1,006	1,150
Wobbe (Btu/cf)	1,320	1,433	1,320	1,433
Input Rate (Btu/hr)	54,943	59,334	45,154	49,936
Corrected Gas Flow (scfh)	54.6	51.6	44.9	43.4
Emissions (not from certified tests)				
O_2 (%)	17.8	17.6	18.5	18.5
CO_2 (%)	1.80	1.91	1.39	1.43
CO (ppm @ 0% O_2)	250.0	236.1	498.4	626.8
HC (ppm @ 0% O_2)	137.4	109.0	206.7	138.5
NO_X (ppm @ 0% O_2)	68.1	75.4	72.7	72.2
Ultimate CO_2 (%)	12.1	12.3	12.2	12.3
Equivalence Ratio (Φ)	0.16	0.17	0.14	0.15
Temperatures (°F)				
Gas Temp	77.9	78.5	79.1	79.3
Avg. Flue Temp	211.3	226.0	193.8	197.7
Avg. Broiler Temp	144.5	151.6	144.1	145.5
Avg. Hood Temp	158.4	173.4	155.0	154.4
RT TB Pilot	304.0	397.6	339.0	359.7
LT TB Pilot	355.3	454.5	377.3	390.8
Oven Temp A	205.9	210.6	190.9	191.6
OvenTemp B	196	196.2	177.2	178.1
Oven Temp C	189.2	191.9	175.5	174.6
Oven Temp D	189.7	193.2	174.2	175.7
Oven Temp E	210.9	195.5	183.6	178.5
Avg. Oven Temp	195.2	198.0	179.5	180.0
Avg. External Surface Temp	77.1	84.3	84.7	85.7
Avg. Knob Temp	80.0	79.5	80.8	80.8
Avg. Internal Oven Surface Temp	147.6	149.7	138.5	139.7
Pressures (in. w.c.)				
Inlet	10.5	10.6	3.6	3.5
Manifold	4.1	4.1	3.0	3.0

Increased & Reduced Inlet Pressure Tests (Tuned w/ Gas 8)

Table of Averages Gas Range Increase/Reduced Inlet Pressure (Tuned with Gas 8) July 12, 2006				
Gases	**Base**	**3**	**Base**	**3**
HHV (Btu/cf)	1,009	1,150	1,009	1,150
Wobbe (Btu/cf)	1,320	1,433	1,320	1,433
Input Rate (Btu/hr)	51,842	54,965	43,885	49,386
Corrected Gas Flow (scfh)	51.4	47.8	43.5	42.9
Emissions (not from certified tests)				
O_2 (%)	17.9	17.7	18.1	17.9
CO_2 (%)	1.83	1.91	1.69	1.81
CO (ppm @ 0% O_2)	277.2	310.3	562.8	684.7
HC (ppm @ 0% O_2)	129.3	95.7	198.9	358.5
NO_X (ppm @ 0% O_2)	66.9	72.4	71.0	71.9
Ultimate CO_2 (%)	12.6	12.6	12.6	12.7
Equivalence Ratio (Φ)	0.16	0.17	0.15	0.16
Temperatures (°F)				
Gas Temp	83.9	84.8	85.6	85.3
Avg. Flue Temp	253.2	277.0	240.7	267.3
Avg. Broiler Temp	157.7	163.9	155.2	160.2
Avg. Hood Temp	185.8	203.8	187.8	201.9
RT TB Pilot	379.2	480.4	414.9	483.1
LT TB Pilot	442.9	508.9	443.5	418.0
Oven Temp A	252.8	258.2	239.7	253.8
OvenTemp B	234.2	237.9	217.9	230.5
Oven Temp C	224.7	227.1	210.3	220.2
Oven Temp D	230.1	235.6	215.5	228.4
Oven Temp E	227.9	215.6	208.9	208.5
Avg. Oven Temp	235.5	239.7	220.9	233.2
Avg. External Surface Temp	84.1	88.8	89.8	89.0
Avg. Knob Temp	84.5	91.3	93.7	95.2
Avg. Interanal Oven Surface Temp	165.6	168.1	157.0	164.7
Pressures (in. w.c.)				
Inlet	10.5	10.6	3.6	3.5
Manifold	3.9	3.9	3.0	2.9

12% Overfired Tests (Tuned w/ Base Gas)

Table of Averages Gas Range 12% Overfired Test (Tuned with Base Gas) July 18, 2006			
Gases	**Base**	**Base**	**Gas 3**
HHV (Btu/cf)	1,007	1,007	1,150
Wobbe (Btu/cf)	1,322	1,322	1,433
Input Rate (Btu/hr)	60,235	58,667	64,566
Corrected Gas Flow (scfh)	59.8	58.3	56.1
Emissions (not from certified tests)			
O_2 (%)	17.7	17.9	17.6
CO_2 (%)	1.90	1.79	1.96
CO (ppm @ 0% O_2)	166.2	152.0	145.0
HC (ppm @ 0% O_2)	281.5	125.1	122.7
NO_X (ppm @ 0% O_2)	66.2	69.1	70.6
Ultimate CO_2 (%)	12.3	12.3	12.5
Equivalence Ratio (Φ)	0.17	0.16	0.17
Temperatures (°F)			
Gas Temp	77.4	79.8	81.3
Avg. Flue Temp	327.9	349.7	356.4
Avg. Broiler Temp	157.8	175.0	189.4
Avg. Hood Temp	240.3	245.5	253.2
RT TB Pilot	598.9	689.3	721.2
LT TB Pilot	659.8	667.3	672.6
Oven Temp A	322.0	340.7	359.9
OvenTemp B	294.6	315.1	329.3
Oven Temp C	284.8	305.1	321.9
Oven Temp D	305.1	320.8	332.0
Oven Temp E	238.1	258.4	275.8
Avg. Oven Temp	301.6	320.4	335.8
Avg. External Surface Temp	82.1	90.7	91.4
Avg. Knob Temp	87.1	99.4	100.9
Avg. Internal Oven Surface Temp	225.0	245.8	256.8
Pressures (in. w.c.)			
Inlet	8.7	8.7	8.7
Manifold	4.9	4.9	4.9

12% Overfired Tests (Tuned w/ Gas 8)

Table of Averages Gas Range 12% Overfired Test (Tuned with Gas 8) July 19, 2006			
Gases	**Base**	**Base**	**Gas 3**
HHV (Btu/cf)	1,010	1,010	1,150
Wobbe (Btu/cf)	1,327	1,327	1,433
Input Rate (Btu/hr)	58,427	57,432	62,716
Corrected Gas Flow (scfh)	57.8	56.9	54.5
Emissions (not from certified tests)			
O_2 (%)	17.8	17.9	17.6
CO_2 (%)	1.83	1.73	1.90
CO (ppm @ 0% O_2)	165.9	172.6	175.1
HC (ppm @ 0% O_2)	122.8	107.3	116.4
NO_X (ppm @ 0% O_2)	72.4	72.1	75.5
Ultimate CO_2 (%)	12.9	11.8	11.9
Equivalence Ratio (Φ)	0.16	0.16	0.17
Temperatures (°F)			
Gas Temp	78.9	79.0	79.2
Avg. Flue Temp	334.6	331.8	356.9
Avg. Broiler Temp	185.7	188.8	200.0
Avg. Hood Temp	232.0	246.6	265.8
RT TB Pilot	479.4	566.3	596.6
LT TB Pilot	643.3	666.1	653.2
Oven Temp A	356.2	349.9	371.8
OvenTemp B	327.8	324.6	342.4
Oven Temp C	323.8	317.5	333.7
Oven Temp D	331.1	329.9	349.8
Oven Temp E	308.1	307.1	326.0
Avg. Oven Temp	334.7	330.5	349.4
Avg. External Surface Temp	83.9	85.9	88.4
Avg. Knob Temp	92.6	95.8	101.4
Avg. Internal Oven Surface Temp	259.5	254.9	269.4
Pressures (in. w.c.)			
Inlet	7.4	7.4	7.2
Manifold	4.9	5.0	4.9

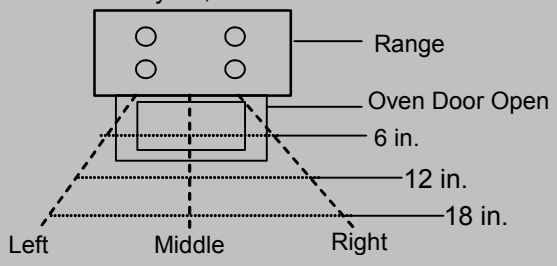
Oven Door Open Tests (Tuned w/ Base Gas)

Table of Averages Gas Range Oven Door Open Test, Top Burner Emissions (Tuned with Base Gas) July 27, 2006					
Gases	**Base**	**Base**	**Gas 7**	**Gas 3**	**Base**
HHV (Btu/cf)	1,009	1,009	1,142	1,150	1,009
Wobbe (Btu/cf)	1,326	1,326	1,395	1,433	1,326
Input Rate (Btu/hr)	53,162	51,726	54,235	56,227	51,178
Corrected Gas Flow (scfh)	52.7	51.3	47.5	48.9	50.7
Emissions (not from certified tests)					
O_2 (%)	18.3	18.4	18.2	18.2	18.4
CO_2 (%)	1.57	1.53	1.65	1.67	1.54
CO (ppm, uncorrected)	8.8	7.4	6.6	6.8	6.7
NO (ppm, uncorrected)	11.0	11.2	12.5	12.4	10.9
NO_X (ppm, uncorrected)	12.9	13.2	14.6	14.6	13.0
HC (ppm, uncorrected)	12.9	12.3	10.7	14.5	14.8
Ultimate CO_2 (%)	12.6	12.7	12.9	12.8	12.7
Equivalence Ratio (Φ)	0.14	0.13	0.14	0.15	0.13
Temperatures (°F)					
Gas Temp	79.4	80.4	81.3	81.8	82.2
Avg. Flue Temp	495.8	506.1	527.8	530.6	507.1
Avg. Broiler Temp	254.3	273.7	283.4	274.2	268.6
Avg. Hood Temp	355.1	364.3	383.2	383.1	369.6
RT TB Pilot	418.4	450.9	472.3	460.9	443.1
LT TB Pilot	422.5	440.4	459.6	461.7	440.1
Oven Temp A	193.5	203.3	208.4	208.2	209.5
OvenTemp B	208.1	218.4	223.4	224.6	224.5
Oven Temp C	210.4	221.8	226.8	228.5	228.9
Oven Temp D	126.8	136.9	140.5	136.4	138.5
Oven Temp E	110.4	155.4	165.6	147.8	157.5
Avg. Oven Temp	184.7	195.1	199.8	199.4	200.3
Avg. External Surface Temp	90.8	103.4	106.3	103.6	106.5
Avg. Knob Temp	127.7	153.7	159.2	155.3	157.7
Avg. Internal Oven Surface Temp	228.2	260.2	268.2	260.1	264.4
Pressures (in. w.c.)					
Inlet	7.1	7.1	7.2	6.0	7.3
Manifold	4.1	4.1	4.1	4.1	4.1
Oven Door Open test, Oven emissions (Tuned with Base Gas)					
Emissions (not from certified tests)					
O_2 (%)	20.4	20.5	20.4	20.4	20.4
CO (ppm, uncorrected)	27	20	17	18	21
NO (ppm, uncorrected)	1	1	2	2	2
NO_2(ppm, uncorrected)	0	0	1	1	1
NO_X (ppm, uncorrected)	2	1	2	3	3

Hand held emissions Test – Rated Input (Tuned w/ Base Gas)

Average Emissions Close to the Gas Range
Tuned with Base Gas - Oven Door Open
Emissions are Uncorrected (ppm)

July 27, 2006



Position From front edge of the Range	Left			Midddle			Right		
	Base			Base			Base		
	CO	NO_X	NO_2	CO	NO_X	NO_2	CO	NO_X	NO_2
6 in.	12	4	1	35	2	0	3	1	0
12 in.	4	3	1	2	1	1	1	2	1
18 in.	0	0	0	1	1	0	2	0	0
	Gas 7			Gas 7			Gas 7		
	CO	NO_X	NO_2	CO	NO_X	NO_2	CO	NO_X	NO_2
6 in.	8	1	0	19	4	1	4	2	1
12 in.	2	1	1	15	4	0	1	3	1
18 in.	1	2	0	2	0	0	2	1	0
	Gas 3			Gas 3			Gas 3		
	CO	NO_X	NO_2	CO	NO_X	NO_2	CO	NO_X	NO_2
6 in.	6	0	0	14	2	0	7	3	1
12 in.	3	0	0	5	3	0	4	4	1
18 in.	2	2	1	1	2	0	2	2	1

Appendix C: Test Gases

Gas Sample Date	Baseline 7/12/2006	3 7/1/2005	6 7/1/2005	7 6/20/2005	8 8/5/2005
COMPONENTS	**MolPct**	**MolPct**	**MolPct**	**MolPct**	**MolPct**
C6 + 57/28/14	0.000	0.000	0.000	0.023	0.001
NITROGEN	0.2613	0.128	0.274	3.025	3.839
METHANE	96.6037	86.549	91.168	86.466	89.998
CARBON DIOXIDE	1.5528	0.035	0.003	0.034	0.120
ETHANE	1.1754	9.480	5.747	0.312	0.000
PROPANE	0.2805	2.725	1.727	9.946	5.997
i-BUTANE	0.0456	1.034	0.534	0.094	0.041
n-BUTANE	0.0461	0.000	0.531	0.061	0.000
NEOPENTANE	0.0000	0.000	0.000	0.000	0.000
i-PENTANE	0.0146	0.000	0.000	0.019	0.001
n-PENTANE	0.0093	0.000	0.000	0.016	0.001
OXYGEN	0.000	0.049	0.016	0.004	0.003
TOTAL	**99.989**	**100.000**	**100.000**	**100.000**	**100.000**
Compressibility Factor	0.9980	0.9972	0.9975	0.9971	0.9976
HHV (Btu/real cubic foot)	**1008.05**	**1150.00**	**1106.00**	**1142.00**	**1066.30**
LHV (Btu/real cubic foot)	990.47	1039.90	998.90	1033.40	963.10
Specific Gravity	0.5810	0.6442	0.6167	0.6697	0.6312
WOBBE Index	**1322.50**	**1432.81**	**1408.37**	**1395.49**	**1342.13**

Appendix D: Zero, Span and Linearity Tables

Rated Input Test (Tuned w/ Base Gas)

	Zero, Span & Linearity Data Gas Range Rated Input (Tuned w/ Base Gas) July 12, 2006	O_2 (%)	CO_2 (%)	CO (ppm)	HC (ppm)	NO_x (ppm)
	Analyzer Emission Ranges	**0 - 25**	**0 - 20**	**0 - 200**	**0 - 1000**	**0 - 100**
Zero	**Zero Calibration Gas (Low-Range Values)**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Zero	**Allowable Zero Drift (Less Than ± 3% of Range)**	**0.75**	**0.60**	**6.00**	**30.00**	**3.00**
Zero	Zero Calibration - 08:10:00 AM	-0.02	0.07	0.31	-1.01	0.00
Zero	Zero Drift Check - 1:23:00 PM	-0.02	0.11	-0.16	0.92	0.00
Zero	**Total Drift Over Test Period**	**0.00**	**0.04**	**0.47**	**1.93**	**0.00**
Zero	**Was the Zero Drift Within Allowable Deviation?**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Span	**Span Calibration Gas (High-Range Values)**	**20.19**	**12.15**	**181.00**	**443.00**	**44.70**
Span	**Allowable Span Drift (Less Than ± 3% of Range)**	**0.75**	**0.60**	**6.00**	**30.00**	**3.00**
Span	Span Calibration - 8:27:50 AM	20.13	12.22	182.84	441.74	44.73
Span	Span Drift Check - 1:26:30 PM	20.07	12.29	182.26	443.48	43.47
Span	**Total Drift Over Test Period**	**0.06**	**0.07**	**0.58**	**1.74**	**1.26**
Span	**Was the Span Drift Within Allowable Deviation?**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Linearity	**Linearity Calibration Gas (Mid-Range Values)**	**8.97**	**9.22**	**82.00**	**443.00**	**9.21**
Linearity	**Allowable Linearity Drift (Less Than ±1% of Range)**	**0.25**	**0.20**	**2.00**	**10.00**	**1.00**
Linearity	Linearity Check - 8:34:40 AM	8.95	9.40	81.54	440.48	8.96
Linearity	**Difference From Mid-Range Values**	**0.02**	**0.18**	**0.46**	**2.52**	**0.25**
Linearity	**Was the Linearity Within Allowable Deviation?**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Linearity	Linearity Check - 1:35:50 PM	8.90	9.42	80.44	443.87	8.91
Linearity	**Difference From Mid-Range Values**	**0.07**	**0.20**	**1.56**	**0.87**	**0.30**
Linearity	**Was the Linearity Within Allowable Deviation?**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Rated Input Test (Tuned w/ Gas 8)

	Zero, Span & Linearity Data Gas Range Rated Input (Tuned w/ Gas 8) July 13, 2006	O_2 (%)	CO_2 (%)	CO (ppm)	HC (ppm)	NO_x (ppm)
	Analyzer Emission Ranges	**0 - 25**	**0 - 20**	**0 - 200**	**0 - 1000**	**0 - 100**
Zero	**Zero Calibration Gas (Low-Range Values)**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Allowable Zero Drift (Less Than ± 3% of Range)	**0.75**	**0.60**	**6.00**	**30.00**	**3.00**
	Zero Calibration - 08:20:00 AM	-0.01	0.05	0.35	-0.98	0.00
	Zero Drift Check - 1:23:00 PM	-0.01	0.16	-2.17	-0.23	-0.04
	Total Drift Over Test Period	**0.00**	**0.11**	**2.52**	**0.75**	**0.04**
	Was the Zero Drift Within Allowable Deviation?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Span	**Span Calibration Gas (High-Range Values)**	**20.19**	**12.15**	**181.00**	**443.00**	**44.70**
	Allowable Span Drift (Less Than ± 3% of Range)	**0.75**	**0.60**	**6.00**	**30.00**	**3.00**
	Span Calibration - 8:23:00 AM	20.13	12.22	182.65	444.56	44.73
	Span Drift Check - 2:00:00 PM	20.11	12.34	180.18	446.79	44.66
	Total Drift Over Test Period	**0.02**	**0.12**	**2.47**	**2.23**	**0.07**
	Was the Span Drift Within Allowable Deviation?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Linearity	**Linearity Calibration Gas (Mid-Range Values)**	**8.97**	**9.22**	**82.00**	**443.00**	**9.21**
	Allowable Linearity Drift (Less Than ±1% of Range)	**0.25**	**0.20**	**2.00**	**10.00**	**1.00**
	Linearity Check - 8:30:00 AM	8.95	9.35	81.54	440.48	8.96
	Difference From Mid-Range Values	**0.02**	**0.13**	**0.46**	**2.52**	**0.25**
	Was the Linearity Within Allowable Deviation?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
	Linearity Check - 2:02:40 PM	8.93	9.32	80.68	446.62	9.43
	Difference From Mid-Range Values	**0.04**	**0.10**	**1.32**	**3.62**	**0.22**
	Was the Linearity Within Allowable Deviation?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Increased Decrease Inlet Pressure Tests - (Tuned w/ Base Gas)

	Zero, Span & Linearity Data Gas Range Increase/Reduced Inlet Pressure (Tuned with Base Gas) July 12, 2006	O_2 (%)	CO_2 (%)	CO (ppm)	HC (ppm)	NO_x (ppm)
	Analyzer Emission Ranges	**0 - 25**	**0 - 20**	**0 - 200**	**0 - 1000**	**0 - 100**
Zero	**Zero Calibration Gas (Low-Range Values)**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Allowable Zero Drift (Less Than ± 3% of Range)	**0.75**	**0.60**	**6.00**	**30.00**	**3.00**
	Zero Calibration - 02:09:00 PM	-0.02	0.10	-0.15	0.68	0.00
	Zero Drift Check - 3:18:00 PM	-0.02	0.07	0.95	-0.58	-0.01
	Total Drift Over Test Period	**0.00**	**0.03**	**1.10**	**1.26**	**0.01**
	Was the Zero Drift Within Allowable Deviation?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Span	**Span Calibration Gas (High-Range Values)**	**20.19**	**12.15**	**181.00**	**443.00**	**44.70**
	Allowable Span Drift (Less Than ± 3% of Range)	**0.75**	**0.60**	**6.00**	**30.00**	**3.00**
	Span Calibration - 2:14:50 PM	20.16	12.21	183.32	442.74	44.62
	Span Drift Check - 3:22:00 PM	20.15	12.21	183.20	446.18	44.04
	Total Drift Over Test Period	**0.01**	**0.00**	**0.12**	**3.44**	**0.58**
	Was the Span Drift Within Allowable Deviation?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Linearity	**Linearity Calibration Gas (Mid-Range Values)**	**8.97**	**9.22**	**82.00**	**443.00**	**9.21**
	Allowable Linearity Drift (Less Than ±1% of Range)	**0.25**	**0.20**	**2.00**	**10.00**	**1.00**
	Linearity Check - 2:19:07 PM	8.95	9.48	80.62	442.64	9.00
	Difference From Mid-Range Values	**0.02**	**0.26**	**1.38**	**0.36**	**0.21**
	Was the Linearity Within Allowable Deviation?	**Yes**	**No**	**Yes**	**Yes**	**Yes**
	Linearity Check - 3:26:19 PM	8.96	9.44	80.20	445.11	9.03
	Difference From Mid-Range Values	**0.01**	**0.22**	**1.80**	**2.11**	**0.18**
	Was the Linearity Within Allowable Deviation?	**Yes**	**No**	**Yes**	**Yes**	**Yes**

Increased Decrease Inlet Pressure Tests - (Tuned w/ Gas 8)

	Zero, Span & Linearity Data Gas Range Increase/Reduced Inlet Pressure (Tuned with Gas 8) July 13, 2006	O_2 (%)	CO_2 (%)	CO (ppm)	HC (ppm)	NO_x (ppm)
	Analyzer Emission Ranges	**0 - 25**	**0 - 20**	**0 - 200**	**0 - 1000**	**0 - 100**
Zero	**Zero Calibration Gas (Low-Range Values)**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Allowable Zero Drift (Less Than ± 3% of Range)	**0.75**	**0.60**	**6.00**	**30.00**	**3.00**
	Zero Calibration - 08:20:00 AM	-0.01	0.05	0.35	-0.98	0.00
	Zero Drift Check - 1:23:00 PM	-0.01	0.16	-2.17	-0.23	-0.04
	Total Drift Over Test Period	**0.00**	**0.11**	**2.52**	**0.75**	**0.04**
	Was the Zero Drift Within Allowable Deviation?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Span	**Span Calibration Gas (High-Range Values)**	**20.19**	**12.15**	**181.00**	**443.00**	**44.70**
	Allowable Span Drift (Less Than ± 3% of Range)	**0.75**	**0.60**	**6.00**	**30.00**	**3.00**
	Span Calibration - 8:23:00 AM	20.13	12.22	182.65	444.56	44.73
	Span Drift Check - 2:00:00 PM	20.11	12.34	180.18	446.79	44.66
	Total Drift Over Test Period	**0.02**	**0.12**	**2.47**	**2.23**	**0.07**
	Was the Span Drift Within Allowable Deviation?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Linearity	**Linearity Calibration Gas (Mid-Range Values)**	**8.97**	**9.22**	**82.00**	**443.00**	**9.21**
	Allowable Linearity Drift (Less Than ±1% of Range)	**0.25**	**0.20**	**2.00**	**10.00**	**1.00**
	Linearity Check - 8:30:00 AM	8.95	9.35	81.54	440.48	8.96
	Difference From Mid-Range Values	**0.02**	**0.13**	**0.46**	**2.52**	**0.25**
	Was the Linearity Within Allowable Deviation?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
	Linearity Check - 2:02:40 PM	8.93	9.32	80.68	446.62	9.43
	Difference From Mid-Range Values	**0.04**	**0.10**	**1.32**	**3.62**	**0.22**
	Was the Linearity Within Allowable Deviation?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

12% Overfired Tests - (Tuned w/ Base Gas)

	Zero, Span & Linearity Data Gas Range 12% Overfired Test (Tuned with Base Gas) July 18, 2006	O_2 (%)	CO_2 (%)	CO (ppm)	HC (ppm)	NO_x (ppm)
	Analyzer Emission Ranges	**0 - 25**	**0 - 20**	**0 - 200**	**0 - 1000**	**0 - 100**
Zero	**Zero Calibration Gas (Low-Range Values)**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Zero	**Allowable Zero Drift (Less Than ± 3% of Range)**	**0.75**	**0.60**	**6.00**	**30.00**	**3.00**
Zero	Zero Calibration - 08:06:00 AM	-0.02	0.06	0.77	-0.04	-0.05
Zero	Zero Drift Check - 10:51:20 AM	-0.02	0.12	-0.56	0.03	-0.04
Zero	**Total Drift Over Test Period**	**0.00**	**0.06**	**1.33**	**0.07**	**0.01**
Zero	**Was the Zero Drift Within Allowable Deviation?**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Span	**Span Calibration Gas (High-Range Values)**	**20.19**	**12.15**	**181.00**	**443.00**	**44.70**
Span	**Allowable Span Drift (Less Than ± 3% of Range)**	**0.75**	**0.60**	**6.00**	**30.00**	**3.00**
Span	Span Calibration - 8:11:10 AM	20.18	12.20	183.89	429.57	45.35
Span	Span Drift Check - 10:42:00 AM	20.15	12.29	182.02	434.42	43.57
Span	**Total Drift Over Test Period**	**0.03**	**0.09**	**1.87**	**4.85**	**1.78**
Span	**Was the Span Drift Within Allowable Deviation?**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Linearity	**Linearity Calibration Gas (Mid-Range Values)**	**8.97**	**9.22**	**82.00**	**443.00**	**9.21**
Linearity	**Allowable Linearity Drift (Less Than ±1% of Range)**	**0.25**	**0.20**	**2.00**	**10.00**	**1.00**
Linearity	Linearity Check - 8:23:40 AM	8.97	9.39	81.19	433.10	9.09
Linearity	**Difference From Mid-Range Values**	**0.00**	**0.17**	**0.81**	**9.90**	**0.12**
Linearity	**Was the Linearity Within Allowable Deviation?**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Linearity	Linearity Check - 10:46:20 AM	8.94	9.46	80.36	434.64	8.97
Linearity	**Difference From Mid-Range Values**	**0.03**	**0.24**	**1.64**	**8.36**	**0.24**
Linearity	**Was the Linearity Within Allowable Deviation?**	**Yes**	**No**	**Yes**	**Yes**	**Yes**

12% Overfired Tests - (Tuned w/ Gas 8)

	Zero, Span & Linearity Data Gas Range 12% Overfired Test (Tuned with Gas 8) July 19, 2006	O_2 (%)	CO_2 (%)	CO (ppm)	HC (ppm)	NO_x (ppm)
	Analyzer Emission Ranges	**0 - 25**	**0 - 20**	**0 - 200**	**0 - 1000**	**0 - 100**
Zero	**Zero Calibration Gas (Low-Range Values)**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Allowable Zero Drift (Less Than ± 3% of Range)	**0.75**	**0.60**	**6.00**	**30.00**	**3.00**
	Zero Calibration - 08:36:50 AM	-0.02	0.06	-0.29	-0.08	-0.06
	Zero Drift Check - 11:41:00 AM	-0.02	0.07	-0.32	0.22	-0.01
	Total Drift Over Test Period	**0.00**	**0.01**	**0.03**	**0.30**	**0.05**
	Was the Zero Drift Within Allowable Deviation?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Span	**Span Calibration Gas (High-Range Values)**	**20.19**	**12.15**	**181.00**	**443.00**	**44.70**
	Allowable Span Drift (Less Than ± 3% of Range)	**0.75**	**0.60**	**6.00**	**30.00**	**3.00**
	Span Calibration - 9:03:00 AM	20.17	12.22	182.82	431.89	44.55
	Span Drift Check - 11:34:00 AM	20.15	12.15	183.23	435.65	44.53
	Total Drift Over Test Period	**0.02**	**0.07**	**0.41**	**3.76**	**0.02**
	Was the Span Drift Within Allowable Deviation?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Linearity	**Linearity Calibration Gas (Mid-Range Values)**	**8.97**	**9.22**	**82.00**	**443.00**	**9.21**
	Allowable Linearity Drift (Less Than ±1% of Range)	**0.25**	**0.20**	**2.00**	**10.00**	**1.00**
	Linearity Check - 9:09:00 AM	8.96	9.42	80.22	433.50	9.12
	Difference From Mid-Range Values	**0.01**	**0.20**	**1.78**	**9.50**	**0.09**
	Was the Linearity Within Allowable Deviation?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
	Linearity Check - 11:38:14 AM	8.93	9.35	80.51	434.86	9.15
	Difference From Mid-Range Values	**0.04**	**0.13**	**1.49**	**8.14**	**0.06**
	Was the Linearity Within Allowable Deviation?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Oven Door Open Test – (Tuned w/ Base Gas)

	Zero, Span & Linearity Data Gas Range Oven Door Open Test (Tuned w/ Base Gas) July 27, 2006	O_2 (%)	CO_2 (%)	CO (ppm)	HC (ppm)	NO_x (ppm)
	Analyzer Emission Ranges	**0 - 25**	**0 - 20**	**0 - 200**	**0 - 1000**	**0 - 100**
Zero	**Zero Calibration Gas (Low-Range Values)**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Allowable Zero Drift (Less Than ± 3% of Range)	**0.75**	**0.60**	**6.00**	**30.00**	**3.00**
	Zero Calibration - 09:03:00 AM	-0.02	0.09	0.68	-0.26	-0.05
	Zero Drift Check - 3:33:00 PM	-0.04	0.17	-2.69	-0.38	0.04
	Total Drift Over Test Period	**0.02**	**0.08**	**3.37**	**0.12**	**0.09**
	Was the Zero Drift Within Allowable Deviation?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Span	**Span Calibration Gas (High-Range Values)**	**20.19**	**12.15**	**182.60**	**432.00**	**84.50**
	Allowable Span Drift (Less Than ± 3% of Range)	**0.75**	**0.60**	**6.00**	**30.00**	**3.00**
	Span Calibration - 10:00:00 AM	20.17	12.06	184.59	434.08	81.79
	Span Drift Check - 2:40:00 PM	20.11	12.27	181.15	438.78	82.04
	Total Drift Over Test Period	**0.06**	**0.21**	**3.44**	**4.70**	**0.25**
	Was the Span Drift Within Allowable Deviation?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Linearity	**Linearity Calibration Gas (Mid-Range Values)**	**8.97**	**9.22**	**82.00**	**432.00**	**44.70**
	Allowable Linearity Drift (Less Than ±1% of Range)	**0.25**	**0.20**	**2.00**	**10.00**	**1.00**
	Linearity Check - 10:07:00 AM	8.97	9.40	80.91	431.88	44.68
	Difference From Mid-Range Values	**0.00**	**0.18**	**1.09**	**0.12**	**0.02**
	Was the Linearity Within Allowable Deviation?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
	Linearity Check - Not Available	-	-	-	-	-
	Difference From Mid-Range Values	-	-	-	-	-
	Was the Linearity Within Allowable Deviation?	-	-	-	-	-

Appendix E: Calculations

Emission Concentrations

Corrected to O_2 Standard (0% O_2)

$$\text{CO, HC \& NO}_x\text{ Concentrations (corrected to 3\% O}_2\text{)} = \text{Raw Concentrations (ppm)} \times \left[\frac{20.9 - 0}{20.9 - \%\,O_2}\right]$$

Where

Raw Concentration = Measured CO, HC & NO_x concentrations, by volume (ppm)

% O_2 = Measured O_2 Concentration

Ultimate CO_2

$$\text{Ultimate CO}_2\text{ (\%)} = \text{Raw CO}_2 \times \left[\frac{20.9}{20.9 - \text{Raw O}_2}\right]$$

Where

Raw CO_2 = Measured CO_2 Concentration (%)

Raw O_2 = Measured O_2 Concentration (%)

% Excess Air

To determine the % Excess Air, the theoretical air and theoretical flue gas values for each gas tested must be calculated. The table above lists the constituents found in natural gas, the balanced chemical equations for each constituent and their respective theoretical air and theoretical flue gas values (expressed in moles).

Constituent	Balanced Chemical Composition	Theo. Air	Theo. Flue Gas
Methane (CH_4)	$CH_4 + 2O_2 + 2(3.78)N_2 \Rightarrow 1CO_2 + 2H_2O + 2(3.78)N_2$	9.56	8.56
Ethane (C_2H_6)	$C_2H_6 + 3.5O_2 + 3.5(3.78)N_2 \Rightarrow 2CO_2 + 3H_2O + 3.5(3.78)N_2$	16.73	15.23
Propane (C_3H_8)	$C_3H_8 + 5O_2 + 5(3.78)N_2 \Rightarrow 3CO_2 + 4H_2O + 5(3.78)N_2$	23.90	21.90
i-Butane (C_4H_{10})	$C_4H_{10} + 6.5O_2 + 6.5(3.78)N_2 \Rightarrow 4CO_2 + 5H_2O + 6.5(3.78)N_2$	31.07	28.57
n-Butane (C_4H_{10})	$C_4H_{10} + 6.5O_2 + 6.5(3.78)N_2 \Rightarrow 4CO_2 + 5H_2O + 6.5(3.78)N_2$	31.07	28.57
i-Pentane (C_5H_{12})	$C_5H_{12} + 8O_2 + 8(3.78)N_2 \Rightarrow 5CO_2 + 6H_2O + 8(3.78)N_2$	38.24	35.24
n-Pentane (C_5H_{12})	$C_5H_{12} + 8O_2 + 8(3.78)N_2 \Rightarrow 5CO_2 + 6H_2O + 8(3.78)N_2$	38.24	35.24
Hexanes (C_6H_{14})	$C_6H_{14} + 9.5O_2 + 9.5(3.78)N_2 \Rightarrow 6CO_2 + 7H_2O + 9.5(3.78)N_2$	45.41	41.91

The theoretical air value for each constituent is the sum of moles for both O_2 and N_2 on the reactants side of the balanced chemical equation (ex: For Methane, 2 moles of O_2 plus 7.56 moles of N_2 = 9.56 moles of Theoretical Air). The theoretical flue value for each constituent is the sum of moles for both CO_2 and N_2 on the product side of the balanced chemical equation (ex: For Methane, 1 mole of CO_2 plus 7.56 moles of N_2 = 8.56 moles of Theoretical Flue Gas).

Once the test gases have been analyzed (via gas chromatography), the % composition of each gas is used to determine the theoretical air and theoretical flue gas values for each gas tested. Thus,

$$\text{Theoretical Air} = \sum C_1P + C_2P + \ldots + C_nP$$

$$\text{Theoretical Flue} = \sum D_1P + D_2P + \ldots + D_nP$$

Where *C* is the theoretical air value for each constituent, *D* is the theoretical flue gas value for each constituent and *P* is the percent composition for each constituent (expressed as a decimal, not a percentage). Therefore, the % Excess Air is calculated as follows:

$$\%\,\text{Excess Air} = \left[\text{Theo. Flue Value} \times \frac{\text{Ult.}CO_2 - \text{Raw } CO_2}{\text{Theo. Air Value} \times \text{Raw } CO_2}\right] \times 100$$

Air/Fuel Ratio

$$\text{Air/Fuel Ratio} = \text{Theoretical Air Value} + \frac{\text{Theoretical Air Value} \times \%\,\text{Excess Air}}{100}$$

Equivalence Ratio (ϕ)

$$\text{Equivalence Ratio } (\phi) = \frac{100}{100 + \%\,\text{Excess Air}}$$

Gas Meter Accuracy Table

The gas meter used during testing was compared to a certified bell prover to determine its accuracy (error percentage) at various flow rates.

The gas meter accuracy table (below) shows the prover flow rates that the meter was tested, error percentage for each accuracy test and an average meter error.

Also included on the table is a gas meter flow rate. The gas meter flow rate is the meter's reading at each prover flow rate when the average meter error is factored in. This flow rate was calculated using the meter accuracy equation:

$$\%\,\text{Error} = \left(\frac{\text{Gas Meter Flow - Prover Flow}}{\text{Prover Flow}}\right) \times 100$$

Through algebraic manipulation, the gas meter flow is determined using the following equation:

$$\text{Gas Meter Flow} = \text{Prover Flow} \times \left(1 + \frac{\%\,\text{Error}}{100}\right)$$

A negative error percentage indicates the gas meter flow rate was below the prover flow rate whereas a positive error percentage indicates the gas meter flow rate was above the prover flow rate.

2 CU. FT. BELL NO. 4087 CPUC CERTIFICATE OF BELL PROVER ACCURACY # 1004							
Model Number: DTM-200A **Meter Number:** U258696				**Date:** August 1, 2004 **Prepared By:** Joe Garcia			
Prover Flow Rate cfh	**Gas Meter Error Percentage** Test #1	Test #2	Test #3	Test #4	Test #5	**Average Meter Error**	**Gas Meter Flow Rate** cfh
50	0.78%	0.67%	0.48%	0.58%	0.53%	**0.61%**	**50.30**
100	0.57%	0.58%	0.66%	0.72%	0.66%	**0.64%**	**100.64**
150	0.85%	0.84%	0.95%	1.18%	1.11%	**0.99%**	**151.48**
200	0.78%	1.03%	0.90%	0.87%	0.88%	**0.89%**	**201.78**

Actual Gas Flow with Meter Correction (acfh)

To correct the actual gas flow that was measured during testing, a gas meter flow rate range is selected from the meter accuracy table. The gas meter flow rates and the average meter error (divided by 100) will be used to calculate the meter correction factor at any given gas flow rate.

Setting y = average meter error (divided by 100) and x = gas meter flow rate, the error can be calculated using the following equation:

$$\frac{y - y_0}{y_1 - y_0} = \frac{x - x_0}{x_1 - x_0}$$

Manipulating the right side of the equation algebraically:

$$\alpha = \frac{x - x_0}{x_1 - x_0}$$

The equation would then simplify into:

$$y = \frac{y_1 - y_0}{x_1 - x_0}(x - x_0) + y_0$$

If the appliance has an actual gas flow rate (F_A) of 110.0 actual cubic feet per hour (acfh), the gas meter flow rate range would be 100.64 to 151.48 acfh and the average meter error range (divided by 100) would be 0.0064 to 0.0099. Using this information, the meter error (y) is:

$$y = \frac{0.0099 - 0.0064}{151.48\ \text{acfh} - 100.64\ \text{acfh}}(110.0\ \text{acfh} - 100.64\ \text{acfh}) + 0.0064 = 0.007021$$

Once the meter error is known, the actual gas flow rate with meter correction ($F_{meter.}$) can be calculated using the following equation:

$$F_{meter} = \frac{F_A}{(1 + y)}$$

$$F_{meter} = \frac{110.0\ \text{acfh}}{(1 + 0.007021)} = 109.2331\ \text{acfh}$$

Corrected Gas Flow (scfh)

$$F_{corrected} = F_{meter} \times \left[\frac{P_{Fuel}\,(psig) + P_1\,(psia)}{P_{standard}} \right] \times \left[\frac{T_{standard}}{T_{Fuel}\,(^{o}F) + 459.67} \right]$$

Where

$F_{corrected}$ = Gas flow corrected to standard temperature and pressure (scfh)

F_{meter} = Actual gas flow with meter correction (acfh)

P_{Fuel} = Natural gas inlet pressure (psig)

P_1 = Average pressure in Pico Rivera at an average elevation of 161 ft (psia)

$P_{standard}$ = Standard atmospheric pressure (14.735 psia @ 60°F)

$T_{standard}$ = Standard atmospheric temperature (519.67 R @ 1 atm)

T_{Fuel} = Fuel temperature (°F)

Input Rate (Btu/cf)

$$\text{Input Rate} = \text{Corrected Gas Flow} \times \text{HHV}$$

Where

HHV = Higher Heating Value (Btu/cf)

Wobbe Number (Btu/cf)

$$W_0 = \frac{HHV}{\sqrt{G}}$$

Where

W_0 = Wobbe Number (Btu/cf)

HHV = Higher Heating Value (Btu/cf)

G = Specific gravity of gas sample

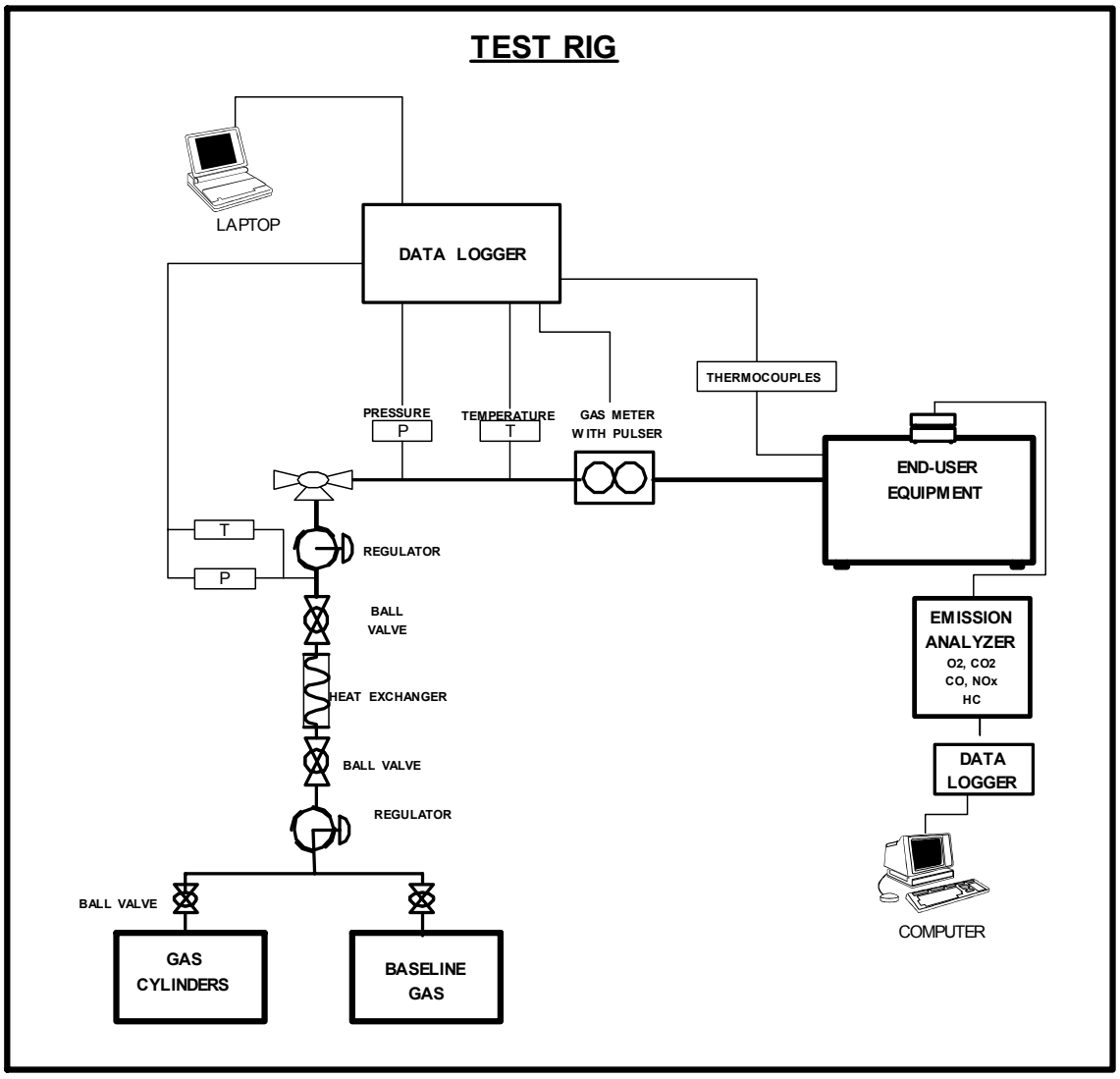
Appendix F: Test Equipment

Emissions analyzers (meet CARB and SCAQMD standards), Analyzer Calibration Gases, and Instrumentation.

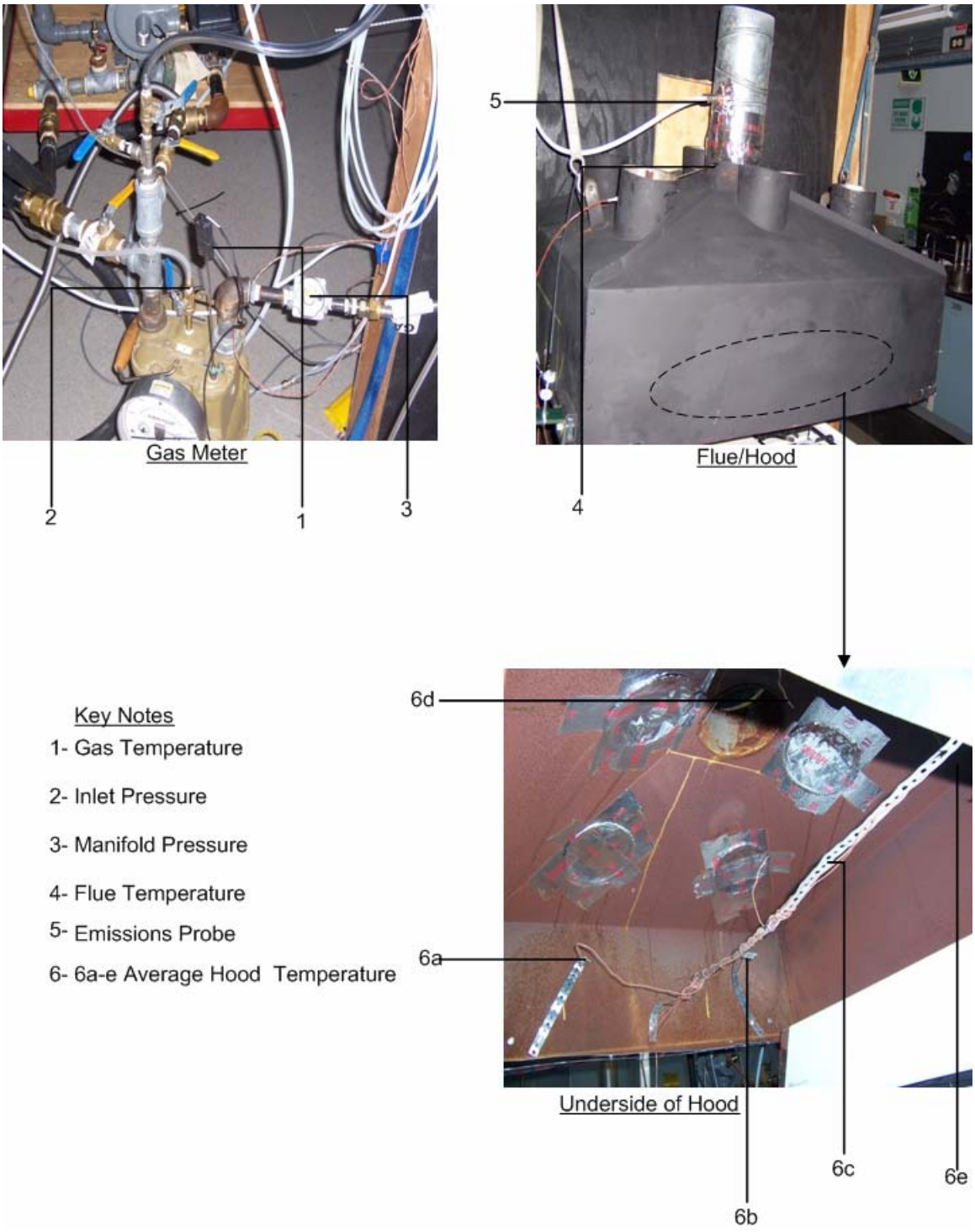
Emissions Analyzer				
Analyzer	**Manufacturer**	**Model**	**Type**	**Accuracy**
NO/NO_X	California Analytical Instruments, Inc.	650	Chemiluminescent	± 1% of full scale
CO	Thermo Environmental Instruments Inc.	48	Nondispersive infrared (NDIR) gas analyzer	± 1% of full scale
CO_2	Fuji	ZRH	Nondispersive infrared (NDIR) gas analyzer	± 1% of full scale
HC	California Analytical Instruments, Inc.	300 HFID	Flame ionization detector (FID)	± 1% of full scale
O_2	Teledyne	326RA	Electrochemical cell	± 1% of full scale
Calibration & Span Gases				
Gas	**Manufacturer**	**Type**		**Accuracy**
Calibration	Scott Specialty Gases	Certified Master Class		± 2%
NO/NO_X	Matheson Tri Gas	Certified Master Class		± 2%
CO	Matheson Tri Gas	Certified Master Class		± 2%
CO_2	Matheson Tri Gas	Certified Master Class		± 2%
HC	Scott Specialty Gases	Certified Master Class		± 2%
O_2	Scott Specialty Gases	Certified Master Class		± 2%
Test Equipment				
Equipment	**Manufacturer**	**Model**		**Accuracy**
Datalogger	Delphin	D51515		n/a
Gas Chromatograph	Agilent	6890		± 0.5 BTU/scf
K	Omega Engineering Co.	KMQSS		2.2°C or 0.75%
J	Omega Engineering Co.	JMQSS		2.2°C or 0.75%
R	Omega Engineering Co.	RMQSS		2.2°C or 0.75%
T	Omega Engineering Co.	TMQSS		2.2°C or 0.75%
Dry Test Gas Meter 200 cf/h max	American Meter Company	DTM-200A		@ 200 cf/h – 100.1 % @60 cf/h – 99.9 %
Gas Meter Pulser 2 pulses per 1/10 cf	Rio Tronics	4008468		n/a
Gas Pressure Regulator	Fisher	299H		± 1.0 %
Differential Pressure Transmitter	Dwyer	607-4		±0.25 -0.50%
Pressure Transducer	Omega	PX205-100GI		±0.25% of full scale
Water Temperature Mixing Valve	Powers	434		n/a

Appendix G: Test Set-Up/Schematic

Equipment utilized for testing adheres to industry standards for testing laboratories that certify such equipment. The test rig is transportable and includes a data logger, emissions cart, gas meter, thermocouples and pressure transducers; plus, a gas regulation system that can take natural gas from 3,000 psig and deliver up to 2,000 cubic feet per hour (cfh) at low pressure (approx. 8 in. w.c.). The test rig is illustrated below.



Appendix H: Test Set-Up Description



Oven Door Open set up: