Rowan Williams Davies & Irwin Inc.
Consulting Engineers
650 Woodlawn Road West
Guelph, Ontario
Canada N1K 1B8
Tel: (519) 823-1311
Fax: (519) 823-1316
Email: info@rwdi.com
Website: http://www.rwdi.com

FINAL REPORT
EXHAUST DISPERSION ASSESSMENT
PLASTICAIR INC.
MISSISSAUGA, ONTARIO

Project Number:	04-1506A
Date:	August 3, 2004
Submitted By:	Rowan Williams Davies & Irwin Inc.
	Technical Coordinator - Sonia Beaulieu, M.Sc.
	Project Manager - Bill Smeaton, P.Eng.
	Project Director - Glenn D. Schuyler, P.Eng.

Submitted to:	Plasticair Inc.

TABLE OF CONTENTS

Page No.

1. EXECUTIVE SUMMARY

Rowan Williams Davies & Irwin Inc. (RWDI) was retained by Plasticair Inc. to assess the performance of their latest air-induction stack design by conducting concentration and velocity profile tests through the use of physical modelling in a boundary-layer wind tunnel. The design's performance was assessed by calculating entrainment ratios (ER) (i.e., the ratio of the total entrained air volume to that of the inlet) while varying the inlet and outlet flow conditions. The total and inlet air flow volumes were monitored through tracer gas concentration measurements at the stack top and inlet. Flow conditions that were varied included the discharge velocity at the nozzle, the wind speeds and the wind approach angle to the stack. Stack performance was also assessed by measuring the discharge velocities at the top of the stack and by using smoke to visually observe inlet and outlet flows.

We conclude that the currently proposed stack design will typically achieve entrainment ratios between 1.7 and 2.1 independently of the wind approach angle and wind speed with minimum inlet nozzle velocities of 3,000 fpm. The stack design should not be implemented with nozzle inlet velocities lower than 2,000 fpm. Similar entrainment ratios are expected for models of larger sizes.

Several design issues were observed as a result of the measurement and smoke visualization tests. These included non-uniform concentration and velocity profiles, loss of exhaust effluent through the stack bottom and significant dependance of results with respect to wind approach angle. It was also noted that the discharge velocity at the top of the stack was significantly lower than that entering the nozzle, making the stack vulnerable to exhaust downwash for a broader range of wind speeds.

2. INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was retained by Plasticair Inc. to assess the performance of their latest air-induction stack design through the use of physical modelling in a boundary-layer wind tunnel. The use of air-induction fans increase dilution of exhausts by two means. First, by entraining clean air within the stack which is then combined with the contaminated exhausts. Secondly, by increasing the mass of the plume, which then results in greater momentum and dispersion of exhausts.

The stack's performance is closely linked to the overall volume of air that can be entrained since larger air volumes result in greater dilution of contaminants. However, more important than the entrained volume is the relationship between the volumes of contaminated air and entrained air. This parameter is defined as the entrainment ratio (ER). It is advantageous to increase the entrainment ratio as it is associated with a greater difference between the contaminated and clean air volumes. The ER is calculated with flow rates as follows:

$$Entrainment\ Ratio = \frac{Total\ Air\ Volume\ at\ Stack\ Top\ (inlet + entrained)}{Total\ Air\ Volume\ from\ Building\ (inlet)}$$

This method was used to calculated entrainment ratios based on velocity measurements. ER based on tracer gas concentrations were calculated by dividing the averaged inlet tracer gas concentration by the averaged concentrations measured at the top of the entrainment ring.

Air is entrained within the stack by the negatively-pressurized zone (i.e., vacuum) located at the base of the stack. This vacuum is itself created as a result of the fast discharging building air from the stack nozzle. Factors which influence the vacuum, and thus entrainment, include the nozzle velocity, velocity of winds around the stack, the approach angle of the wind to the stack, and the stack/nozzle design.

3. PROJECT OBJECTIVES

The main objectives and goals accomplished by this research project included to:

- Assess the performance of the new Plasticair stack design by calculating entrainment ratios;
- Determine how entrainment ratios vary with wind speed, wind approach angles and nozzle velocities;
- Assess the stack performance by measuring the discharge velocity at the top of the stack;
- Determine how the velocity profile varies with wind speed and wind approach angle;
- Conduct visual observations of the stack performance using smoke to validate findings of the study;
- Provide recommendations to maximize entrainment and to reduce negative features of the stack design.

4. PROJECT PARAMETERS

4.1 Prototype Parameters

Details of the stack design and dimensions were provided by Plasticair via email on May 28 and June 3, 2004. Photographs of the stack prototype constructed by RWDI based on this information are shown in Figure 1. Figure 2 contains photographs of the scale model as installed and tested in the wind tunnel. The stack was mounted along the sidewall of the tunnel, at 4 ft from the tunnel floor, and at 1ft from the tunnel wall.

A summary of the prototype parameters is shown in Table 1. These parameters represent full-scale dimensions of a Model 6, or half-scale dimensions of a Model 12. The new stack can be supplied by Plasticair in model sizes ranging from 6 to 66, for which inlet dimensions were provided on May 28, 2004. While the overall geometry of the stacks remains the same, the physical dimensions of the stacks increase proportionally with model size. Most of the tests were completed for a full-scale Model 6 unit.

Table 1: Summary of Prototype Dimensions

Inlet diameter at the bottom of the nozzle	6.25 in
Area at the bottom of the nozzle	0.21 ft^2
Area at the top of the nozzle	0.24 ft^2 [a]
Diameter at the top of the entrainment ring	12.5 in
Area at the top of the entrainment ring	0.85 ft^2

Notes:
[a] The cross-sectional area was found to be constant throughout the nozzle from the inlet. A constant area will ensure that no pressure drops will be encountered in the nozzle as a result of flow constrictions or expansion.

4.2 Testing Parameters

The relationship between the inlet flow rate and resulting flow rate at the top of the stack (i.e., entrained and inlet) was assessed by measuring tracer gas (i.e., carbon monoxide, CO) concentrations at the top of the stack which were compared against known CO concentrations measured at the stack inlet. The inlet concentration was maintained at approximately 80 ppm during all tests.

Concentrations were measured at a total of 73 points (i.e., receptors). Five inlet measurements were taken through tubes mounted perpendicular to the flow (at receptors 1, 9, 17, 25 and 33) inside the pipe connecting the fan to the nozzle (i.e., prior to air entering the nozzle). Two measurements were taken from tubes located outside of the stack, upwind (receptor 8) and downwind (receptor 24), immediately below the bottom of the entrainment ring and between the nozzle lobes. The remaining 66 measurements were obtained at the top of the stack; half were measured with a rake setting identified as “A”, while the remaining half were measured with a rake setting of “B”, as shown in Figures 3 and 4. The rake was placed so that the measurement tubes would begin slightly within the stack entrainment ring.

Concentrations were measured while varying inlet and outlet flow parameters such as the nozzle discharge velocities, wind speeds and wind approach angles. A summary of the full-scale nozzle velocities and wind speeds tested in the wind tunnel is presented in Table 2. The two approaching wind angles for which tests were conducted as shown in Figures 3 and 4. The first angle (Position 1) consisted of winds approaching perpendicular to the nozzles, while the second angle (Position 2) consisted of winds approaching between the nozzles, perpendicular to broad face of the stack. The nozzle velocities shown in the table represent the desired velocity of the air entering the nozzle, the actual velocity of the air entering and leaving the nozzle and the actual exhaust flow rates measured for each test. Since most tests were completed for a Model 6, the parameters presented in this table represent full-scale nozzle and wind velocities.

Velocities at the top of the entrainment ring were also measured at the same location as the concentrations for one nozzle velocity scenario, three wind speeds and two wind approach angles. In addition, visual observations of flows within and around the stack were also conducted by introducing smoke upstream of the nozzle. This information was useful to validate findings from the tracer gas concentration and velocity measurements.

Table 2: Summary of Test Parameters

Desired nozzle velocity		**Actual velocity entering the nozzle**		**Actual velocity at the top of the nozzle**		**Actual flow rates**	**Tested Wind speeds**	
fpm	fps	fpm	fps	fpm	fps	cfm	fps	mph
1,000	16.7	971	16.2	850	14.2	204	0	0
2,000	33.3	1,962	32.7	1,716	28.6	412	15	10
3,000	50	2,946	49.1	2,578	42.9	619	22	15
4,000	66.6	4,021	67	3,519	58.6	847	29	20
--	--	--	--	--	--	--	44	64.5

5. DISCUSSION AND FINDINGS

Raw data for the tracer gas concentration (in parts per million of carbon monoxide) and velocity (in feet per second) profile measurements are presented in Appendices A and B.

The data presented in both appendices show that concentration and velocity profiles at the top of the entrainment ring are not consistent across the total area. This finding inherently implies uneven mixing of the contaminated and entrained air throughout the stack and also highlights the presence of dead zones (i.e., areas where air is neither entrained or discharged) within the stack arrangement. The location of dead zones was found to depend on the nozzle location, the approaching wind angle and speed, and the nozzle discharge velocity.

The inconsistency of the concentration profile is one of the reasons why the entrainment ratios calculated using arithmetically averaged concentrations at the top of the entrainment ring must be interpreted with caution for two reasons. First, a simple arithmetic average places equal weight on measured concentrations at each of the receptor points, even though some areas experienced much lower velocities (and hence would contribute less to the overall weighted average). Secondly, the averaging method does not account for actual losses of tracer gas (downwash) through the bottom of the entrainment ring. The loss of tracer gas through the bottom of the stack was confirmed by the large carbon monoxide concentrations measured at receptor 24, and observed during the smoke visualization tests. The concentrations were largest when winds approached from Position #1 and occurred for a larger range of wind speeds with lower nozzle discharge velocities. This downwash effect is a serious concern with respect to the performance of the stack design and is discussed further in Section 5.3.

5.1 Entrainment Ratios

A summary of the entrainment ratios calculated for each of the tested scenarios is presented in Table 4. These values are based on averaged concentrations measured at the top of the stack (at the 66 receptors) and at the nozzle inlet (at the 5 receptors).

Table 3: Summary of Entrainment Ratios for Model 6 (using concentration measurements)

Tested Wind speed (fps)	Desired inlet nozzle velocity of 1,000 fpm		Desired inlet nozzle velocity of 2,000 fpm		Desired inlet nozzle velocity of 3,000 fpm		Desired inlet nozzle velocity of 4,000 fpm		Average
	Position #1	Position #2	Position #1	Position #2	Position #1	Position #2	Position #1	Position #2	
0	2.65	2.65	1.84	1.93	1.77	1.79	1.78	1.78	2.02
15	2.55	1.99	2.22	2.04	2.08	2.14	2.05	2.15	2.15
22	3.95	1.88	2.33	2	2.23	2.11	2.2	2.09	2.35
29	4.75	2.38	2.34	1.8	2.27	2.09	2.21	2.04	3.49
44	7.34	5.04	3.78	1.79	2.57	2.09	2.32	2.02	3.37

As shown in Table 4, large entrainment ratios were calculated for desired nozzle velocities of approximately 1,000 fpm and 2,000 fpm, and especially for higher wind speed cases. These entrainment ratios do not represent large entrainment volumes in the stack. Rather, they are the result of several dead zones and of losses of tracer gas in the stack arrangement (as measured at receptor 24). For these reasons, the entrainment ratios shown in Table 3 should not be used and stacks should not be sized for nozzle velocities of 1,000 fpm to 2,000 fpm.

Entrainment ratios calculated with the 3,000 fpm and 4,000 fpm nozzle velocity were more consistent throughout the tested wind speeds. Similar ratios, as shown in Table 5, were also calculated using the averaged velocity measurements and discharge area at the top of the entrainment ring. Loss of tracer gas (downwash) was observed for the higher wind speed cases, while inconsistent concentration and velocity profiles were still present.

Table 4: Summary of Entrainment Ratios for Model 6 (using velocity measurements)

Wind speed (fps)	Position 1		Position 2	
	Average velocity at the stack top (fps)	Entrainment Ratio	Average velocity at the stack top (fps)	Entrainment Ratio
0	23.8	1.99	21.9	1.78
22	24.0	1.98	21.3	1.69
44	30.2	2.43	21.3	1.69

5.2 Combined Analysis of Tracer Gas and Velocity Measurements

Additional calculations were completed to quantify the loss of tracer gas within the system via downwash through the bottom of the stack. To accomplish this, the entrainment ratio was calculated in terms of emission rates by combining the velocity measurements and concentration measurements to obtain a weighted average, which then was used to determine the ratio between the mass emission rate from the nozzle to the mass emission rate through the top of the stack. The results of this analysis identified the tendency of higher wind speeds to cause increasing percentages of the effluent from the nozzle to be discharged through the bottom of the entrainment ring. Ratios between the nozzle inlet and stack top carbon monoxide mass emission rates were calculated using the velocity and concentration measurements. A graph of the calculated tracer gas losses (as percent) with respect to wind speed and wind direction is presented in Figure 5. While tracer gas losses through the bottom of the entrainment ring are expected to be zero during no wind conditions, significant losses were predicted for the higher wind speeds, at up to 40% of the inlet emissions.

6. CONCLUSIONS

Based on our findings, we conclude that the currently proposed stack design will typically achieve entrainment ratios between 1.7 and 2.1 independently of the wind approach angle and wind speed with minimum inlet nozzle velocities of 3,000 fpm. The stack design should not be implemented with nozzle inlet velocities lower than 3,000 fpm. Similar entrainment ratios are expected for models of larger sizes.

Several design issues were observed as a result of the measurement and smoke visualization tests. Non-uniform concentration and velocity profiles, loss of tracer gas at the stack bottom even with nozzle velocities up to 4,000 fpm, and significant dependance of results with respect to wind approach angle were all observed. It was also noted that the discharge velocity at the top of the stack was lower than that entering the nozzle, hence giving the stack a tendency to exhibit exhaust downwash for a broader range of wind speeds. For these, we propose the following design solutions:

- Reduce the diameter at the top of the stack to achieve greater discharge velocities. Coning the stack may, however, create pressure drops and flow constriction within the stack that may impede entrainment.

- Reduce the area at the bottom of the entrainment ring to increase the negative pressure zone located at the stack base.

- Modify the shape of the stack to reduce its aerodynamic effects on the air flow (i.e., remove square and blunt edges) and reduce the effect of the wind approach angle on entrainment.

- Modify the nozzle design to address the downwash and short-circuiting of exhausts downwind of the stack. Modification of the nozzle design should also aim to reduce the sensitivity of entrainment and dispersion with respect to wind directionality.

- Investigate increasing the height of the entrainment ring (or height difference between the top of the nozzle and top of the stack) to increase entrainment.

FIGURES

Full-scale Prototype of Model 6
(Half-scale Prototype of Model 12)

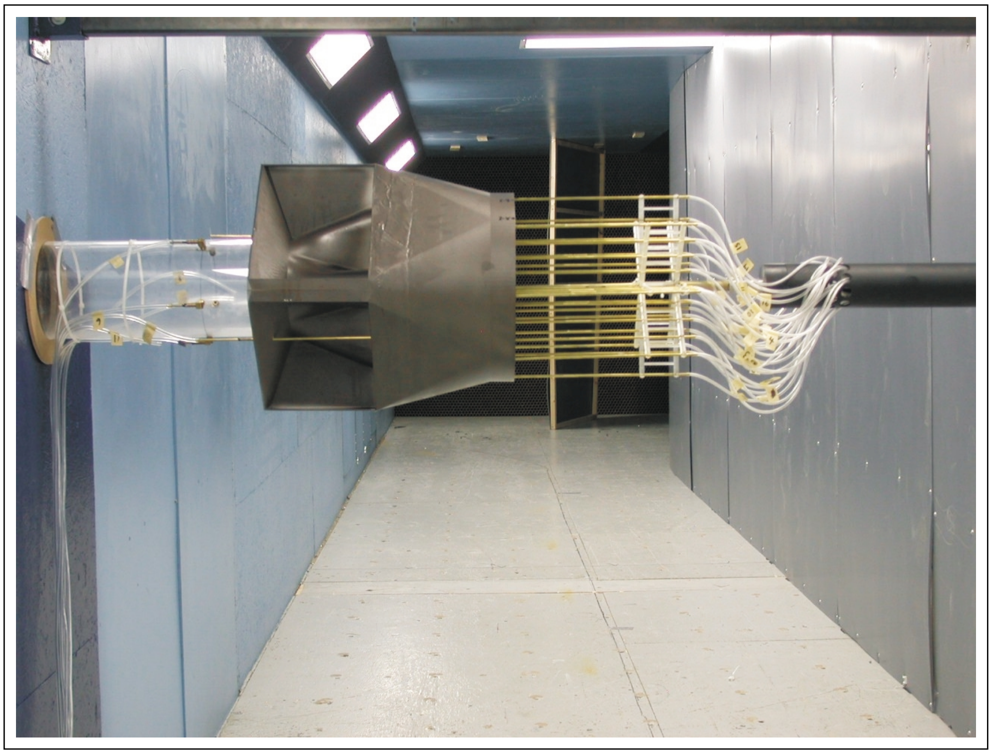
Plasticair - Mississauga, Ontario

Project #04-1506

Figure No. 1

Date: Aug. 3, 2004

RWDI



Wind Tunnel Study Model

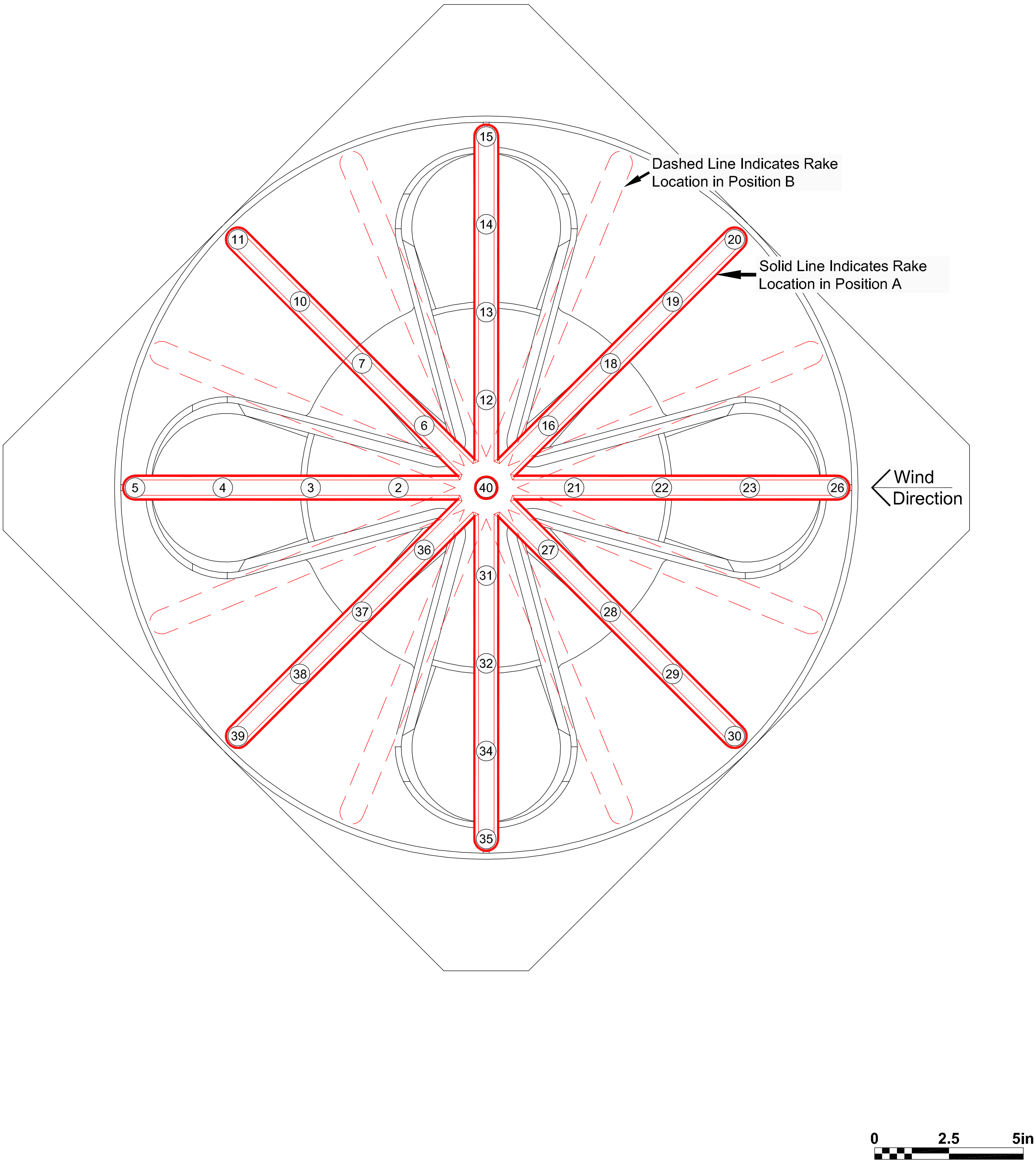
Plasticair - Mississauga, Ontario

Project #04-1506

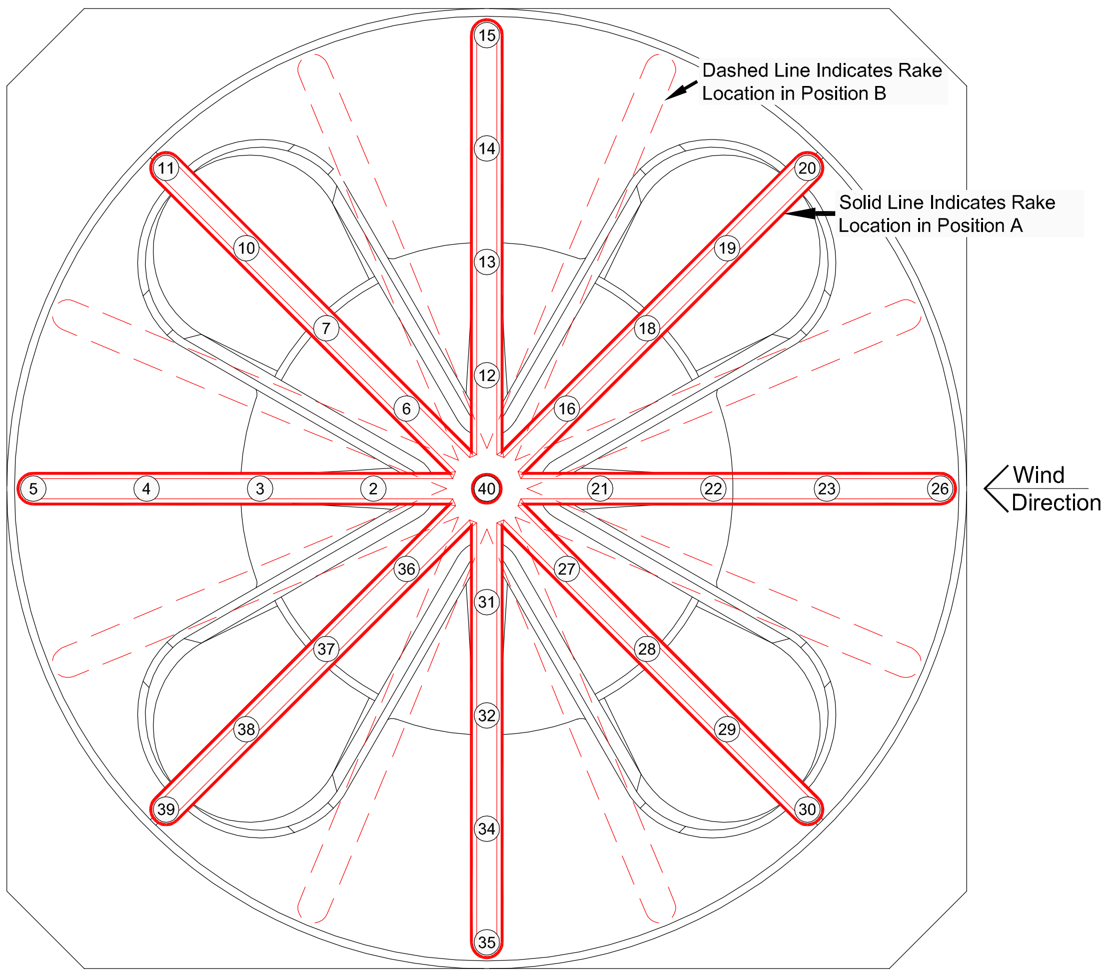
Figure No. 2

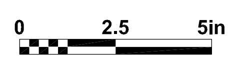
Date: Aug. 3, 2004

RWDI

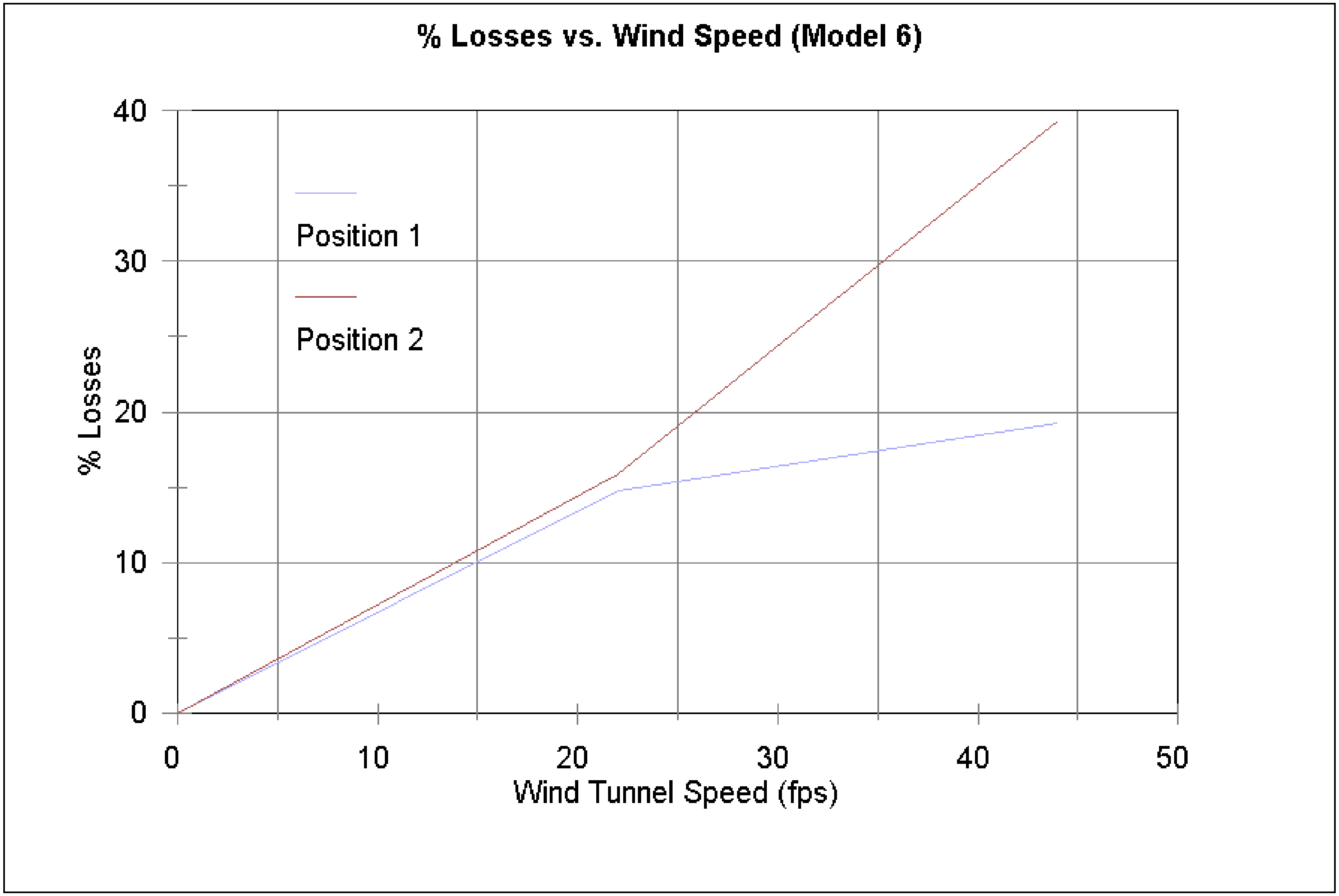


Receptor Location at Stack Tip - Position 1	Drawn by: KO	Figure: 3	RWDI
	Approx. Scale: 1"=5"		
Plasticair - Mississauga, Ontario Project #04-1506	Date Revised: Aug 3, 2004		





Receptor Location at Stack Tip - Position 2	Drawn by: KO	Figure: 4	RWDI
	Approx. Scale: 1"=5"		
Plasticair - Mississauga, Ontario Project #04-1506	Date Revised: Aug 3, 2004		



Plot of Losses Through Bottom of Entrainment Ring **Positions 1 and 2** Plasticair - Mississauga, Ontario Project #04-1506	Figure No. **5** Date: August 3, 2004	RWDI

APPENDIX A

Concentration measurements (ppm of CO) for an estimated inlet velocity of 1,000 fpm.

	0 fps wind speed				*15 fps wind speed*				*22 fps wind speed*				*29 fps wind speed*				*44 fps wind speed*			
Receptor	Position 1A	Position 1B	Position 2A	Position 2B	Position 1A	Position 1B	Position 2A	Position 2B	Position 1A	Position 1B	Position 2A	Position 2B	Position 1A	Position 1B	Position 2A	Position 2B	Position 1A	Position 1B	Position 2A	Position 2B
1	81.8	85.5	90.8	96.1	80.5	81.1	87.5	87.4	85.9	85.5	87.9	88.8	80.1	80.1	80.1	81.2	82.1	83.1	81.3	81.3
9	79.4	82.7	88.3	94.9	80.5	81.4	87.4	86.9	85.4	85.7	89.1	88.5	79.9	80.3	80.5	81.4	82.6	82.9	81.8	81.4
17	76.9	78.3	90.3	93.4	80.7	81.6	87.2	87.5	86.0	86.2	88.6	88.8	79.8	79.7	80.6	81.4	82.4	83.0	80.9	80.9
25	77.6	78.4	89.3	92.1	81.2	81.9	87.4		85.1	85.4	88.4	88.5	80.1	79.2	80.2	80.6	82.3	82.0	81.0	81.5
33	75.4	77.7	87.2	90.7	81.4	81.7	87.5		85.8	85.7	89.2	88.6	79.6	79.8	80.8	82.0	82.4	82.5	81.3	80.9
Average	0		0		0		0		0		0		0		0		0		0	
Receptor																				
8	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
24	***	***	***	***	56.7	60.5	21.1	24.8	70.2	70.9	33.4	37.2	63.4	63.3	14.7	17.0	58.3	58.0	6.0	6.1
Receptor																				
2	42.7	49.6	47.3	51.3	22.9	27.5	68.6	68.1	16.6	19.3	70.6	69.5	12.9	15.9	50.4	47.3	8.3	11.5	14.4	14.0
3	13.1	25.9	2.6	9.1	42.3	54.0	64.9	65.3	28.3	34.9	64.1	64.7	19.2	24.7	31.1	34.4	13.7	14.5	4.9	4.2
4	50.0	40.3	14.0	22.8	65.6	62.9	67.9	68.7	60.5	56.9	55.0	60.9	48.0	45.0	28.3	31.6	44.2	34.0	12.6	12.6
5	71.1	64.2	18.0	51.9	75.1	53.4	65.5	68.2	79.4	64.2	44.3	49.6	70.8	56.8	30.5	29.6	65.3	19.1	***	***
6	49.8	49.9	45.5	43.2	7.2	5.3	69.8	67.6	13.2	6.4	70.6	68.7	14.2	6.2	53.2	51.7	11.9	7.0	15.2	15.6
7	19.2	24.9	37.4	17.9	43.1	32.6	69.6	72.8	57.5	36.8	72.9	75.1	45.1	35.6	55.9	60.5	30.9	28.0	15.0	16.1
10	9.2	28.1	56.5	30.0	57.7	71.8	72.7	76.0	67.8	75.6	74.1	77.1	56.7	61.6	52.1	60.6	43.0	41.3	13.2	16.7
11	9.0	28.9	72.3	59.7	42.0	22.1	77.4	80.3	52.8	27.7	74.0	80.7	41.8	15.3	44.3	61.5	20.7	11.2	6.4	14.0
12	35.1	33.0	32.4	38.5	8.6	12.5	48.3	26.6	6.2	9.8	55.9	35.5	2.6	2.9	42.8	31.3	***	***	16.6	18.6
13	34.5	17.6	10.4	32.2	15.8	10.1	70.2	59.0	13.2	8.0	73.8	63.4	10.2	2.3	55.5	43.0	***	***	6.3	9.2
14	59.8	33.1	8.7	37.0	36.5	11.5	79.6	82.6	29.7	5.3	78.7	77.2	23.9	2.7	67.7	60.3	16.3	2.3	34.6	37.2
15	58.2	52.5	14.5	55.2	16.1	5.0	72.4	46.5	15.0	3.7	80.2	56.1	10.4	2.2	70.6	54.3	10.2	2.4	50.2	48.0
16	25.7	30.8	29.4	22.7	25.2	37.8	9.7	2.8	15.3	17.6	10.0	1.7	4.4	4.4	7.9	2.3	***	***	11.2	2.2
18	9.5	28.7	36.7	15.2	29.1	54.2	44.8	6.9	10.4	12.5	33.2	17.8	1.6	1.9	22.9	14.2	***	***	21.0	14.2
19	***	36.2	69.0	51.1	16.2	36.5	41.9	14.6	***	***	25.7	3.2	***	***	15.2	1.3	***	***	12.5	***
20	6.2	29.9	59.0	44.1	20.3	21.4	2.3	49.8	4.4	4.4	1.1	3.8	***	***	1.1	3.0	***	***	2.1	2.6
21	23.3	20.4	19.4	24.9	47.9	36.6	1.9	2.2	17.0	12.8	***	1.4	4.8	4.1	***	2.0	***	***	***	***
22	37.5	19.4	14.1	14.2	64.4	52.8	7.5	13.6	12.1	9.4	5.7	16.3	2.6	2.5	5.0	15.1	***	***	4.3	14.2
23	63.3	35.7	18.2	38.5	36.6	43.8	10.9	13.8	7.1	5.6	7.0	10.7	1.5	1.2	5.5	9.3	***	***	5.7	8.6
26	47.8	41.5	11.9	50.4	16.3	23.3	7.1	***	4.5	3.6	4.7	4.7	***	***	3.6	3.6	***	***	3.4	3.3
27	6.0	9.4	24.2	21.3	15.6	7.7	***	2.4	2.6	***	2.3	23.5	***	***	3.7	20.2	***	***	5.3	12.8
28	13.5	27.3	44.1	29.7	38.4	20.3	29.9	***	9.1	5.1	29.3	57.2	1.8	1.8	23.7	38.7	***	***	18.7	25.2
29	8.5	52.5	72.6	62.9	39.5	28.3	42.1	74.2	6.4	4.6	29.2	63.2	1.2	1.9	27.8	53.1	***	***	4.0	13.8
30	3.2	38.6	63.5	46.6	27.0	22.4	3.9	7.8	5.1	2.9	1.7	28.4	1.2	1.4	1.5	34.5	***	1.2	1.6	34.7
31	26.1	28.8	30.2	26.7	14.9	9.1	47.6	64.1	7.3	6.0	53.4	68.1	2.9	5.0	46.2	54.9	1.6	6.2	26.9	24.5
32	39.6	29.7	16.2	12.4	13.6	29.2	65.2	71.4	6.6	22.8	72.7	76.0	5.1	22.3	57.5	61.5	4.3	16.3	33.7	32.0
34	57.1	32.2	19.3	32.6	16.8	45.4	76.3	***	7.0	32.9	72.9	76.9	5.8	29.9	64.9	64.5	4.6	21.2	39.3	37.6
35	49.6	34.1	1.3	36.0	***	2.1	55.5	2.4	***	***	70.9	80.2	***	2.8	65.2	65.8	***	1.7	45.9	31.9
36	1.3	3.9	7.6	11.1	2.7	5.6	33.1	***	3.1	5.9	34.6	35.0	3.2	6.2	27.0	25.7	3.5	4.6	9.4	8.3
37	13.2	12.7	33.0	30.3	42.2	44.7	67.7	66.3	41.4	48.1	70.4	66.9	35.1	36.9	54.7	45.3	4.7	8.2	5.3	1.1
38	6.1	45.2	57.2	45.2	71.2	72.0	76.6	72.6	66.8	73.9	75.6	63.3	54.1	61.1	55.5	39.0	36.9	51.2	28.4	19.0
39	***	26.3	63.9	64.5	52.0	71.5	79.8	72.7	46.3	76.2	78.3	58.8	45.8	72.0	60.1	38.3	38.9	58.8	26.7	19.7
40	26.5	30.6	44.4	48.4	22.9	22.1	21.3	26.9	13.1	13.5	37.1	40.7	5.1	5.2	30.2	32.1	1.7	1.8	14.9	14.5

Concentration measurements (ppm of CO) for an estimated inlet velocity of 2,000 fpm.

	0 fps wind speed				*15 fps wind speed*				*22 fps wind speed*				*29 fps wind speed*				*44 fps wind speed*			
Receptor	Position 1A	Position 1B	Position 2A	Position 2B	Position 1A	Position 1B	Position 2A	Position 2B	Position 1A	Position 1B	Position 2A	Position 2B	Position 1A	Position 1B	Position 2A	Position 2B	Position 1A	Position 1B	Position 2A	Position 2B
1	80.7	80.1	88.1	87.4	78.8	78.7	84.6	84.0	84.0	84.0	81.4	81.4	83.5	83.2	81.8	81.7	82.7	83.2	83.0	83.3
9	80.8	79.8	88.0	87.1	79.0	78.9	84.7	84.5	84.0	84.1	81.7	81.5	82.7	83.0	82.0	81.7	83.2	82.8	83.3	83.7
17	80.3	78.8	86.6	87.4	79.1	78.9	84.9	84.5	83.8	84.1	81.8	82.0	83.1	83.0	82.3	81.9	83.0	82.8	83.7	83.6
25	81.5	78.5	86.6	86.6	79.2	79.2	84.6	84.2	84.2	84.0	81.8	81.3	83.2	83.2	81.6	81.9	83.2	83.2	83.7	83.7
33	82.8	78.6	85.9	87.6	79.1	78.7	84.4	84.1	84.4	83.9	81.5	81.6	83.3	83.2	81.6	81.7	83.3	83.2	83.7	83.8
Average	0		0		0		0		0		40.82		0		0		0		0	
Receptor																				
8	2.3	***	4.7	2.1	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
24	11.1	8.5	10.5	8.0	7.6	7.5	1.1	1.1	43.1	44.9	6.7	6.1	59.9	57.9	9.4	9.8	68.8	68.3	22.3	25.6
Receptor																				
2	44.7	47.2	47.6	50.2	48.1	44.9	49.0	51.2	31.0	22.4	48.6	49.6	32.0	19.1	54.6	56.4	12.7	12.6	65.1	65.3
3	34.1	29.7	26.2	21.6	45.4	36.1	31.4	32.4	50.2	46.7	42.6	43.3	41.9	39.4	49.8	53.0	19.8	24.9	59.5	63.0
4	67.0	45.4	26.0	36.1	66.2	44.4	31.9	41.6	69.8	56.7	48.6	52.1	69.7	66.3	55.8	59.6	52.5	48.7	57.7	63.5
5	70.2	61.2	20.5	46.7	72.0	58.3	34.5	55.7	80.3	48.4	51.3	63.0	99.0	87.5	83.7	91.4	99.0	96.2	72.7	85.5
6	52.7	49.6	55.4	54.4	33.2	16.7	55.8	56.3	10.3	7.2	51.8	45.8	5.8	6.6	58.1	54.9	10.7	4.4	64.6	61.6
7	39.1	48.1	46.5	45.3	45.1	45.0	47.6	53.3	50.8	37.1	56.4	59.4	45.1	30.0	62.7	65.5	53.2	41.4	69.5	70.6
10	30.7	58.0	66.2	54.3	25.0	64.5	59.9	66.7	52.9	71.1	61.8	66.7	64.4	73.3	65.8	69.9	65.0	75.9	69.3	72.0
11	24.0	40.1	65.1	50.5	***	44.8	65.0	57.8	27.6	31.4	71.8	73.2	44.3	27.5	70.3	74.1	47.2	18.7	70.8	75.9
12	47.2	40.0	53.0	45.9	12.3	15.3	46.2	28.7	7.9	12.2	25.3	10.9	9.8	18.0	35.9	20.2	3.3	5.0	44.4	26.8
13	49.5	36.6	40.4	48.4	29.6	15.9	53.7	48.4	27.9	14.1	58.6	55.0	38.6	31.6	97.2	86.7	38.4	21.2	98.9	86.7
14	67.1	45.1	23.4	56.8	66.7	21.3	56.8	65.3	61.6	15.0	69.7	73.0	34.1	9.8	74.9	77.2	31.5	3.3	74.3	71.3
15	64.7	53.9	22.7	50.8	32.0	16.1	56.8	57.3	32.6	9.1	68.2	39.8	19.9	5.3	67.5	38.1	12.2	2.1	72.1	43.9
16	42.2	38.3	41.0	35.5	23.8	34.3	14.9	7.1	21.0	36.9	7.4	5.5	28.9	48.0	8.8	3.5	6.9	7.7	10.3	2.0
18	40.5	50.8	44.4	32.2	17.5	48.6	42.0	18.4	23.5	54.0	41.5	19.8	27.8	50.0	42.9	18.7	3.9	4.9	26.8	14.7
19	15.8	59.7	73.8	60.6	14.6	55.8	73.5	38.7	20.7	46.3	56.7	16.7	12.2	25.0	46.7	9.1	***	***	18.0	1.0
20	18.8	36.2	58.5	44.4	30.7	38.5	24.6	22.1	28.8	30.4	9.6	12.1	17.0	18.7	3.4	6.7	1.3	1.3	***	3.4
21	40.7	35.5	38.8	41.8	35.1	23.9	7.1	9.7	44.7	35.0	6.7	24.6	80.3	65.2	18.6	19.5	26.7	24.6	16.7	17.5
22	48.7	29.9	31.1	42.7	57.9	28.4	13.1	14.7	72.8	49.9	11.5	13.8	56.4	44.3	7.0	11.8	5.3	4.1	4.9	13.2
23	69.4	37.8	24.5	52.8	70.9	50.6	18.6	29.8	55.6	57.5	14.2	21.7	34.8	32.2	9.0	13.5	2.2	1.5	5.8	8.6
26	63.7	47.1	24.7	50.8	44.0	48.6	17.0	24.9	28.5	37.3	10.7	13.1	18.7	18.5	6.7	7.1	1.4	1.2	***	3.8
27	31.1	32.2	35.0	33.0	5.1	2.2	6.8	15.6	10.9	4.3	1.7	7.7	16.3	7.9	***	7.7	***	***	***	15.6
28	37.5	50.7	55.1	50.2	13.7	18.5	32.8	49.3	28.1	16.1	26.6	43.5	32.5	18.4	27.1	44.6	3.0	2.4	24.5	46.5
29	33.7	63.8	80.8	69.9	27.2	25.0	69.1	73.4	44.6	28.4	63.6	99.1	52.0	43.5	76.9	99.0	19.0	19.4	49.7	84.2
30	21.2	48.3	64.5	41.0	40.2	15.2	37.3	34.9	39.6	25.6	13.8	16.0	19.8	13.9	3.7	15.3	***	***	***	30.0
31	47.2	38.4	41.2	41.6	13.9	21.4	36.8	42.3	11.0	8.5	29.3	37.4	13.1	8.6	35.7	47.1	3.3	4.2	49.7	62.0
32	52.7	31.6	33.2	33.9	42.3	54.1	49.9	48.3	21.4	46.9	50.0	51.3	13.8	28.8	55.4	60.7	6.6	24.0	66.4	70.1
34	64.9	36.0	28.6	43.2	66.3	59.4	58.5	59.7	30.5	74.0	65.1	61.8	17.4	49.7	68.1	67.2	9.7	40.8	68.4	71.2
35	64.9	41.3	9.8	42.9	4.8	46.0	42.7	52.5	3.1	31.0	50.0	60.0	1.5	21.5	56.8	65.2	***	11.1	65.4	72.6
36	23.1	20.2	23.1	24.6	10.6	15.6	17.1	17.9	3.1	7.5	16.5	18.1	2.3	5.2	21.0	21.7	2.3	4.1	30.2	30.8
37	31.9	32.2	46.6	53.0	48.8	51.5	51.3	49.1	50.7	50.7	54.5	79.7	69.7	67.9	87.8	85.2	67.2	64.4	95.8	92.5
38	27.9	59.7	71.3	73.1	53.5	65.2	72.3	62.4	74.9	74.1	69.5	62.6	74.4	73.3	71.8	64.9	68.1	67.4	69.8	60.8
39	25.4	45.0	67.9	59.5	36.5	45.3	66.9	56.1	59.4	71.6	69.4	62.1	57.8	75.4	69.3	59.9	49.1	78.6	66.4	50.1
40	46.7	42.4	51.6	52.5	23.6	23.0	22.7	23.6	23.2	22.8	8.6	8.7	32.5	33.9	12.2	13.0	6.5	6.5	30.0	32.4

Concentration measurements (ppm of CO) for an estimated inlet velocity of 3,000 fpm.

	0 fps wind speed				*15 fps wind speed*				*22 fps wind speed*				*29 fps wind speed*				*44 fps wind speed*			
Receptor	Position 1A	Position 1B	Position 2A	Position 2B	Position 1A	Position 1B	Position 2A	Position 2B	Position 1A	Position 1B	Position 2A	Position 2B	Position 1A	Position 1B	Position 2A	Position 2B	Position 1A	Position 1B	Position 2A	Position 2B
1	79.6	81.7	83.3	82.7	81.8	81.2	84.2	84.3	82.9	82.6	83.6	83.3	82.6	82.4	81.8	81.7	83.8	83.7	82.6	83.0
9	79.9	81.0	83.4	81.5	82.3	81.6	84.8	84.5	82.8	83.1	84.0	83.6	82.9	82.6	82.5	82.1	84.1	84.1	83.5	83.5
17	81.3	79.5	82.0	80.2	81.9	81.4	84.7	84.6	83.3	83.0	83.9	83.7	82.7	82.5	82.2	82.1	83.8	84.2	83.6	83.5
25	81.1	79.2	82.2	78.4	82.0	81.8	84.4	84.5	83.0	83.2	83.6	83.6	82.9	82.7	82.1	82.1	84.1	84.2	83.2	83.3
33	81.8	78.5	80.8	77.2	82.0	81.3	84.5	84.2	83.3	83.1	83.7	83.5	82.6	82.7	82.0	82.1	84.1	84.5	83.4	83.4
Average	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
Receptor																				
8	8.0	2.0	8.7	2.9	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
24	16.7	13.2	12.5	13.8	***	***	***	***	5.2	5.1	***	***	24.2	25.6	3.7	3.8	63.2	62.1	8.8	9.0
Receptor																				
2	43.4	46.9	40.4	41.1	49.0	52.5	44.3	44.6	47.5	49.2	46.8	49.8	37.6	35.4	47.7	48.5	32.8	18.7	50.2	51.3
3	37.6	30.8	21.1	20.5	42.5	41.2	21.1	19.5	48.3	37.1	31.2	30.0	50.3	43.6	34.3	34.9	45.5	46.9	48.9	48.9
4	71.7	44.4	22.3	36.4	70.9	52.5	17.4	28.7	71.4	44.4	30.6	36.8	69.9	49.4	38.9	42.2	72.0	65.0	55.3	57.3
5	69.3	60.1	15.8	47.4	74.8	64.3	9.3	37.0	74.4	60.4	25.0	45.7	77.1	57.7	39.7	53.6	78.4	53.1	53.3	58.4
6	49.8	51.3	46.8	50.0	52.3	43.1	51.7	54.0	37.8	23.2	54.2	52.2	18.7	10.6	52.1	48.2	6.8	4.7	52.9	47.2
7	36.7	46.5	51.1	49.9	50.2	51.8	46.1	51.7	44.4	52.0	48.6	53.5	48.7	49.6	51.2	55.3	53.0	36.2	61.6	65.1
10	29.5	60.0	71.1	60.0	38.5	62.2	64.3	64.3	21.0	68.6	61.8	66.3	40.8	71.2	61.5	66.9	66.6	76.6	65.8	70.6
11	22.9	36.8	60.7	45.5	13.8	44.6	55.8	38.7	***	42.8	60.9	51.9	11.6	44.0	68.2	65.1	42.3	30.6	71.0	75.2
12	51.8	44.2	54.2	51.9	32.9	29.2	48.6	37.0	15.2	16.2	36.3	18.8	7.9	10.4	31.2	16.1	7.7	14.1	28.2	18.2
13	56.9	41.4	45.0	49.2	42.9	21.6	48.2	44.1	37.3	13.6	48.9	42.4	30.4	11.7	54.3	50.0	17.6	10.7	63.6	57.0
14	72.3	46.0	31.3	56.3	70.5	32.5	41.3	63.1	69.8	20.3	54.1	69.5	63.9	15.4	62.0	72.8	35.4	10.5	77.0	78.7
15	65.1	54.6	26.5	54.8	53.7	35.3	38.9	62.4	44.0	17.5	53.3	56.4	42.1	11.3	60.5	43.9	19.3	5.7	70.4	39.2
16	45.5	39.9	52.9	47.1	32.3	34.3	23.0	16.7	24.6	34.7	9.9	8.0	20.2	35.2	9.7	6.3	25.0	43.4	10.6	5.1
18	45.6	51.1	51.1	40.0	23.2	47.0	36.0	19.4	16.8	49.1	39.8	19.0	19.4	49.4	43.0	19.4	25.8	51.0	41.1	18.1
19	24.4	57.2	70.6	48.7	10.6	55.7	73.4	42.2	16.6	59.1	70.8	32.0	20.4	51.5	63.1	25.3	12.8	31.8	39.0	6.1
20	29.4	45.6	60.8	45.4	21.0	44.7	35.7	20.8	31.8	43.4	24.1	21.5	32.0	37.4	16.2	17.7	20.7	25.0	3.8	6.1
21	44.9	35.9	48.5	45.6	31.4	22.7	18.3	24.0	35.0	24.3	9.3	11.8	41.2	32.7	5.9	6.2	49.9	38.1	2.4	3.2
22	53.4	30.6	41.0	48.2	49.6	24.0	13.1	23.3	59.4	30.5	13.5	15.5	68.8	46.7	12.2	13.3	60.9	45.7	7.7	11.2
23	72.4	37.9	32.2	55.2	73.2	43.1	13.0	35.2	71.6	53.2	17.2	28.0	60.8	55.8	15.1	23.4	41.3	35.3	9.0	11.9
26	63.6	47.1	26.1	51.2	49.3	51.4	14.0	26.3	43.1	45.4	16.4	22.7	36.6	37.1	13.5	16.4	24.1	21.7	3.0	5.2
27	30.5	32.3	37.3	29.0	4.5	5.6	21.2	27.9	4.6	1.7	8.3	16.6	9.1	2.7	1.4	6.8	14.7	5.8	***	4.6
28	35.3	50.3	54.3	41.4	14.8	25.2	47.8	49.8	16.6	18.8	36.5	53.2	25.4	16.9	27.0	46.5	33.1	19.7	24.3	41.1
29	30.0	60.7	77.3	57.8	21.6	35.9	76.1	67.3	32.1	23.6	68.2	73.4	40.4	26.5	62.5	75.0	29.2	23.9	39.5	66.3
30	21.5	50.3	65.1	35.8	22.5	7.3	47.1	43.9	36.1	18.6	31.5	35.4	35.0	28.7	21.2	24.6	20.7	15.7	4.3	15.5
31	50.9	44.5	44.3	40.8	25.2	36.1	43.0	45.3	11.7	18.1	34.9	39.0	9.8	8.8	28.0	36.8	11.4	7.5	29.1	39.3
32	60.7	41.8	37.8	40.8	50.7	54.3	44.4	47.5	39.1	58.5	50.6	48.8	22.8	45.3	50.8	52.2	14.0	26.2	52.4	58.1
34	70.1	38.8	27.4	42.4	73.4	52.6	37.6	48.1	59.5	67.6	56.7	58.8	30.6	70.8	63.8	63.1	16.5	44.0	68.6	66.8
35	66.4	44.4	8.0	37.3	24.2	47.4	19.9	29.2	7.3	53.4	38.9	47.5	3.4	44.5	48.3	59.0	***	21.6	61.2	66.2
36	28.7	26.2	29.9	25.0	18.6	20.8	22.1	21.5	11.5	19.0	20.6	21.7	5.3	10.8	20.2	21.9	3.2	7.9	22.1	24.0
37	35.3	39.7	54.1	46.7	42.9	44.1	51.0	44.7	51.5	52.8	49.7	48.0	48.7	50.5	52.6	48.6	43.1	45.7	58.5	56.5
38	30.4	60.7	74.1	58.8	40.8	58.4	73.1	57.0	58.3	68.1	71.8	61.3	70.8	71.5	71.6	56.7	73.2	76.2	73.5	65.9
39	26.0	44.8	65.7	43.8	31.6	38.4	54.5	32.0	41.6	41.4	62.9	51.3	58.8	62.7	67.0	54.6	61.9	76.3	69.4	59.4
40	47.0	41.8	50.6	47.7	27.9	28.2	39.8	40.8	23.3	23.2	21.3	21.3	23.5	22.8	10.7	12.1	30.4	31.5	8.3	9.4

Concentration measurements (ppm of CO) for an estimated inlet velocity of 4,000 fpm.

	0 fps wind speed				*15 fps wind speed*				*22 fps wind speed*				*29 fps wind speed*				*44 fps wind speed*			
Receptor	Position 1A	Position 1B	Position 2A	Position 2B	Position 1A	Position 1B	Position 2A	Position 2B	Position 1A	Position 1B	Position 2A	Position 2B	Position 1A	Position 1B	Position 2A	Position 2B	Position 1A	Position 1B	Position 2A	Position 2B
1	80.3	78.9	76.4	78.4	80.5	79.6	89.0	81.7	81.6	81.9	80.1	79.7	80.8	80.9	80.1	79.6	81.0	81.4	79.8	79.5
9	81.5	77.8	74.7	77.1	80.8	80.1	89.3	82.2	82.5	81.9	80.7	80.4	81.3	81.1	80.7	80.6	81.6	81.7	80.6	80.4
17	80.9	76.9	76.9	76.3	81.0	80.1	89.6	82.0	82.3	82.2	80.9	80.1	81.2	81.6	80.5	80.4	81.5	81.4	80.7	80.6
25	79.1	76.6	77.6	76.8	80.8	79.8	89.3	82.0	82.2	81.9	80.8	80.0	81.1	81.2	80.5	80.2	81.6	81.5	80.3	80.3
33	80.2	79.1	81.8	74.7	80.4	79.6	89.1	81.8	82.3	81.9	80.4	80.1	81.5	81.4	80.4	80.0	81.5	81.8	80.3	80.2
Average	79.13		77.07		80.27		85.6		82.07		80.32		81.21		80.3		81.5		80.27	
Receptor																				
8	5.0	3.6	4.4	2.9	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
24	17.4	13.8	14.0	15.2	***	***	***	***	1.6	1.4	***	***	7.5	8.7	***	***	47.9	47.2	6.3	6.3
Receptor																				
2	42.8	46.1	36.0	43.8	45.7	49.3	43.7	40.5	52.2	53.7	43.3	46.7	50.6	51.7	46.1	47.4	42.3	32.0	49.4	50.2
3	38.4	32.6	14.6	21.7	39.1	37.5	16.8	13.4	44.7	35.7	21.3	23.3	49.1	38.6	25.5	25.9	54.1	49.9	41.0	41.7
4	74.8	45.1	17.4	33.6	73.6	52.1	11.8	21.3	73.5	46.1	18.8	27.5	72.2	45.5	25.6	31.3	70.0	55.6	44.3	47.6
5	70.2	59.6	10.8	42.7	71.1	63.5	5.2	28.3	71.8	59.5	11.5	31.0	72.8	61.2	25.5	39.8	76.2	46.4	44.6	51.8
6	50.4	51.0	42.1	50.7	53.2	50.8	51.9	51.1	50.1	37.6	50.0	52.9	38.0	23.4	51.8	53.2	14.6	6.4	52.6	48.9
7	36.3	42.4	46.9	47.6	45.3	48.7	49.9	51.9	35.6	50.4	46.3	52.3	43.5	53.8	49.9	54.6	55.4	49.1	57.1	62.2
10	27.0	56.5	64.6	55.8	30.0	54.6	71.9	64.3	18.3	64.8	63.1	65.3	21.1	66.8	64.7	67.9	51.4	75.2	63.5	69.3
11	21.0	30.5	50.5	41.5	16.3	32.9	55.4	32.9	***	33.2	57.3	37.1	***	38.5	56.7	47.1	25.4	38.6	68.3	71.0
12	52.5	46.6	46.7	49.7	43.0	36.0	53.6	43.4	24.3	20.6	46.1	30.6	12.3	10.5	42.3	27.0	4.4	8.1	28.3	15.6
13	58.0	44.0	37.4	48.1	49.2	27.5	51.2	48.6	43.8	12.2	48.3	46.2	37.2	9.4	52.3	51.6	22.5	8.4	61.1	55.7
14	77.1	47.1	23.9	53.0	73.6	37.8	37.2	59.7	72.6	22.2	44.2	63.2	70.2	17.1	54.1	67.5	51.3	11.4	71.8	76.7
15	66.6	57.3	20.2	49.3	57.5	45.0	33.3	54.8	49.5	23.6	41.8	59.4	43.0	15.3	53.0	54.4	25.2	6.5	68.5	38.5
16	46.2	42.0	47.0	44.5	36.2	35.8	30.7	21.5	28.5	34.9	17.1	10.1	19.7	33.0	11.8	5.5	15.5	31.3	6.8	3.8
18	44.0	50.9	52.7	33.6	25.9	46.9	45.2	21.5	16.5	47.9	40.9	18.0	13.2	44.3	44.9	19.0	19.6	49.3	41.4	18.0
19	20.8	55.1	68.9	42.5	7.3	53.3	81.8	44.1	10.9	60.4	72.7	37.7	13.9	57.8	70.3	33.6	17.4	49.9	58.8	14.9
20	28.0	47.7	54.3	34.8	19.6	48.7	38.4	26.2	31.2	49.7	28.9	24.0	34.0	46.1	23.1	21.2	32.2	37.5	9.1	11.4
21	44.8	36.4	45.8	41.7	32.1	22.3	22.8	27.7	32.7	21.0	11.4	16.0	36.5	25.9	4.6	7.1	44.0	34.9	2.9	3.5
22	53.6	30.9	35.1	43.5	48.1	22.1	13.6	25.4	53.8	24.1	11.2	17.6	61.5	34.8	10.8	13.2	70.8	51.1	8.9	11.9
23	73.2	38.1	24.0	46.1	72.0	39.9	13.8	33.7	73.9	45.9	14.9	29.3	70.8	56.5	16.0	25.2	56.5	53.9	11.9	18.0
26	60.9	47.2	26.2	49.6	58.4	52.6	17.1	30.5	52.1	52.0	16.6	26.8	43.7	46.5	16.0	21.5	34.5	34.5	9.7	10.6
27	28.0	29.9	36.6	34.4	5.5	8.8	30.1	33.6	2.9	1.1	17.7	25.0	4.1	***	6.7	16.8	9.2	2.1	***	5.9
28	31.5	46.1	56.7	47.9	12.2	25.3	56.3	51.4	11.8	17.7	47.0	54.9	14.5	14.5	38.0	55.0	28.7	15.6	27.6	48.8
29	26.9	51.7	74.6	58.8	13.8	37.5	82.9	67.9	23.6	21.3	73.5	69.0	32.2	19.8	69.7	73.0	40.1	27.7	57.7	73.7
30	20.3	46.8	58.7	39.8	21.2	3.9	47.7	38.5	36.9	7.8	41.1	34.9	40.1	21.9	31.9	25.2	35.4	28.5	9.2	6.6
31	49.9	44.9	42.4	44.3	35.1	42.2	48.7	46.7	17.0	31.8	42.2	43.0	9.7	17.3	39.4	43.7	7.3	7.3	32.3	43.0
32	60.9	41.7	33.8	40.7	56.7	51.9	46.2	45.6	47.9	61.3	46.4	46.9	32.1	59.0	52.0	51.3	14.9	34.8	56.4	58.8
34	71.7	36.7	32.2	38.7	73.8	48.1	33.1	35.1	67.5	60.8	42.2	47.3	43.4	72.2	56.5	59.0	17.4	48.8	68.7	67.9
35	63.9	41.7	15.2	32.7	31.2	44.7	9.1	17.0	4.7	46.7	24.1	25.2	1.1	46.4	36.3	46.5	***	17.5	47.9	61.8
36	27.9	25.5	34.3	28.2	21.6	21.4	26.3	22.5	20.9	25.3	23.9	24.2	13.6	21.9	24.7	24.6	5.7	13.7	24.8	25.2
37	34.1	35.0	59.7	49.3	36.2	37.7	57.3	45.2	48.2	47.3	51.3	47.1	55.1	53.8	51.8	45.5	53.1	56.2	56.9	51.5
38	26.1	53.7	75.8	58.5	26.6	47.3	80.1	60.0	42.7	57.6	71.3	58.1	62.1	67.4	73.7	56.4	74.9	75.6	72.0	58.8
39	22.2	37.7	68.7	46.7	25.3	30.1	48.8	26.8	32.1	34.6	58.1	36.9	48.6	44.3	62.2	47.7	65.9	72.2	72.3	60.8
40	46.0	42.7	55.6	46.5	35.2	35.0	46.8	44.0	29.1	29.2	33.4	31.9	26.5	26.4	22.7	22.4	26.1	26.1	9.2	9.3

Concentration measurements (ppm of CO) for an estimated inlet velocity of 3,000 fpm (model 12).

	0 fps wind speed				*22 fps wind speed*				*44 fps wind speed*			
Receptor	Position 1A	Position 1B	Position 2A	Position 2B	Position 1A	Position 1B	Position 2A	Position 2B	Position 1A	Position 1B	Position 2A	Position 2B
1	81.6	78.9	79.9	79.4	82.7	81.5	83.3	81.8	81.3	81.3	80.2	80.0
9	82.0	78.5	80.5	78.7	83.7	82.5	84.3	82.7	82.2	82.1	81.3	80.8
17	84.1	80.5	80.4	76.6	83.2	81.9	84.2	82.8	82.3	82.0	81.2	81.1
25	87.9	79.3	82.6	78.8	83.3	82.5	83.8	82.8	82.2	82.0	81.1	80.8
33	88.1	84.7	81.9	80.5	83.1	82.2	83.5	82.3	82.1	82.2	81.0	80.7
Average	82.56		79.93		82.66		83.15		81.97		80.82	
Receptor												
8	10.2	2.4	6.5	***	***	***	***	***	***	***	***	***
24	18.6	14.9	12.5	6.9	***	***	***	***	11.7	11.0	1.3	1.5
Receptor												
2	46.7	45.7	48.9	51.7	53.6	52.9	50.8	54.2	56.6	51.6	52.0	53.5
3	47.3	34.1	25.1	34.6	47.6	33.5	24.6	29.0	52.1	37.9	34.0	36.9
4	79.0	45.2	21.6	42.6	77.2	42.6	17.0	32.9	72.9	41.0	31.4	42.6
5	71.5	59.8	15.0	42.4	73.8	56.3	9.4	36.0	75.0	58.1	35.5	54.1
6	54.3	51.7	53.8	47.4	51.6	44.4	57.2	53.8	36.4	21.1	55.2	47.8
7	41.1	41.4	57.1	40.5	32.8	51.1	56.2	55.1	42.8	58.6	57.1	60.6
10	23.9	57.4	75.8	50.2	15.5	66.4	73.7	65.1	22.2	72.6	72.6	71.7
11	17.1	26.5	53.7	39.9	***	13.0	57.5	31.2	***	29.4	68.2	61.1
12	55.9	49.2	49.8	45.9	31.1	20.1	45.3	29.1	9.3	6.3	30.9	21.6
13	58.8	43.0	36.7	47.0	55.4	14.1	50.8	56.4	38.3	7.8	57.4	61.6
14	79.7	44.6	22.8	49.1	80.9	25.5	42.2	70.1	72.8	14.7	65.0	73.9
15	67.9	55.1	20.4	44.1	37.0	24.2	42.5	54.0	25.7	10.5	54.1	28.7
16	51.5	45.1	49.2	40.0	24.1	35.9	18.5	10.1	13.6	29.8	10.5	6.3
18	44.6	54.1	58.4	37.9	11.0	41.3	48.8	20.5	12.9	42.7	40.4	15.6
19	20.1	57.7	73.5	35.9	5.3	55.9	73.7	31.4	15.1	57.3	52.8	12.3
20	28.2	47.5	52.7	31.8	23.1	50.3	32.4	26.0	34.1	43.6	22.0	18.2
21	47.5	40.0	41.7	40.0	40.2	27.5	9.9	13.4	41.1	33.3	5.1	5.7
22	56.4	34.7	28.2	39.9	60.5	27.8	11.8	16.8	68.2	41.9	10.5	13.2
23	76.4	45.3	21.0	46.8	78.6	46.3	15.4	25.5	69.4	59.9	13.5	21.0
26	67.0	51.5	19.1	45.0	56.6	56.3	17.8	25.8	43.5	46.6	14.4	20.4
27	37.1	34.7	41.1	35.0	4.6	3.3	16.3	25.9	6.9	***	2.5	10.5
28	35.6	44.5	64.3	44.9	8.6	15.2	47.6	61.2	15.4	11.0	31.3	56.2
29	30.1	45.9	76.8	47.4	19.1	22.2	71.4	71.8	34.4	20.4	54.7	73.3
30	27.3	41.8	59.1	35.1	36.8	6.0	44.9	43.2	41.5	25.1	31.8	33.2
31	59.4	49.8	44.7	42.7	25.4	41.6	43.3	44.3	6.0	15.2	32.3	43.2
32	70.3	51.3	32.3	34.3	47.3	60.7	50.7	49.4	23.6	54.5	57.2	56.0
34	80.6	51.8	22.3	44.6	66.8	59.4	43.5	49.7	32.0	70.7	62.9	64.3
35	70.9	52.5	6.9	35.2	19.3	48.7	27.0	24.4	2.8	57.3	41.8	54.2
36	35.6	31.8	33.7	34.2	27.6	29.0	28.5	30.6	16.0	27.3	28.4	31.2
37	40.3	41.2	55.5	48.6	46.5	47.0	55.7	49.7	56.1	56.7	55.4	46.8
38	31.7	54.9	76.2	56.0	34.7	54.9	74.4	58.9	66.7	70.3	76.0	53.4
39	33.2	40.9	61.0	49.9	23.6	41.1	60.3	41.1	53.8	50.8	64.1	54.5
40	56.7	52.8	54.9	53.7	43.7	42.4	30.7	25.9	32.5	32.6	12.1	13.2

Concentration measurements (ppm of CO) for an estimated inlet velocity of 4,000 fpm (model 12).

	0 fps wind speed				*22 fps wind speed*				*44 fps wind speed*			
Receptor	Position 1A	Position 1B	Position 2A	Position 2B	Position 1A	Position 1B	Position 2A	Position 2B	Position 1A	Position 1B	Position 2A	Position 2B
1	45.9	50.7	47.9	51.3	49.4	48.8	50.8	50.0	48.0	48.0	48.3	48.0
9	54.8	50.9	51.4	51.7	51.1	50.6	52.3	51.7	49.5	49.6	50.2	49.7
17	57.7	44.4	53.4	50.9	51.3	50.6	52.2	51.7	49.7	49.5	49.9	49.8
25	52.4	50.8	55.0	50.2	50.7	50.1	52.1	51.3	49.2	49.4	50.0	49.7
33	58.0	45.6	57.5	49.8	50.7	50.4	51.7	51.2	49.4	49.4	49.9	49.8
Average	51.12		51.91		50.37		51.5		49.17		49.53	
Receptor												
8	1.2	9.0	***	***	***	***	***	***	***	***	***	***
24	6.9	1.1	8.7	7.2	***	***	***	***	***	***	***	***
Receptor												
2	22.8	32.8	30.8	33.6	32.8	34.2	33.8	32.5	33.1	31.9	31.1	29.5
3	19.5	25.0	7.7	20.9	18.1	21.6	3.6	12.4	22.6	18.0	5.8	13.2
4	42.6	36.8	11.5	29.8	34.9	46.1	4.2	22.4	45.3	32.8	5.5	21.1
5	38.4	39.2	12.5	26.8	42.9	44.4	4.7	17.2	45.4	40.9	5.8	14.0
6	24.5	33.6	27.5	26.1	24.4	29.9	34.8	31.5	27.4	20.7	31.8	29.6
7	16.8	28.6	35.1	24.6	32.3	27.0	39.8	29.2	28.6	33.0	37.8	33.2
10	15.8	33.8	47.9	30.0	35.8	15.5	49.6	31.7	17.3	37.5	46.0	33.1
11	6.2	10.9	26.8	21.3	13.4	3.9	20.3	18.1	1.7	14.4	20.0	19.2
12	34.3	32.6	20.9	26.7	16.4	17.3	28.0	26.8	13.2	13.5	24.9	23.3
13	40.5	32.6	12.8	27.3	11.7	28.4	25.6	37.0	24.2	7.9	28.2	36.1
14	54.5	33.8	8.2	29.7	25.0	47.0	19.2	40.9	45.5	17.8	21.3	39.7
15	44.1	35.6	5.9	17.2	25.1	32.2	12.8	22.1	32.9	17.7	15.3	26.2
16	34.0	33.7	29.5	28.4	26.5	21.4	22.1	13.8	19.8	26.8	18.1	9.8
18	22.5	24.8	43.4	28.7	29.0	13.2	34.9	15.1	12.0	29.9	32.1	12.3
19	4.5	19.3	40.7	18.5	17.7	***	35.5	10.2	***	20.2	35.1	10.2
20	15.2	19.7	32.0	27.0	25.8	5.8	27.2	18.6	12.1	27.2	25.3	19.3
21	36.7	25.3	23.1	22.6	25.5	29.5	9.4	9.8	29.6	24.2	6.1	5.5
22	43.6	17.6	12.6	17.3	23.8	38.9	7.8	14.5	39.4	22.4	7.6	13.1
23	55.9	23.4	8.6	28.7	27.5	45.2	7.8	28.0	44.7	27.7	9.0	29.3
26	34.1	31.7	9.6	17.1	34.1	38.7	8.9	14.3	36.1	31.1	9.2	13.2
27	11.7	20.5	18.1	18.1	3.2	5.2	6.1	12.5	3.5	***	***	7.9
28	10.1	32.0	39.0	32.2	14.8	8.4	34.3	36.2	8.4	12.5	30.7	35.7
29	2.2	34.3	53.9	37.4	23.0	6.5	50.7	45.4	10.4	18.7	48.0	45.9
30	2.2	26.2	38.4	33.9	2.4	11.5	26.9	33.1	17.6	3.9	20.9	35.4
31	29.9	30.2	34.8	32.3	23.2	17.2	30.6	32.8	11.3	17.8	30.4	35.9
32	38.0	28.1	22.8	21.9	32.9	31.5	24.6	25.6	28.6	34.7	28.1	29.0
34	53.2	25.0	15.8	23.9	34.1	47.4	14.4	24.4	45.4	35.3	19.3	29.2
35	35.3	15.4	4.9	10.2	25.7	17.8	4.5	2.9	8.3	22.7	9.4	2.8
36	15.8	14.2	29.3	25.6	20.8	17.9	26.8	25.2	14.7	19.4	26.6	23.2
37	17.1	18.5	43.7	29.8	24.0	22.0	40.1	27.6	28.0	28.8	37.2	24.9
38	11.2	22.1	56.7	36.3	28.9	13.1	52.0	35.6	23.0	34.6	49.8	33.2
39	11.7	14.0	44.5	38.7	21.5	15.3	27.9	36.5	18.2	22.7	31.4	39.3
40	37.7	31.1	37.4	33.7	23.3	23.5	26.8	27.1	21.2	21.3	21.1	21.9

APPENDIX B

Velocity measurements (fps) for an estimated inlet velocity of 3,000 fpm (50 fps).

Position 1A, 0 fps

Receptor	Velocity
1	
2	32.89
3	28.53
4	46.82
5	41.29
6	32.33
7	20.98
8	
9	
10	8.51
11	12.15
12	23.03
13	27.51
14	47.62
15	34.77
16	22.85
17	
18	10.65
19	6.40
20	7.33
21	25.91
22	33.54
23	37.82
24	
25	
26	35.51
27	14.92
28	3.69
29	
30	6.91
31	21.78
32	31.74
33	
34	42.96
35	38.21
36	22.28
37	13.22
38	6.33
39	13.67
40	26.59

Position 1B, 0 fps

Receptor	Velocity
1	
2	32.39
3	28.36
4	32.09
5	41.14
6	27.23
7	32.40
8	
9	
10	38.77
11	23.09
12	18.66
13	6.91
14	23.49
15	29.19
16	24.30
17	
18	29.24
19	27.80
20	17.00
21	18.24
22	12.29
23	13.79
24	
25	
26	21.12
27	14.13
28	22.66
29	30.96
30	16.16
31	24.37
32	24.21
33	
34	19.68
35	32.38
36	22.17
37	13.38
38	35.79
39	14.60
40	25.16

Position 1A, 22 fps

Receptor	Velocity
1	
2	31.58
3	28.74
4	42.01
5	38.12
6	25.78
7	26.24
8	
9	
10	0.92
11	8.95
12	16.52
13	25.64
14	46.14
15	34.97
16	17.35
17	
18	8.76
19	8.81
20	
21	30.73
22	35.91
23	34.58
24	
25	
26	24.89
27	17.40
28	9.00
29	8.95
30	2.77
31	16.21
32	28.29
33	
34	37.54
35	25.09
36	21.14
37	25.64
38	13.03
39	20.61
40	27.26

Position 1B, 22 fps

Receptor	Velocity
1	
2	31.54
3	24.26
4	28.35
5	39.56
6	23.26
7	35.39
8	
9	
10	44.00
11	33.26
12	16.85
13	15.73
14	18.66
15	23.92
16	28.97
17	
18	25.51
19	26.01
20	15.59
21	28.26
22	21.56
23	20.44
24	
25	
26	25.29
27	15.37
28	18.40
29	18.07
30	13.88
31	22.09
32	33.25
33	
34	29.15
35	37.90
36	25.59
37	26.42
38	33.44
39	14.89
40	28.71

Position 1A, 44 fps

Receptor	Velocity
1	
2	35.87
3	30.03
4	29.91
5	40.72
6	40.75
7	34.78
8	
9	
10	20.63
11	16.83
12	30.39
13	34.93
14	35.75
15	42.11
16	28.24
17	
18	17.64
19	14.54
20	17.91
21	33.09
22	27.57
23	25.88
24	
25	
26	27.04
27	28.56
28	16.55
29	14.69
30	16.80
31	30.49
32	30.80
33	
34	24.24
35	40.15
36	32.64
37	33.87
38	26.62
39	34.86
40	35.63

Position 1B, 44 fps

Receptor	Velocity
1	
2	41.61
3	32.84
4	21.72
5	31.97
6	36.01
7	38.88
8	
9	
10	48.75
11	42.83
12	29.40
13	27.60
14	17.43
15	32.35
16	33.86
17	
18	26.78
19	24.64
20	26.91
21	33.27
22	26.17
23	23.62
24	
25	
26	26.80
27	28.07
28	23.56
29	17.67
30	19.70
31	36.69
32	36.64
33	
34	36.31
35	48.33
36	34.74
37	34.77
38	33.12
39	31.74
40	37.25

Position 2A, 0 fps

Receptor	Velocity
1	
2	27.61
3	12.60
4	6.79
5	10.45
6	29.02
7	28.33
8	
9	
10	41.70
11	27.61
12	29.97
13	10.85
14	
15	6.53
16	22.19
17	
18	27.97
19	41.15
20	19.42
21	17.23
22	3.46
23	1.60
24	
25	
26	6.47
27	19.66
28	28.50
29	42.64
30	19.44
31	14.52
32	6.06
33	
34	2.07
35	7.73
36	21.06
37	29.05
38	44.09
39	25.83
40	31.90

Position 2B, 0 fps

Receptor	Velocity
1	
2	24.56
3	15.89
4	21.58
5	16.70
6	22.87
7	17.89
8	
9	
10	31.56
11	27.19
12	21.30
13	19.08
14	30.62
15	21.36
16	25.38
17	
18	17.64
19	30.74
20	15.86
21	20.94
22	17.20
23	27.51
24	
25	
26	15.62
27	26.94
28	29.00
29	33.81
30	18.77
31	28.81
32	17.50
33	
34	20.96
35	15.09
36	22.62
37	27.88
38	38.23
39	28.74
40	32.52

Position 2A, 22fps

Receptor	Velocity
1	
2	28.01
3	4.89
4	
5	
6	28.56
7	21.93
8	
9	
10	40.31
11	18.84
12	26.93
13	18.19
14	13.57
15	15.86
16	22.24
17	
18	27.01
19	38.53
20	14.63
21	19.02
22	14.16
23	12.56
24	
25	
26	14.60
27	23.22
28	28.54
29	40.17
30	14.19
31	27.55
32	19.17
33	
34	13.00
35	18.93
36	24.21
37	20.17
38	39.90
39	15.62
40	25.73

Position 2B, 22fps

Receptor	Velocity
1	
2	27.71
3	12.90
4	6.26
5	9.95
6	27.83
7	14.10
8	
9	
10	30.70
11	14.16
12	26.22
13	29.57
14	33.87
15	25.26
16	20.53
17	
18	16.05
19	22.77
20	15.86
21	21.06
22	14.60
23	19.48
24	
25	
26	15.84
27	26.17
28	32.86
29	37.55
30	16.26
31	26.50
32	12.56
33	
34	25.29
35	
36	24.08
37	22.96
38	32.87
39	25.71
40	27.32

Position 2A, 44fps

Receptor	Velocity
1	
2	
3	
4	
5	
6	11.46
7	
8	
9	
10	18.38
11	20.07
12	38.25
13	23.94
14	15.76
15	16.37
16	45.35
17	
18	30.15
19	33.13
20	34.27
21	44.88
22	34.66
23	25.79
24	
25	
26	24.26
27	42.69
28	29.64
29	34.74
30	28.79
31	30.13
32	10.89
33	
34	
35	17.47
36	13.13
37	5.69
38	30.69
39	
40	40.70

Position 2A, 44fps

Receptor	Velocity
1	
2	
3	
4	
5	
6	25.64
7	1.60
8	
9	
10	21.26
11	16.08
12	42.54
13	30.80
14	30.62
15	36.13
16	44.77
17	
18	30.62
19	28.75
20	27.16
21	44.43
22	29.37
23	28.39
24	
25	
26	25.43
27	38.37
28	29.32
29	32.19
30	40.05
31	21.14
32	
33	
34	15.29
35	13.19
36	13.09
37	
38	23.89
39	7.56
40	40.70