SECTION III: TABLE OF CONTENTS

3. EVALUATION OF RESULTS AND RECOMMENDATIONS

This section presents and discusses the results generated in the CFD simulations for 101 different room configurations. The detailed flow patterns for each room are not discussed; the comparisons focus on the quantitative analysis of the CFD data.

The analysis concentrates on eight parameters defined in section 2.4.2:

Mean cage temperatures
Mean cage CO_2 concentrations Mean
cage relative humidity (RH) Mean cage
NH_3 concentration on day 4
Mean room breathing zone temperature
Mean room breathing zone CO_2 concentration
Mean room breathing zone (RH)
Mean room breathing zone NH_3 concentration on day 4

As each day had a different NH_3 generation rate, the NH_3 concentrations are different on each day. However as the underlying mass fraction information and RH information does not change on a daily basis in the simulations, room performance can be compared by using the results for any of the 10 days. For ease of comparison, results are presented for day 4, which corresponds to the day most widely used to change the bedding in the mice cages.

In addition to the day 4 NH_3 concentrations (i.e., the conditions that would arise four days after clean bedding is placed in every cage), a summary of the complete 10-day cycle is presented.

The analysis focuses on trends in the data that identify any ventilation schemes as particularly good or bad, and recommendations are made. The major recommendation is tested by further post-processing of the CFD data.

3.1 Results for 101 Room Simulations

Figures 3.01 to 3.08 show bar charts of the eight parameters identified as important in categorizing the behavior of the ventilation system on the room and the cages. The individual cases can be identified by comparison of the case number on the bottom of the charts with the complete list of cases in table 3.01 below.

Table 3.01 List of All Whole Room Runs

Case Name	Supply Diffuser Type	Exhaust Location and Number	Change Station (Design/ Status)	Rack Orientation	Rack Density	Pressure of Room to Corridor	Supply Temperature °C (°F)	Supply ACH
Basecase	Radial	Ceiling (x2)	Thoren/ ON	Parallel	Single	Neg.. 100cfm	18.8 (65.8)	15
Case 02	Radial	High (x4)	Thoren/ ON	Parallel	Single	Neg.. 100cfm	18.8 (65.8)	15
Case 03	Radial	Low (x4)	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 04	Slot	Ceiling (x2)	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 05	Slot	High (x4)	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 06	Slot	Low (x4)	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 07	Low Ind	Ceiling (x2)	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 08	Low Ind	High (x4)	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 09	Low Ind	Low (x4)	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 10	Radial	Ceiling (x2)	Thoren/ OFF	Parallel	Single	Neg. 100cfm	20.7 (69.3)	15
Case 11	Radial	Low (x4)	Thoren/ OFF	Parallel	Single	Neg. 100cfm	20.7 (69.3)	15
Case 12	Slot	Ceiling (x2)	Thoren/ OFF	Parallel	Single	Neg. 100cfm	20.7 (69.3)	15
Case 13	Slot	Low (x4)	Thoren/ OFF	Parallel	Single	Neg. 100cfm	20.7 (69.3)	15
Case 14	Low Ind	Ceiling (x2)	Thoren/ OFF	Parallel	Single	Neg. 100cfm	20.7 (69.3)	15
Case 15	Low Ind	Low (x4)	Thoren/ OFF	Parallel	Single	Neg. 100cfm	20.7 (69.3)	15
Case 16	Radial	Ceiling (x2)	Thoren/ ON	Parallel	Single	Pos. 100cfm	18.8 (65.8)	15
Case 17	Slot	Ceiling (x2)	Thoren/ ON	Parallel	Single	Pos. 100cfm	18.8 (65.8)	15
Case 18	Low Ind	Ceiling (x2)	Thoren/ ON	Parallel	Single	Pos. 100cfm	18.8 (65.8)	15
Case 19	Radial	Ceiling (x2)	Thoren/ ON	Perpendicular	Single	Neg. 100cfm	18.8 (65.8)	15
Case 20	Slot	Ceiling (x2)	Thoren/ ON	Perpendicular	Single	Neg. 100cfm	18.8 (65.8)	15
Case 21	Low Ind	Ceiling (x2)	Thoren/ ON	Perpendicular	Single	Neg. 100cfm	18.8 (65.8)	15
Case 22	Radial	Low (x4)	Thoren/ ON	Perpendicular	Single	Neg. 100cfm	18.8 (65.8)	15
Case 23	Slot	Low (x4)	Thoren/ ON	Perpendicular	Single	Neg. 100cfm	18.8 (65.8)	15
Case 24	Low Ind	Low (x4)	Thoren/ ON	Perpendicular	Single	Neg. 100cfm	18.8 (65.8)	15
Case 25 *	Radial	Ceiling (x2)	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 26 *	Slot	Ceiling (x2)	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 27 *	Low Ind	Ceiling (x2)	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 28	Low Ind	Low (x4)	Thoren/ ON	Parallel	Single	Neg. 100cfm	16.8 (62.2)	10
Case 29	Low Ind	Low (x4)	Thoren/ ON	Parallel	Single	Neg. 100cfm	11.0 (51.8)	5
Case 30	Low Ind	Low (x4)	Thoren/ ON	Parallel	Single	Neg. 100cfm	19.8 (67.6)	20
Case 31	Radial	Low (x4)	Thoren/ ON	Perpendicular	Double	Neg. 100cfm	17.5 (63.5)	15
Case 32	Slot	Low (x4)	Thoren/ ON	Perpendicular	Double	Neg. 100cfm	17.5 (63.5)	15
Case 33	Low Ind	Low (x4)	Thoren/ ON	Perpendicular	Double	Neg. 100cfm	17.5 (63.5)	15
Case 34	Radial	Ceiling (x2)	Thoren/ ON	Perpendicular	Double	Neg. 100cfm	17.5 (63.5)	15
Case 35	Slot	Ceiling (x2)	Thoren/ ON	Perpendicular	Double	Neg. 100cfm	17.5 (63.5)	15
Case 36	Low Ind	Ceiling (x2)	Thoren/ ON	Perpendicular	Double	Neg. 100cfm	17.5 (63.5)	15
Case 37	Radial	Ceiling (x1) / Low (x4) (Mass flow in 50/50 split)	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 38	Slot	Ceiling (x1) / Low (x4) (Mass flow in 50/50 split)	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 39	Low Ind	Ceiling (x1) / Low (x4) (Mass flow in 50/50 split)	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 40	Radial	Ceiling (x4)	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15

Case Name	Supply Diffuser Type	Exhaust Location and Number	Change Station (Design/ Status)	Rack Orientation	Rack Density	Pressure of Room to Corridor	Supply Temperature °C (°F)	Supply ACH
Case 41	Slot	Ceiling (x4)	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 42	Low Ind	Ceiling (x4)	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 43	Low Ind (rotated by 90°)	Ceiling (x2)	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 44	Radial (rotated by 90°)	Ceiling (x2)	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 45	Radial	Ceiling (x2)	Thoren/ ON	Parallel	Single	Neg. 50cfm	18.8 (65.8)	15
Case 46	Radial	Ceiling (x2)	Thoren/ ON	Parallel	Single	Neutral	18.8 (65.8)	15
Case 47	Radial	Ceiling (x2)	Thoren/ ON	Parallel	Single	Pos. 50cfm	18.8 (65.8)	15
Case 48	Radial	Ceiling (x2)	Thoren/ ON (swapped with rack1)	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 49	Radial	Ceiling (x2)	Thoren/ ON (swapped with rack2)	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 50	Radial	Ceiling (x2)	Thoren/ ON (swapped with rack3)	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 51	Radial	Ceiling (x2)	Thoren/ ON (swapped with rack4)	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 52	Radial	Ceiling (x2)	Thoren/ ON (swapped with rack5)	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 53	Radial	Ceiling (x2)	Lab. Prod. / ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 54	Slot	Ceiling (x2)	Lab. Prod. / ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 55	Low Ind	Ceiling (x2)	Lab. Prod. / ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 56	Radial	High (x4)	Lab. Prod. / ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 57	Radial	Low (x4)	Lab. Prod. / ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 58	Slot	High (x4)	Lab. Prod. / ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 59	Slot	Low (x4)	Lab. Prod. / ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 60	Low Ind	High (x4)	Lab. Prod. / ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 61	Low Ind	Low (x4)	Lab. Prod. / ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 62	Low Ind	Low (x4)	Thoren/ ON	Perpendicular	Double	Neg. 100cfm	6.6 (43.9)	5
Case 63	Low Ind	Low (x4)	Thoren/ ON	Perpendicular	Double	Neg. 100cfm	14.8 (58.6)	10
Case 64	Low Ind	Low (x4)	Thoren/ ON	Perpendicular	Double	Neg. 100cfm	18.9 (66.0)	20
Case 65	Low Ind	Low (x4)	Lab. Prod. / ON	Perpendicular	Double	Neg. 100cfm	17.5 (63.5)	15
Case 66	Low Ind	Low (x4)	Lab. Prod. / ON	Perpendicular	Double	Neg. 100cfm	6.6 (43.9)	5
Case 67	Low Ind	Low (x4)	Lab. Prod. / ON	Perpendicular	Double	Neg. 100cfm	14.8 (58.6)	10
Case 68	Low Ind	Low (x4)	Lab. Prod. / ON	Perpendicular	Double	Neg. 100cfm	18.9 (66.0)	20

Case Name	Supply Diffuser Type	Exhaust Location and Number	Change Station (Design/ Status)	Rack Orientation	Rack Density	Pressure of Room to Corridor	Supply Temperature °C (°F)	Supply ACH
Case 69	Radial	High (x4) / Low (x4) (Mass flow split evenly amongst exhausts)	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 70	Slot	High (x4) / Low (x4) (Mass flow split evenly amongst exhausts)	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 71	Low Ind	High (x4) / Low (x4) (Mass flow split evenly amongst exhausts)	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 72	Radial	High (x4) / Low (x2) (Mass flow split evenly amongst exhausts)	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 73	Slot	High (x4) / Low (x2) (Mass flow split evenly amongst exhausts)	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 74	Low Ind	High (x4) / Low (x2) (Mass flow split evenly amongst exhausts)	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 75	Radial	Ceiling (x1) / Low (x4) (Mass flow in 50/50 split)	Lab. Prod. / ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 76 **	Radial	Ceiling (x2)	Thoren/ ON	Parallel	Single	Neg. 100cfm	19.2 (66.6)	15
Case 77 **	Slot	Ceiling (x2)	Thoren/ ON	Parallel	Single	Neg. 100cfm	19.2 (66.6)	15
Case 78 **	Low Ind	Ceiling (x2)	Thoren/ ON	Parallel	Single	Neg. 100cfm	19.2 (66.6)	15
Case 79	Radial	2 Door exhausts	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 80	Slot	2 Door exhausts	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 81	Low Ind	2 Door exhausts	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 82	Radial	2 Door exhausts	Thoren/ ON	Parallel	Single	Neg. 100cfm	18.8 (65.8)	15
Case 83	Slot	2 Door exhausts	Thoren/ ON	Perpendicular	Double	Neg. 100cfm	17.5 (63.5)	15
Case 84	Low Ind	2 Door exhausts	Thoren/ ON	Perpendicular	Double	Neg. 100cfm	17.5 (63.5)	15
Case 85	Radial	Low (x4)	Lab. Prod. / ON	Perpendicular	Double	Neg. 100cfm	17.5 (63.5)	15
Case 86	Slot	Low (x4)	Lab. Prod. / ON	Perpendicular	Double	Neg. 100cfm	17.5 (63.5)	15
Case 87	Radial	Low (x4)	Thoren/ ON	Parallel	Reduced	Neg. 100cfm	19.2 (66.6)	15

Case Name	Supply Diffuser Type	Exhaust Location and Number	Change Station (Design/ Status)	Rack Orientation	Rack Density	Pressure of Room to Corridor	Supply Temperature °C (°F)	Supply ACH
Case 88	Slot	Low (x4)	Thoren/ ON	Parallel	Reduced	Neg. 100cfm	19.2 (66.6)	15
Case 89	Low Ind	Low (x4)	Thoren/ ON	Parallel	Reduced	Neg. 100cfm	19.2 (66.6)	15
Case 90	Radial	Ceiling (x2)	Thoren/ ON	Perpendicular all 5 on 1 wall	Single	Neg. 100cfm	18.8 (65.8)	15
Case 91	Slot	Ceiling (x2)	Thoren/ ON	Perpendicular all 5 on 1 wall	Single	Neg. 100cfm	18.8 (65.8)	15
Case 92	Low Ind	Ceiling (x2)	Thoren/ ON	Perpendicular all 5 on 1 wall	Single	Neg. 100cfm	18.8 (65.8)	15
Case 93	Radial	Ceiling (x2)	Thoren/ ON	Perpendicular all 5 on 1 wall	Double	Neg. 100cfm	17.5 (63.5)	15
Case 94	Slot	Ceiling (x2)	Thoren/ ON	Perpendicular all 5 on 1 wall	Double	Neg. 100cfm	17.5 (63.5)	15
Case 95	Low Ind	Ceiling (x2)	Thoren/ ON	Perpendicular all 5 on 1 wall	Double	Neg. 100cfm	17.5 (63.5)	15
Case 96	Radial	Ceiling (x2)	Lab. Prod. / ON	Perpendicular all 5 on 1 wall	Double	Neg. 100cfm	17.5 (63.5)	15
Case 97	Slot	Ceiling (x2)	Lab. Prod. / ON	Perpendicular all 5 on 1 wall	Double	Neg. 100cfm	17.5 (63.5)	15
Case 98	Low Ind	Ceiling (x2)	Lab. Prod. / ON	Perpendicular all 5 on 1 wall	Double	Neg. 100cfm	17.5 (63.5)	15
Case 99 ***	Radial	Ceiling (x2)	Thoren/ ON	Parallel	Single	Neg. 100cfm	22.2 (72.0)	15
Case 100 ***	Radial	Low (x4)	Thoren/ ON	Parallel	Single	Neg. 100cfm	22.2 (72.0)	15
Case 101 ***	Low Ind	Low (x4)	Lab. Prod. / ON	Perpendicular	Double	Neg. 100cfm	22.2 (72.0)	5

* Sealed cages instead of open cages

** Room 4.26m (14’) wide instead of 3.66m (12’)

*** Supply air temperature fixed at 22.2 °C (72.0 °F). In all other cases, the exhaust temperature was set to be 22.2 °C (72.0 °F) by setting the supply air temperature appropriately.

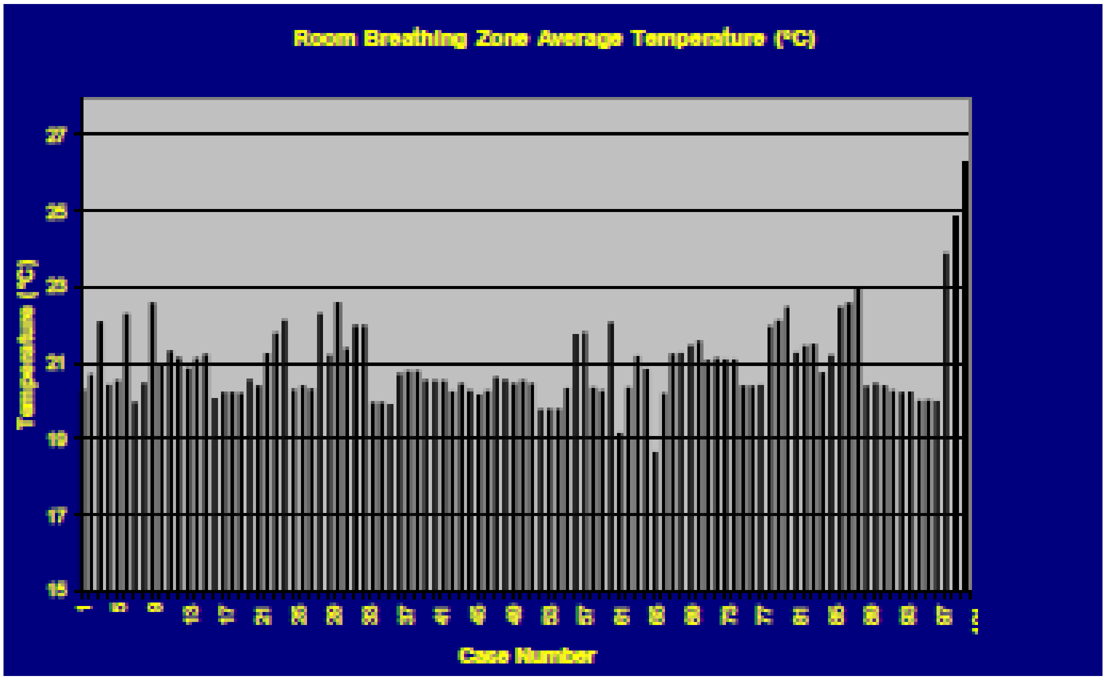

Figure 3.01 Mean Room Breathing Zone Temperature

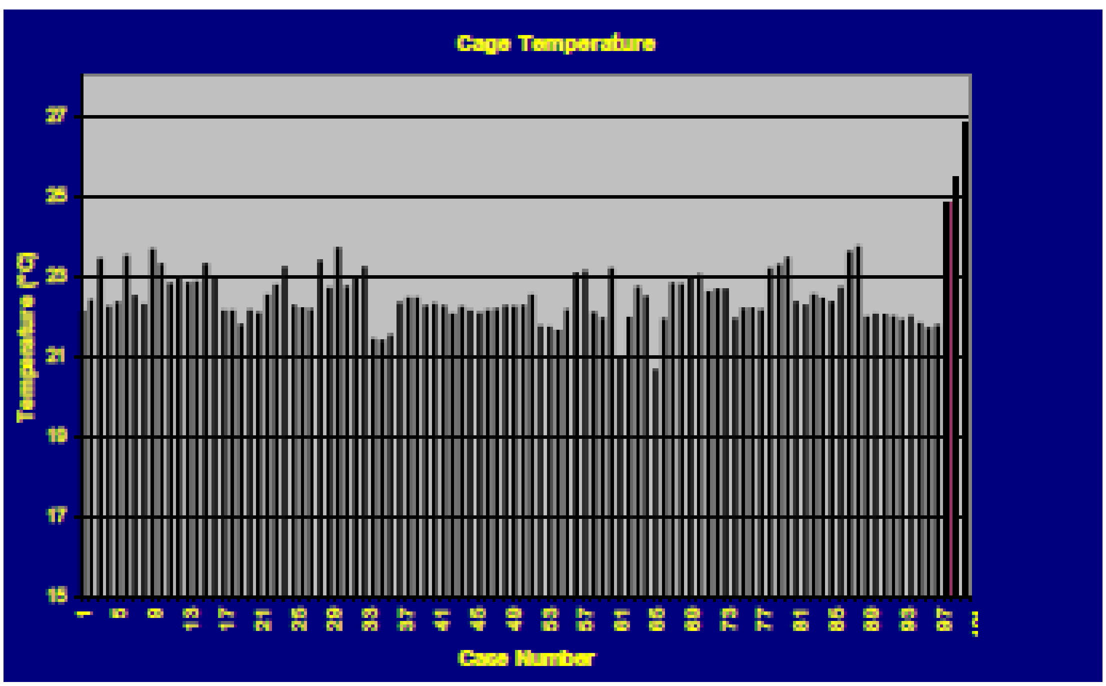

Figure 3.02 Mean Cage Temperatures

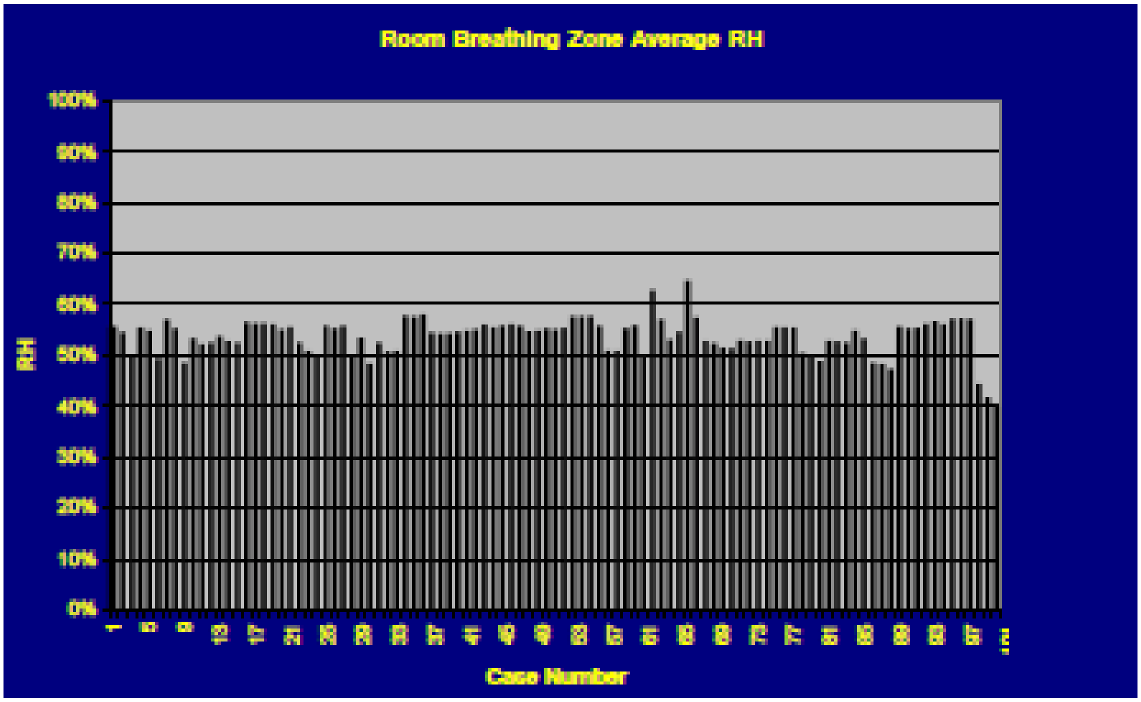

Figure 3.03 Mean Room Breathing Zone Relative Humidity (RH)

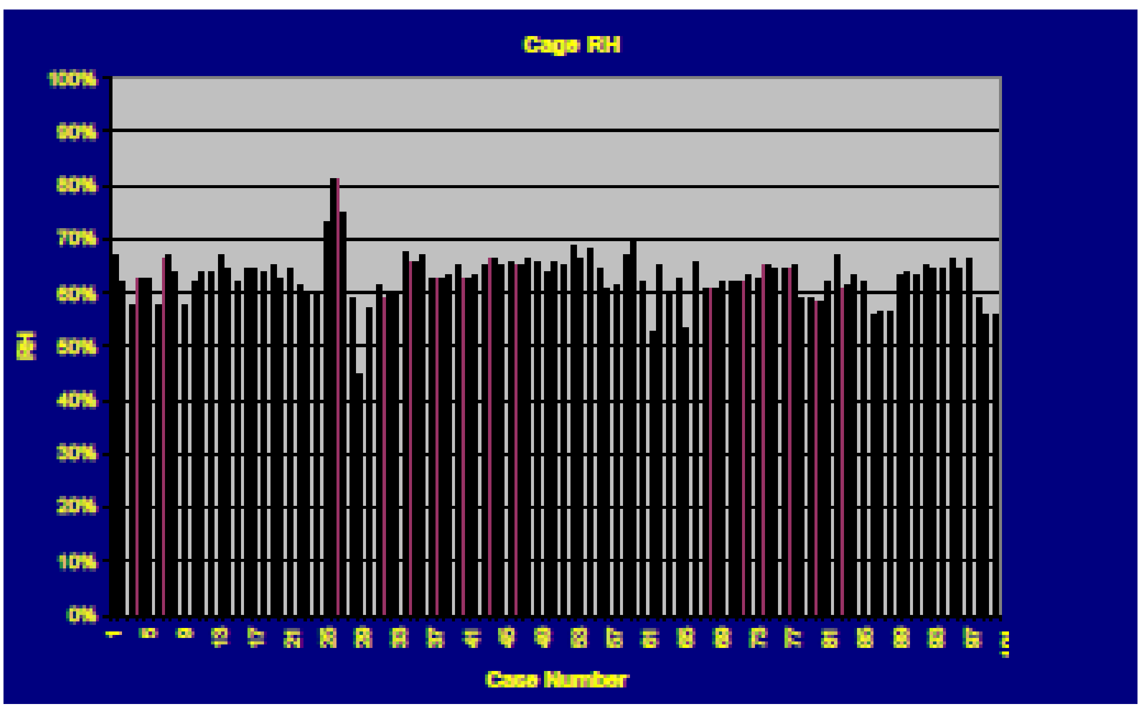

Figure 3.04 *Mean Cage Relative Humidity (RH)*

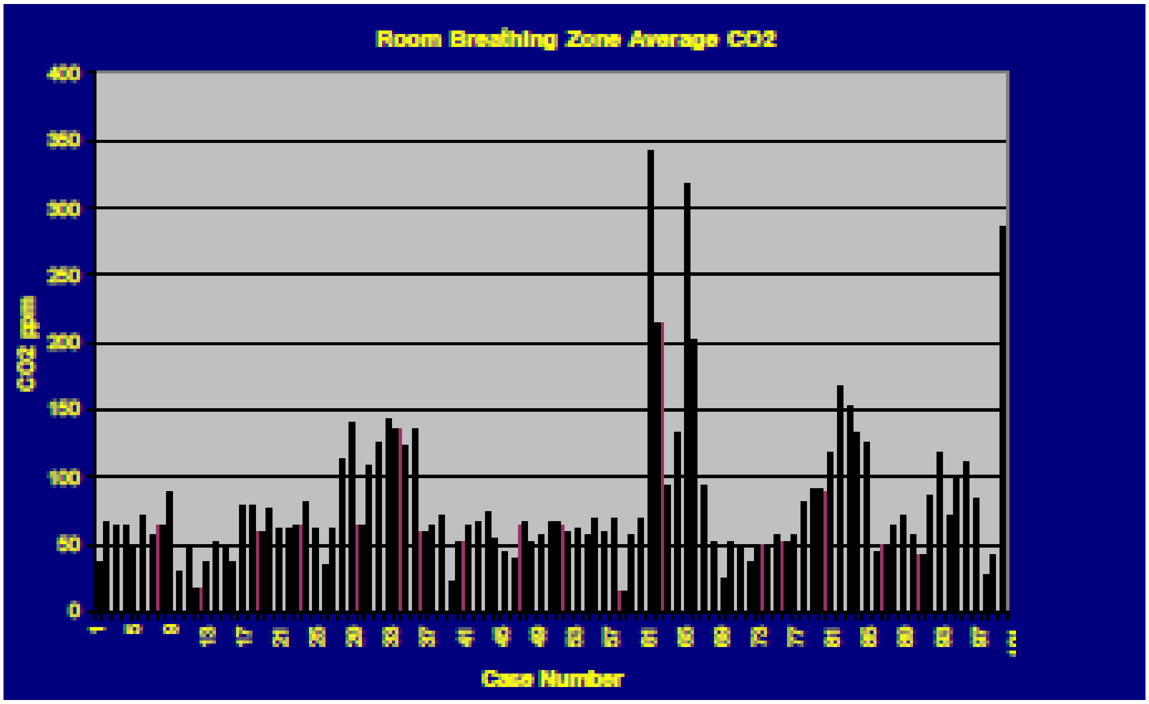

Figure 3.05 Mean Room Breathing Zone CO_2 Concentration

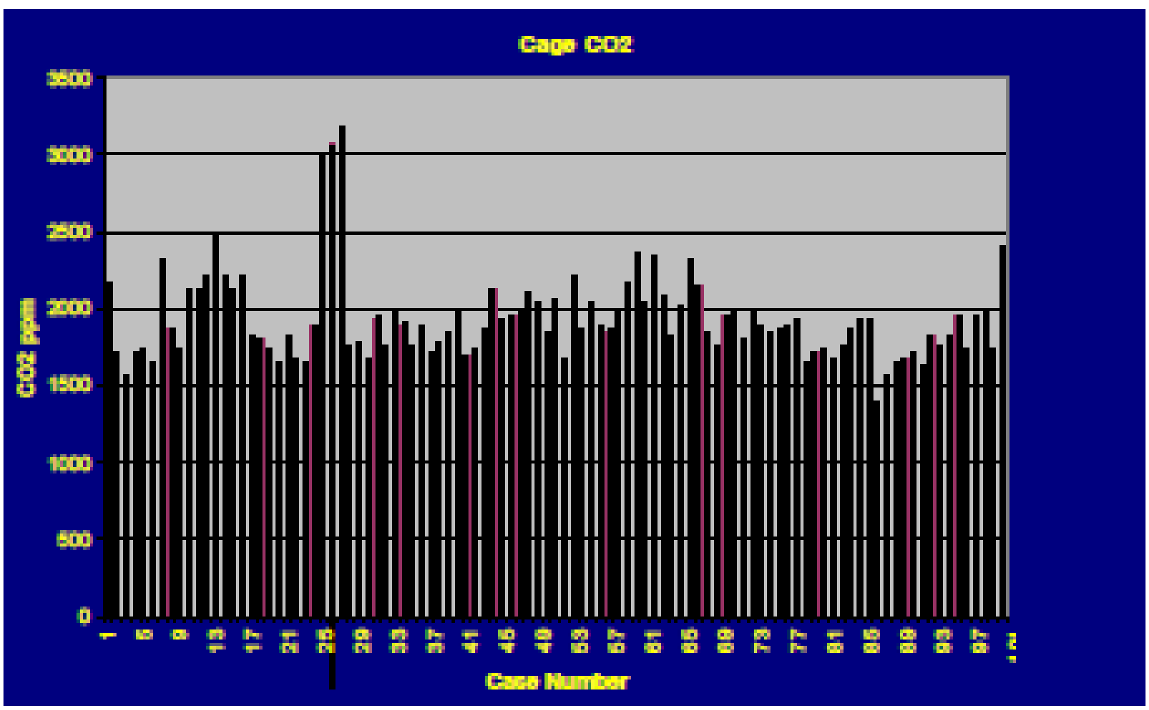

Figure 3.06 Mean Cage CO_2 Concentration

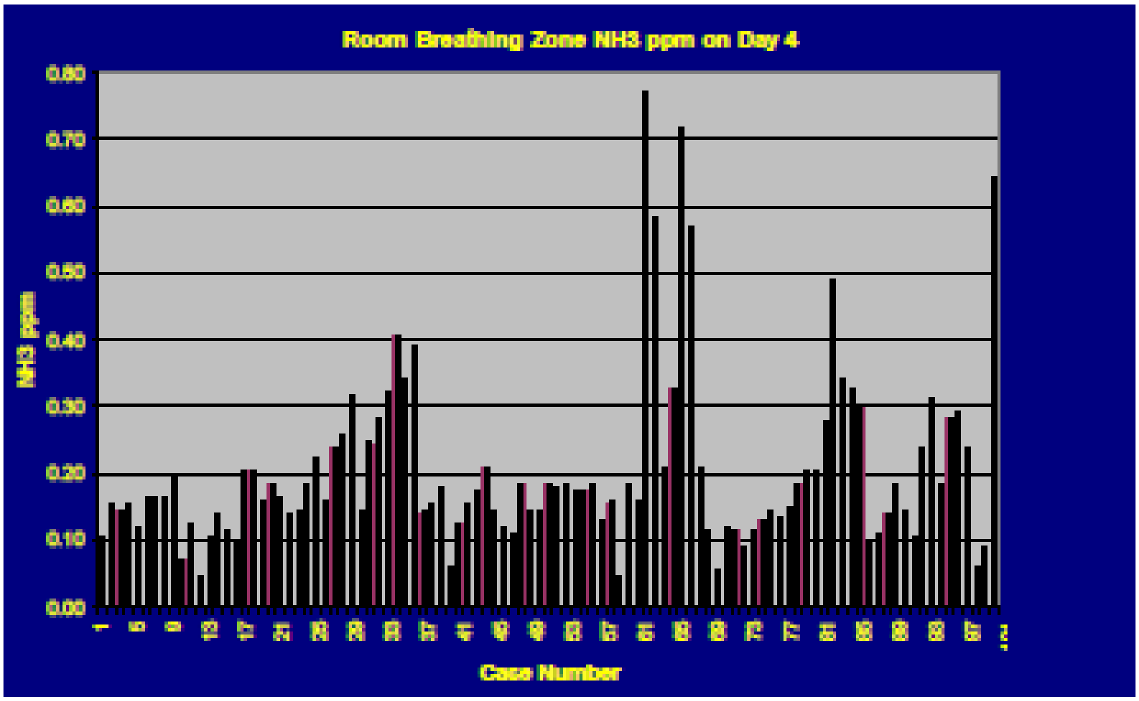

Figure 3.07 Mean Room Breathing Zone NH_3 Concentration on Day 4

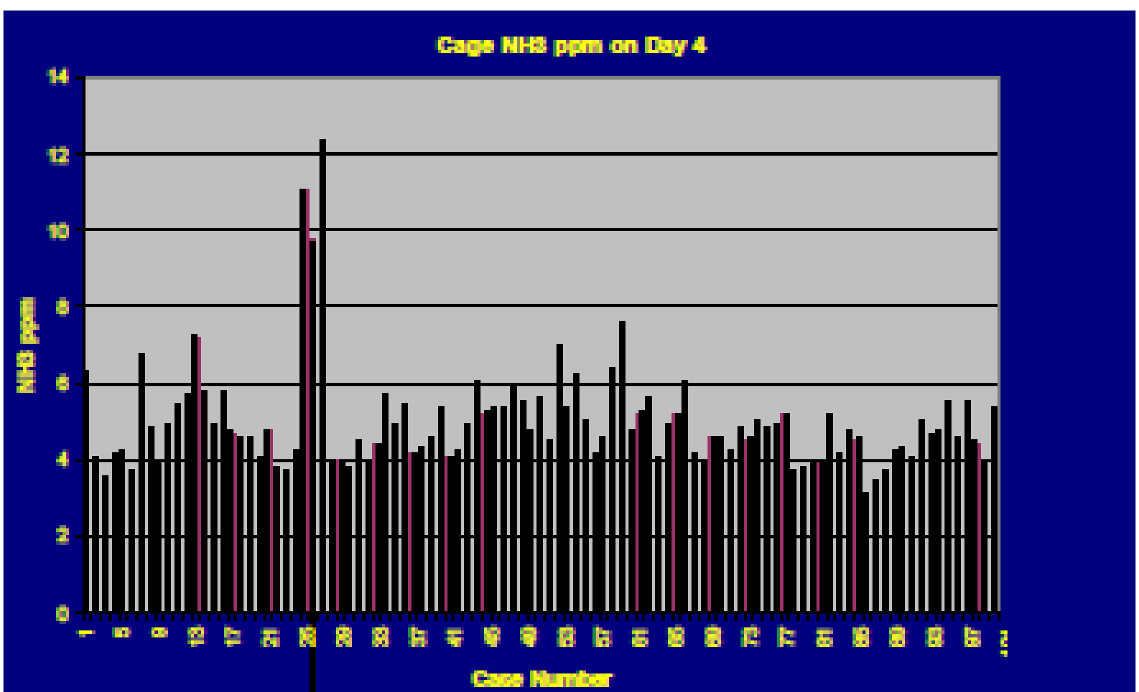

Figure 3.08 Mean Cage NH_3 Concentration on Day 4

Before the detailed comparison of the room configurations, which follows this section, a few general remarks on the results are appropriate.

The ventilation in the rooms was designed to produce 22.2 °C (72.0 °F) at the exhausts in the room (except for cases 99-101). This leads to the room and cage temperatures that do not vary greatly. The variation that does occur seems to be mostly due to temperature stratification in the rooms (i.e., the temperature rises towards the ceiling) in combination with the exhaust position. A low level exhaust means that the design temperature of 22.2 °C (72.0 °F) is the "lowest" in the room whereas a high level exhaust means the temperature should be below 22.2 °C (72.0 °F) in the room.

The CO_2 concentrations are a simple indicator of the ventilation in the room and cages. High values indicate poor ventilation. Good ventilation of the cages can lead to higher values in the room space.

The NH_3 concentration data are more complex measures of the ventilation as they also depend on the relative humidity in the cages, which is also dependent on the temperature. Therefore, poor ventilation of cages at a high temperature and low humidity may produce low NH_3 concentrations.

In making comparisons among the values shown for the cages on the charts, it is important to consider if the differences in the mean values (the average for all cages) is statistically significant. The ANOVA test (see section 6) can be used to determine significant differences. This test was run for several pairs of datasets. In each case the differences were found to be significant, except when the means were actually identical. Please note that comparing 101 datasets with each other for 4 data values produces more than 40,000 tests. This seems to be a result of having 210 or 420 cages in the rooms. Each one appears as a sampling point for the test. With so many samples the test becomes very sensitive and even small variations in means are statistically significant.

3.1.1 Supply Type and Exhaust Position

Cases 1 to 9 allow an easy comparison of the effect of Supply type and exhaust position. Cases 1 (the basecase) to 3 had a radial diffuser supply with ceiling, high level (on side walls) and low level (on side walls) exhausts, respectively. Cases 4 to 6 used a slot diffuser, and cases 7 to 9 a low induction diffuser with the same exhaust configurations.

Figures 3.09 to 3.16 show three-dimensional bar charts comparing temperature, CO_2, NH_3, and relative humidity for both the cages and scientists' breathing zone in the center of the room.

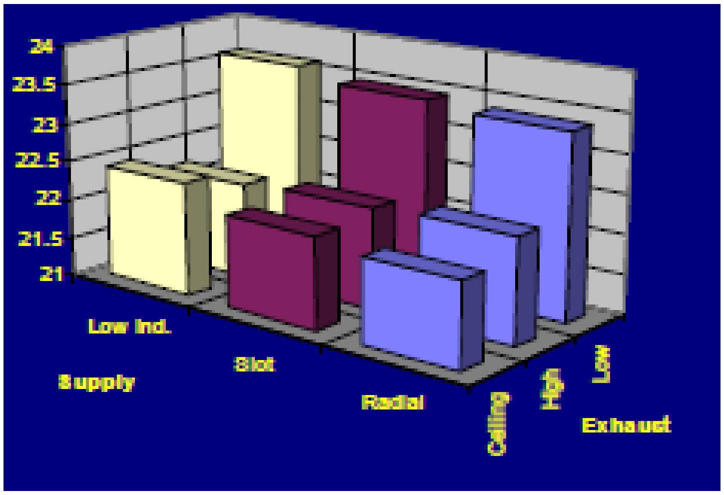

Figure 3.09 Comparison of Mean Cage Temperatures (°C)

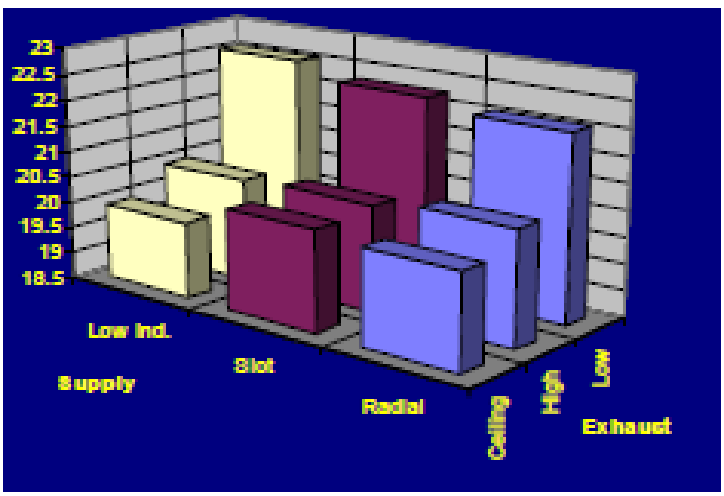

Figure 3.10 Comparison of Room Breathing Zone Temperatures (°C)

The higher temperatures, about 2 ^{o}C (4 ^{o}F) produced in both the cages and breathing zone in the low level exhaust runs indicates this exhaust location is less efficient in cooling the room compared with the high and ceiling level.

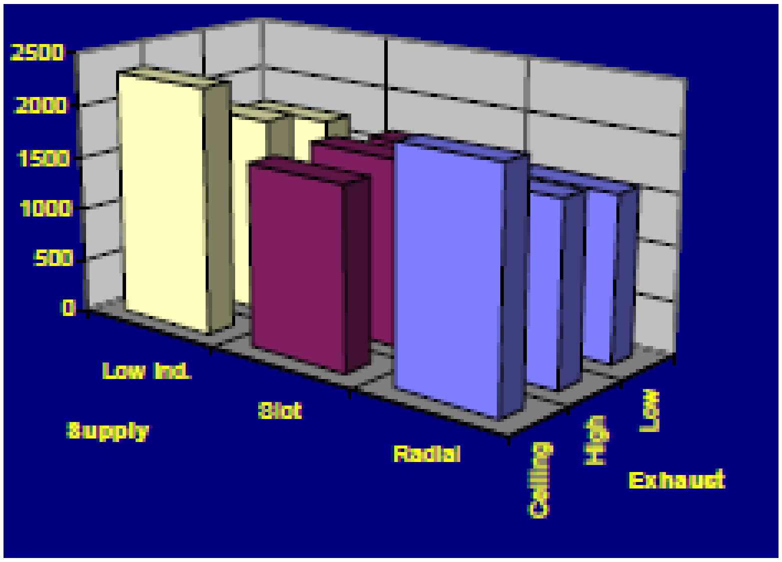

Figure 3.11 Comparison of Mean Cage CO_2 Concentration (ppm)

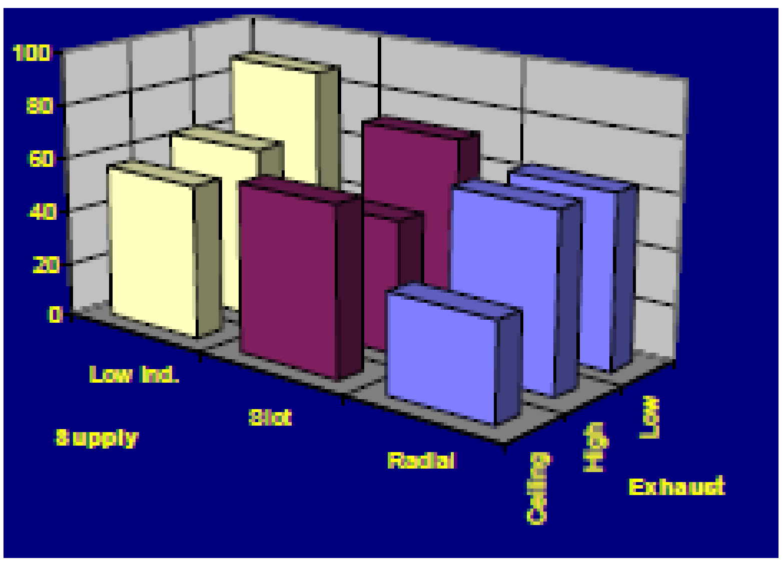

Figure 3.12 Comparison of Room Breathing Zone CO_2 Concentration (ppm)

The lower values of CO_2 concentration in the cages for the low level exhaust (up to 27 percent for the radial diffuser, 4 percent for the slot diffuser and 25 percent for the low induction diffuser) indicate that the cages are better ventilated in this situation. The room values show the best ventilation occurs with a radial diffuser and ceiling level exhausts.

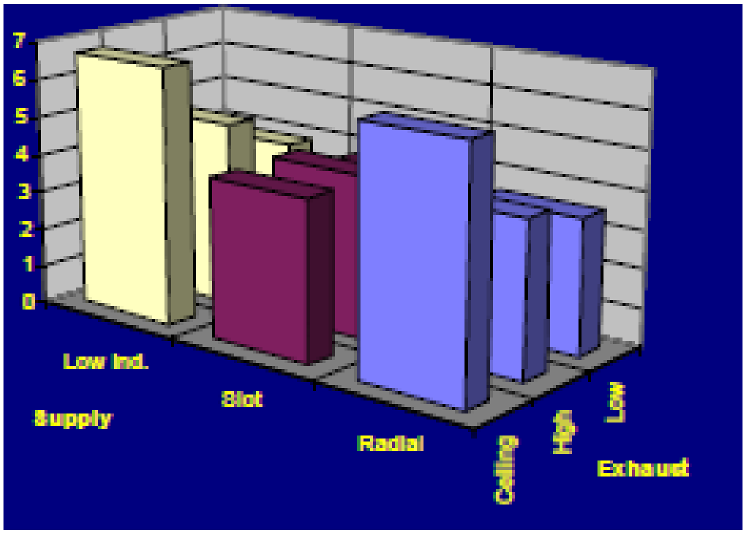

Figure 3.13 Comparison of Mean Cage NH_3 Concentration (ppm)

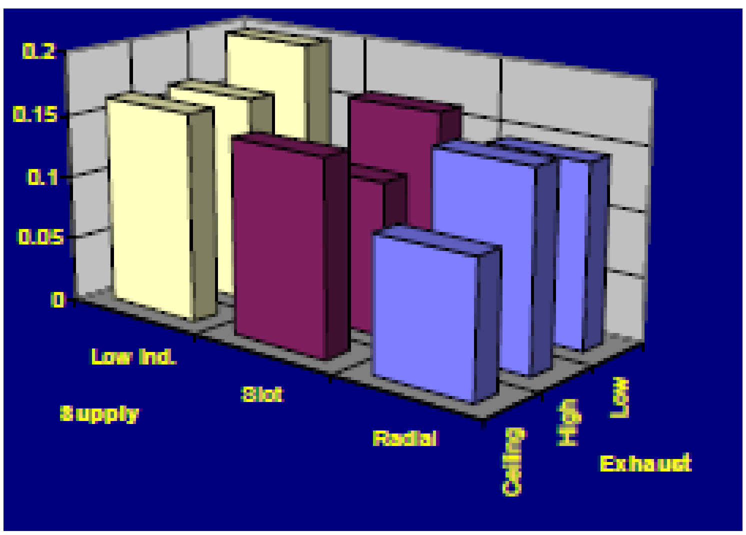

Figure 3.14 Comparison of Room Breathing Zone NH_3 Concentration (ppm)

The cage NH_3 concentrations show a similar pattern to the CO_2 concentrations. The variations are, however, somewhat larger as the higher temperatures in the low level exhaust cases reduce the relative humidity in the cages and reduce the rate of NH_3 generation, which leads to lower conentrations.

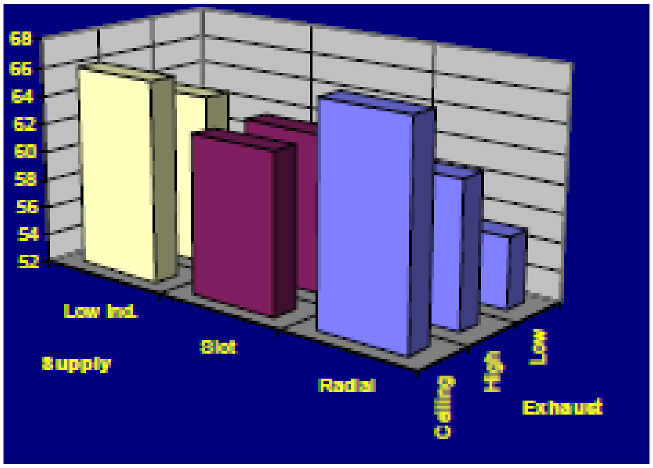

Figure 3.15 Comparison of Mean Cage Relative Humidity (percent)

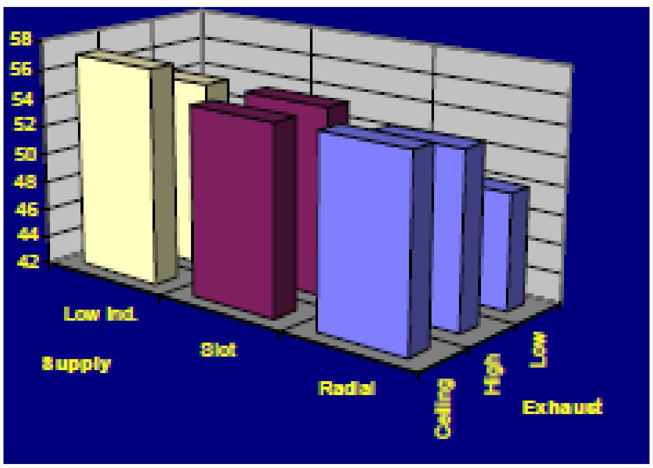

Figure 3.16 Comparison of Mean Breathing Zone Relative Humidity (percent)

Lower humidities in the low level exhaust cases are mainly due to the higher temperatures.

Two features are quickly apparent from these cases:

low level exhausts produce higher temperatures in the room and cages; and

low level exhausts produce the best in-cage ventilation (lowest CO_2 concentrations).

The low CO_2 concentrations seem to be due to the higher flow around the cages. Figures 3.17 and 3.18 show velocity vectors in a slice through the radial supply and the cage racks. For the ceiling level exhaust case (figure 3.17) the velocity vectors are barely visible around the cages, indicating very low flow. In figure 3.18 the low level exhausts case shows much larger velocity vectors representing much greater flow around the cages. This extra flow clearly helps ventilate the cages.

The ceiling level exhausts produce the lowest levels of CO_2 for the radial and low induction diffusers in the room breathing zone. This appears to be caused by the main airflow going through the cages towards the side walls at this height, whereas in the other cases there is more air coming from the side walls into the central region. This can be seen in figures 3.17 and 3.18 as well as in figures 3.19 and 3.20, which show the distribution of CO_2 concentration for the radial diffuser and ceiling and low level exhausts.

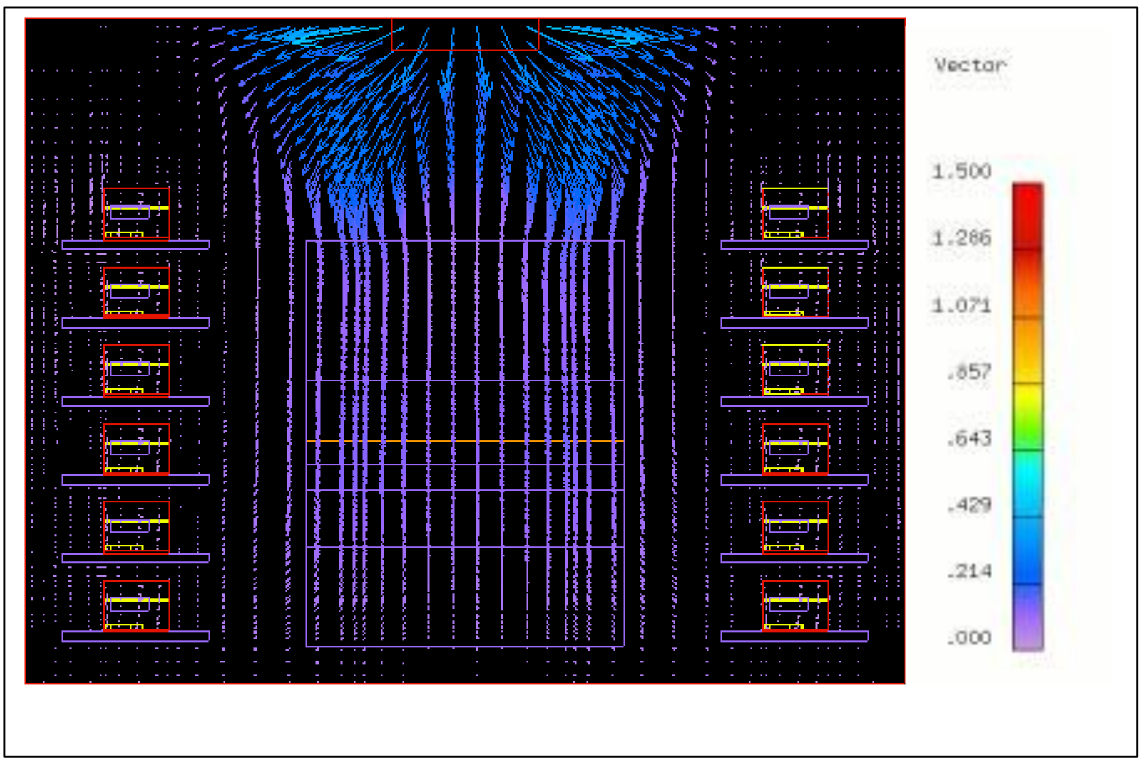

Figure 3.17 *Velocity Vectors through the Radial Diffuser with Ceiling Exhausts (basecase)*

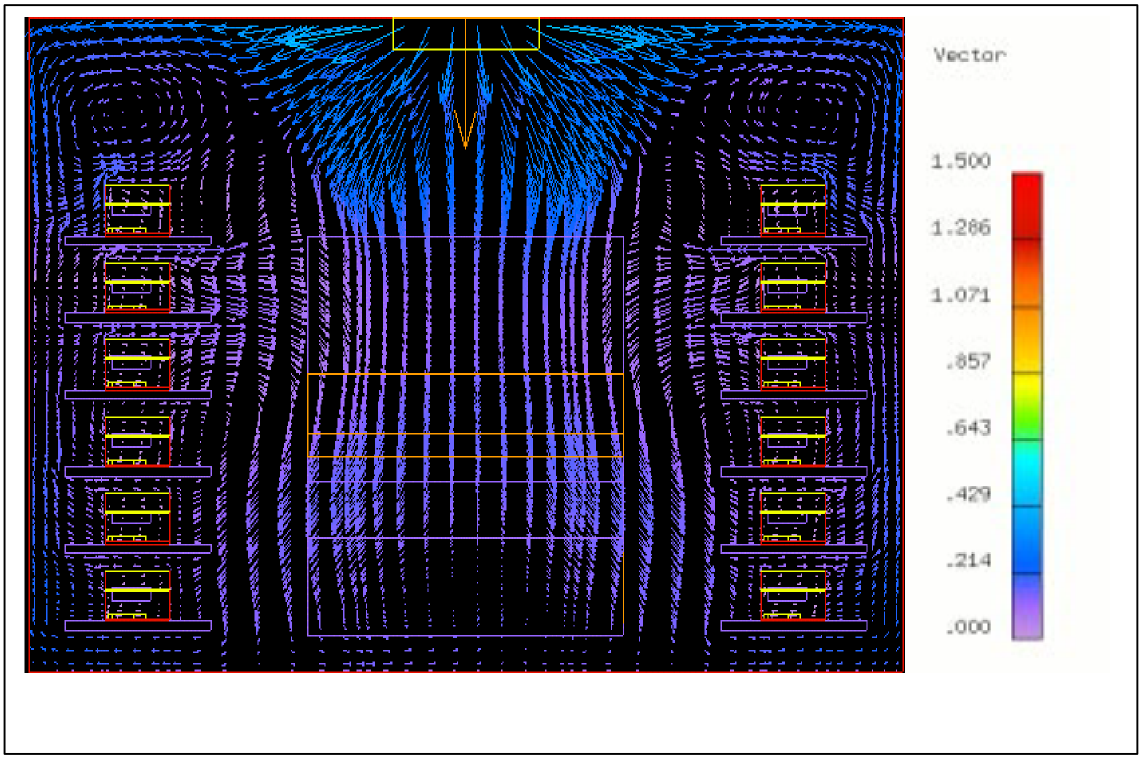

Figure 3.18 *Velocity Vectors through the Radial Diffuser with Low Level Exhausts (Case3)*

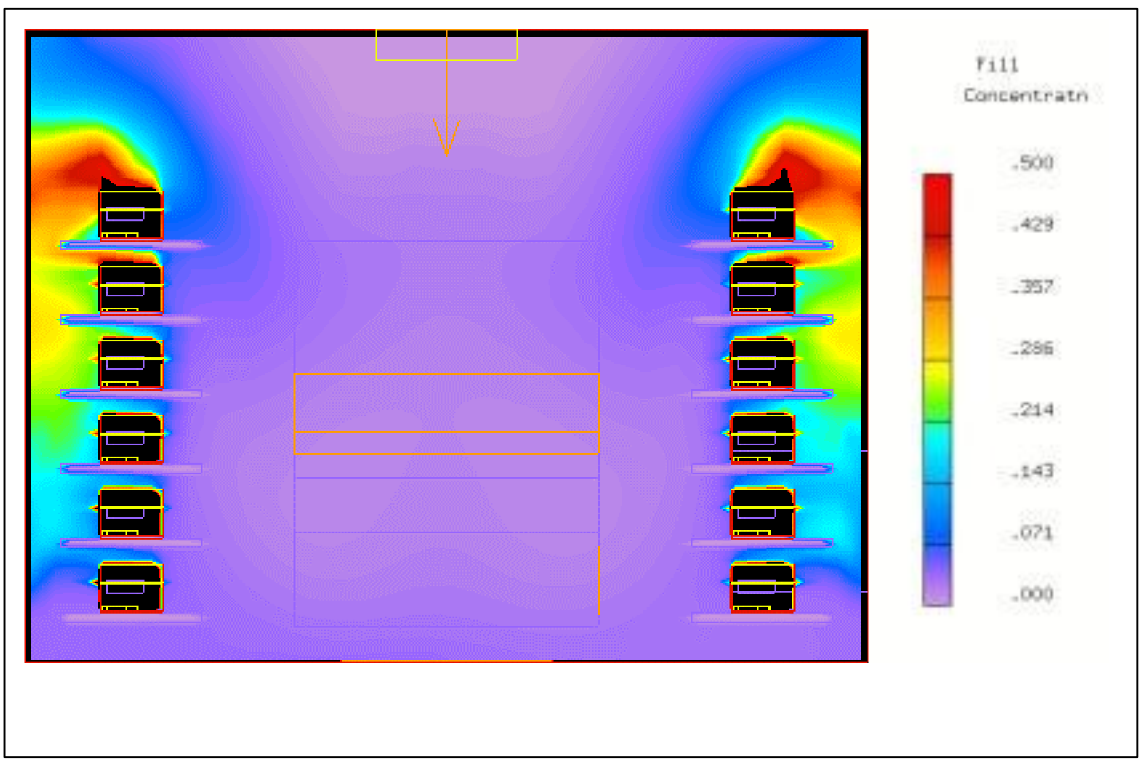

Figure 3.19 *CO_2 Distribution (g/kg) Radial Diffuser with Ceiling Exhausts (basecase)*

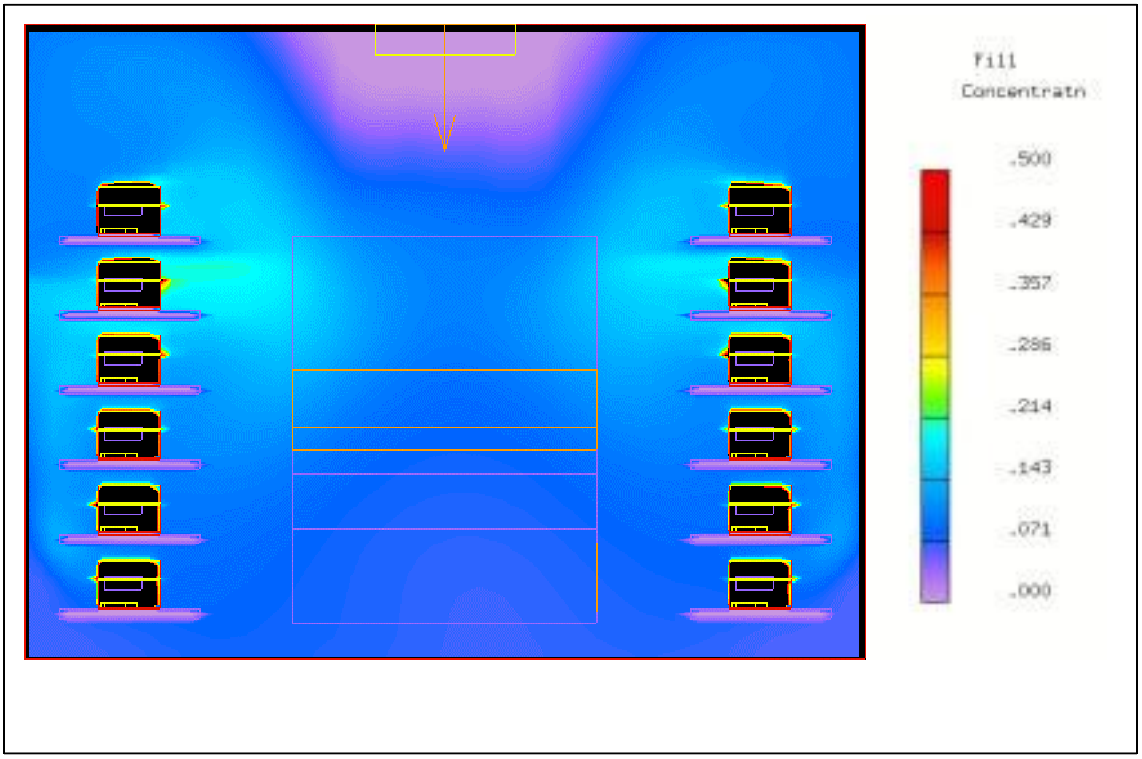

Figure 3.20 *CO_2 Distribution (g/kg) Radial Diffuser with Low Level Exhausts (Case3)*

Figures 3.21 and 3.22 show slices through the racks of cages for the radial diffuser with ceiling and low level exhausts. The low level exhausts clearly show lower CO_2 concentrations within the cages with less orange/red and more blue/green coloration. The variation in concentration is similar in both cases, with the highest values on the left and right edges of the three rack wall, and slightly lower concentrations in the center and on the tops of most of the racks.

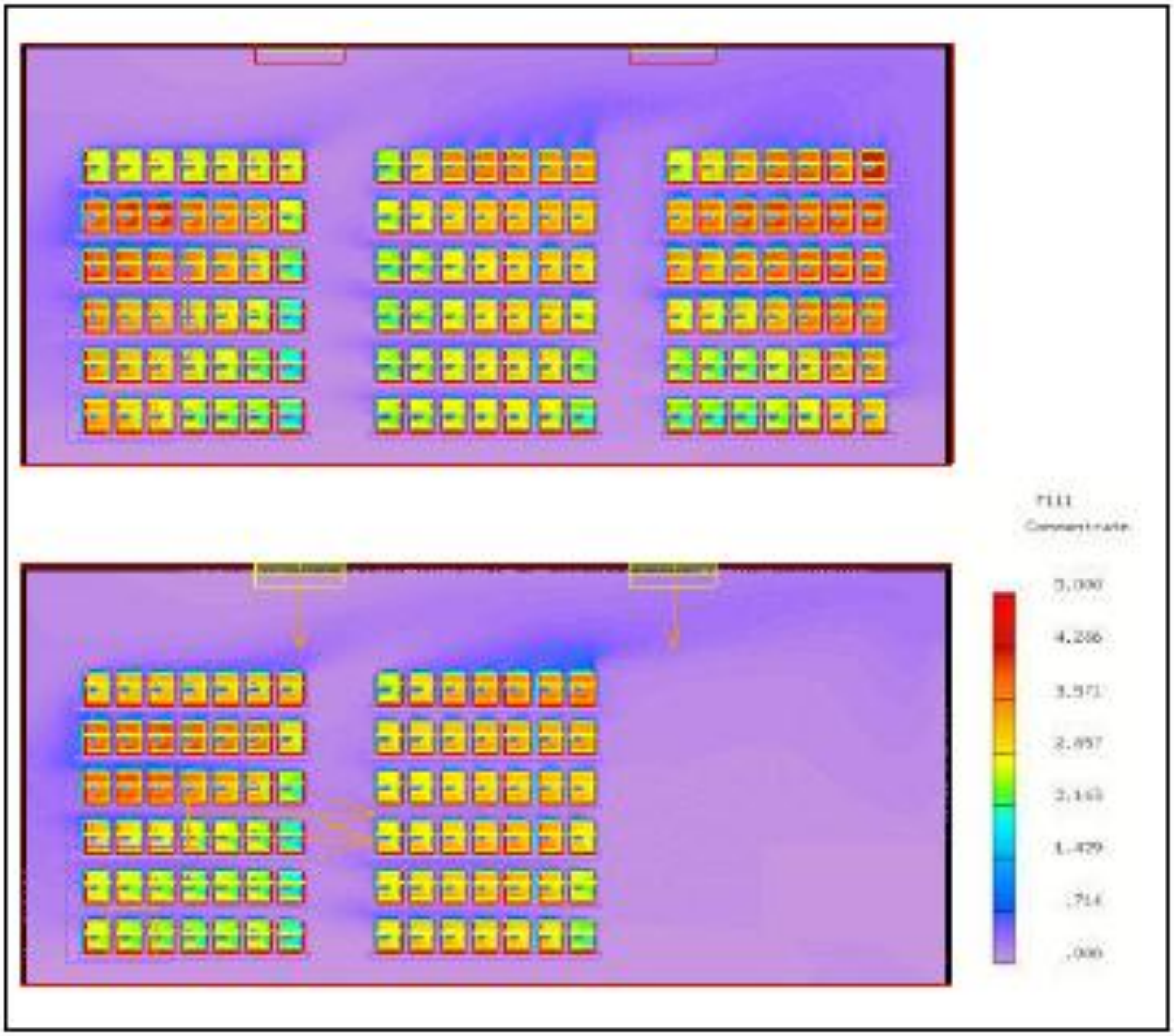

Figure 3.21 *CO_2 Concentration (g/kg), Radial Diffuser with Ceiling Exhaust (basecase)*

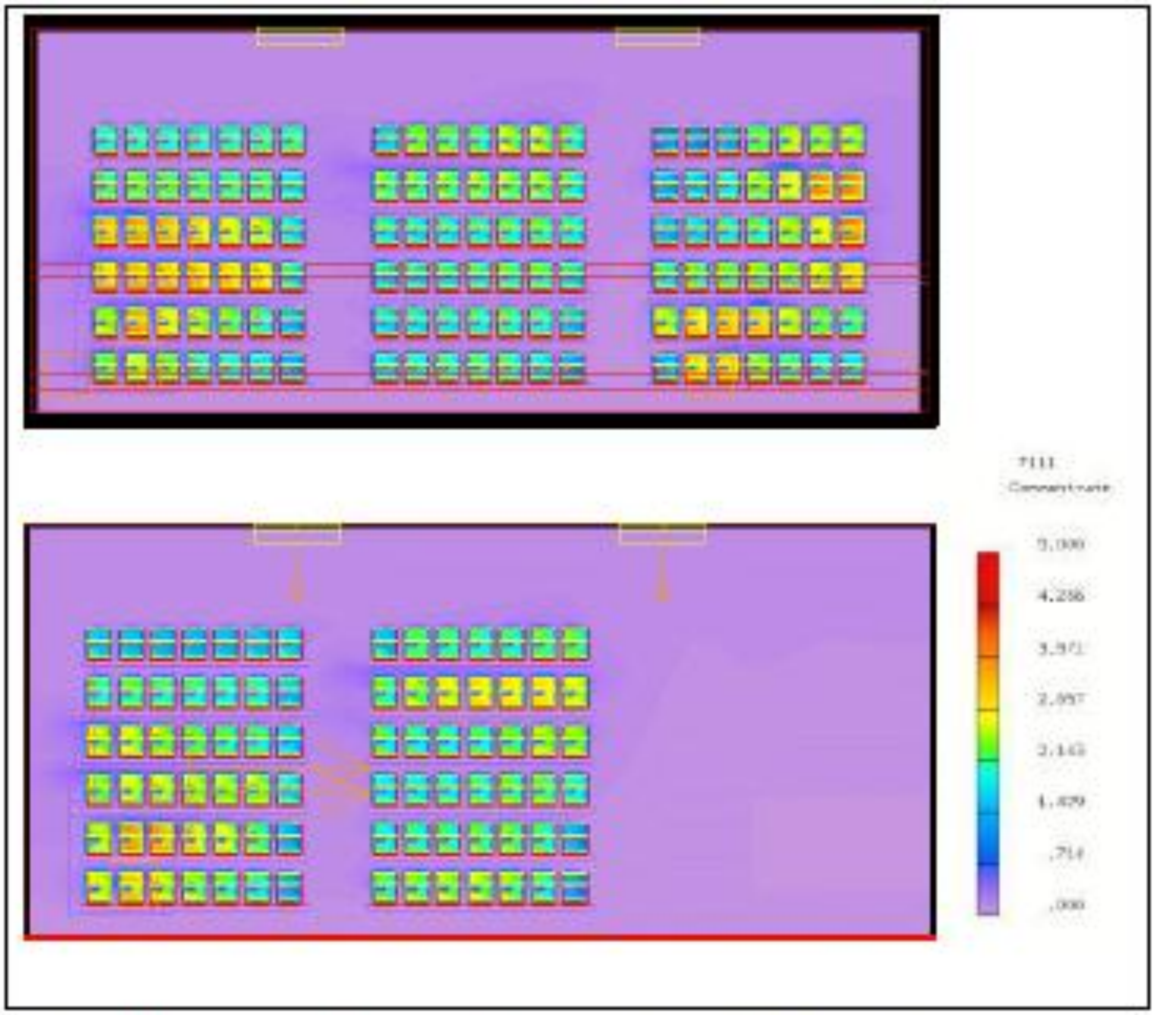

Figure 3.22 CO_2 Concentration (g/kg), Radial Diffuser with Low Level Exhaust (Case3)

The slot diffuser seems least sensitive to exhaust position. This is probably due to the slot diffuser creating much higher entrainment and mixing due to the higher supply air velocity and increased jet area.

The increase in temperature from the lower room ventilation efficiency, apparent in both the cages and the room for the low level exhausts, helps to keep the cage humidity levels low and reduces the NH_3 production.

Further variation in exhaust number and position was investigated in cases 37 to 42, 69 to 75 and 79 to 84. Examination of the data for these runs shows no obvious pattern emerging in cage and room ventilation. Case 40 (radial supply and four ceiling exhausts in the corners) seems to produce particularly low room breathing zone CO_2 and NH_3 concentrations, improving on the basecase values. However the other cases with four ceiling exhausts do not seem significantly better than the two ceiling exhaust cases.

3.1.2 Air Change Rate

Figures 3.23 to 3.28 show comparisons of temperature, CO_2 and NH_3 concentrations for both the cages and scientists' breathing zone for airflow rates between 5ACH and 20ACH. The plots show results for single density racks (42 cages) parallel to the walls (cases 9, 28-30) and double density racks (84 cages, cases 33, 62-64) perpendicular to the walls as well as a variation in change station design (84 cages, cases 65-68). All cases have low induction supplies and low level exhausts.

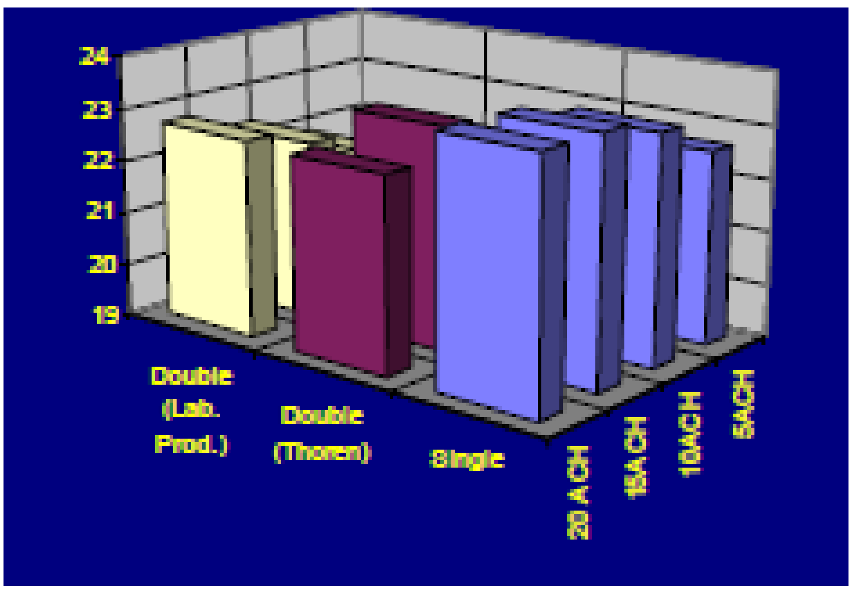

Figure 3.23 Comparison of Mean Cage Temperature (°C)

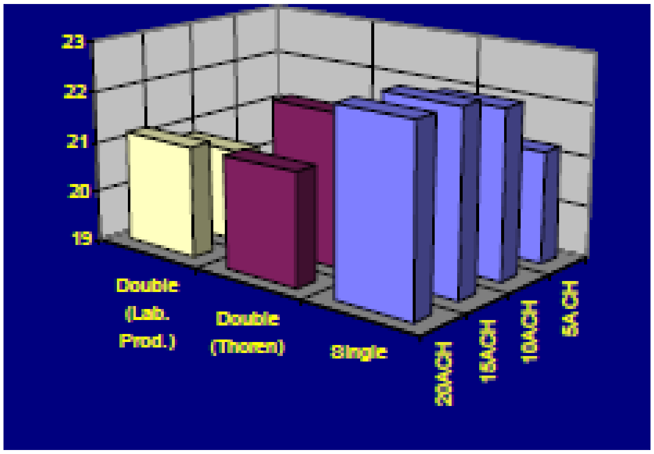

Figure 3.24 Comparison of Room Breathing Zone Temperature (°C)

The cage temperatures vary very little in comparison with the variation in supply temperature (from 19.8 °C (68 °F) to 6.6 °C (44 °F)) and follow the trends shown in the breathing zone temperature. The slightly lower supply temperatures in the double density cases (more mice produce more heat to be extracted) lead to a small reduction in both room and cage temperatures compared with the single density racks.

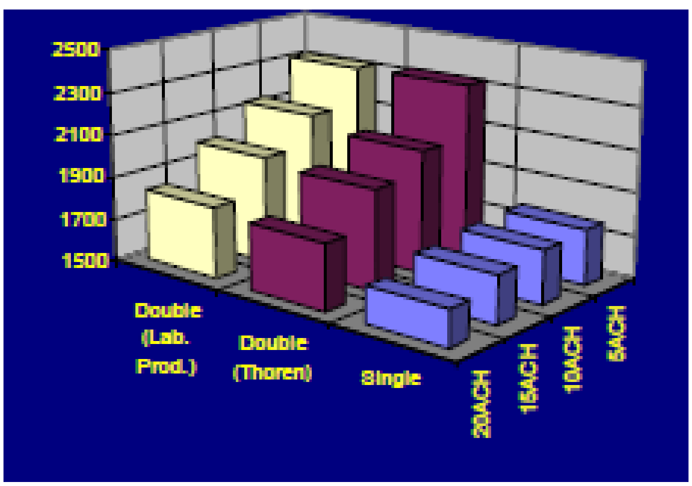

Figure 3.25 Comparison of Mean Cage CO_2 Concentrations (ppm)

Increasing the room ventilation rate does not have a large effect on the cage ventilation. Increasing the supply flow rate from 5 ACH to 20 ACH for single density racks parallel to the walls reduces the CO_2 concentration from 1,764 ppm to 1,667 ppm, a reduction of only six percent. For the double density racks perpendicular to the walls the reduction is larger, but still only from about 2,300 ppm to 1,800 ppm (about 20 percent).

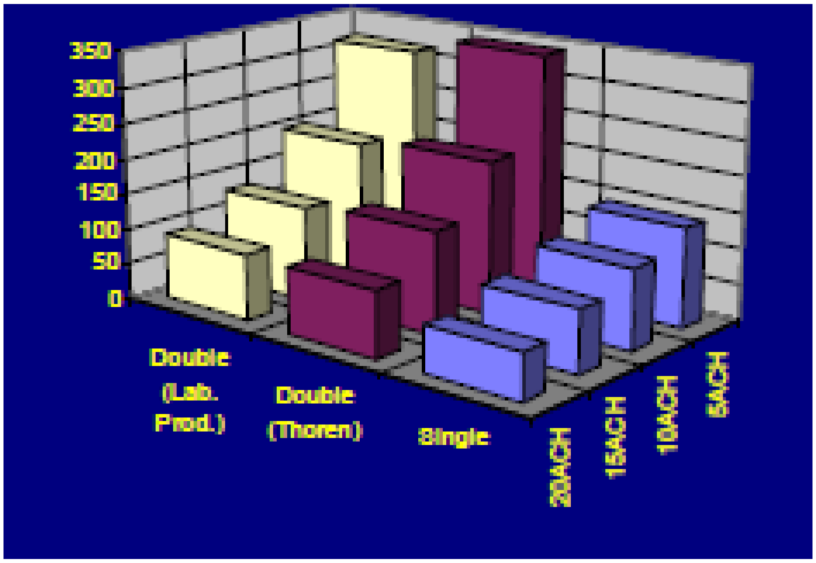

Figure 3.26 Comparison of Room Breathing Zone CO_2 Concentrations (ppm)

Increasing the room ventilation rate has a continuous beneficial effect on the room breathing zone ventilation (as measured by CO_2 and ammonia concentrations). For the single density racks parallel to the walls increasing the supply flow rate from 5 ACH to 20 ACH reduces the breathing zone CO_2 concentration from 140 ppm to 63 ppm, a decrease of 55 percent. For the double density racks perpendicular to the walls the reduction is even more dramatic, from over 300 ppm to 93 ppm (over 70 percent reduction) when the flow rate is increased from 5 ACH to 20 ACH. However, the "high" values of CO_2 concentration, of about 300 ppm above the background levels, are still significantly too low. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends a threshold limit valve (TLV), time weighted average (TWA) of 5,000 ppm (9,000 mg/m^3) for carbon dioxide. ACGIH also recommended a Short Term Exposure Limit (STEL) of 30,000 ppm (54,000 mg/ m^3).

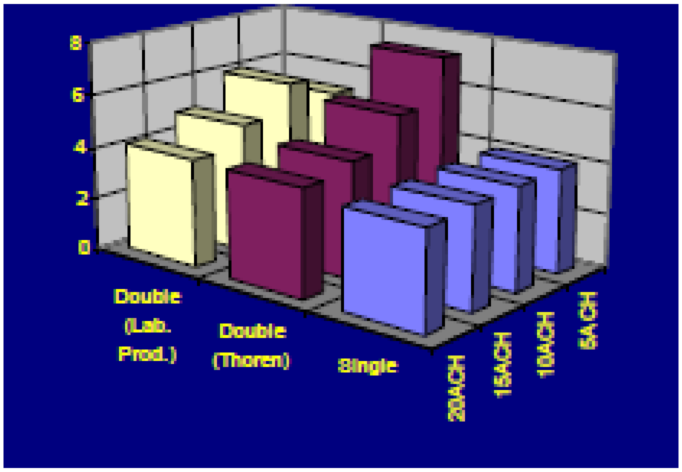

Figure 3.27 Comparison of Mean Cage NH_3 Concentrations (ppm)

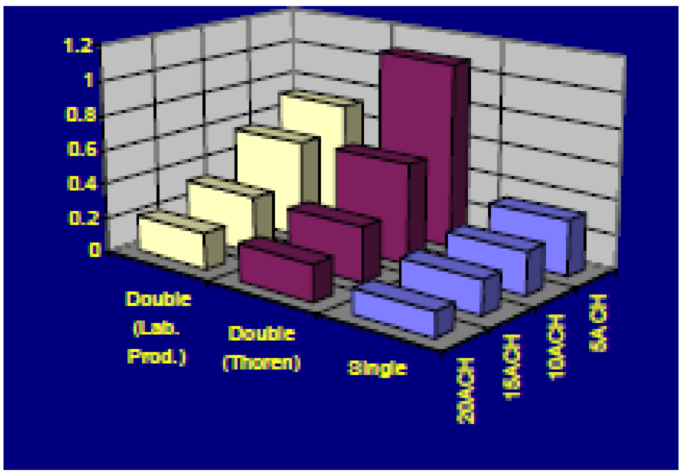

Figure 3.28 Comparison of Mean Breathing Zone NH_3 Concentrations (ppm)

The NH_3 concentrations follow the trends shown by the CO_2 concentrations. The 5 ACH NH_3 results are not directly comparable with those for the other flow rates. This is due to the extremely low supply discharge temperature 6.6 ^oC (44 ^oF) required to extract the heat produced by the mice and the change station, which required the moisture content of the air to be reduced compared to the other flow rates. the standard value used in the simulations represented well over 100 percent humidity. It is also recognised that this low temperature is difficult, if not impossible, to achieve in commercial heating and ventilation systems.

The results do indicate that the cages are not significantly better ventilated at higher flow rates. The rooms are better ventilated up to 20 ACH as would be expected because there is more fresh air available to dilute the gases produced by the mice.

The animal loading in the room is clearly significant. The 5 ACH supply rate in the room with single density cage racks (case 29) produces less than 50 percent of the room CO_2 concentration compared with the 5 ACH with the double density racks (cases 62 and 66). Since 10 ACH seems acceptable for day 4 NH_3 concentration in the cages of the double density rooms, and 5 ACH is acceptable for NH_3 concentrations in the cages of single density rooms, the airflow required in the room is best at 0.85 cfm (4.01e-4 m^3/s) per cage of five mice or 100g body weight of mice (see also section 3.2 below).

3.1.3 Change Station Design and Status

Cases 10 to 15 were run with the change station switched off and no heat generation or recirculated air. These should be compared with cases 1, 3, 4, 6, 7, and 9. Figures 3.29 to 3.32 show comparisons of CO_2 and NH_3 concentrations for the three supply diffusers with ceiling level exhausts and the Thoren change station in operation (on) and also with it present but not operating (off).

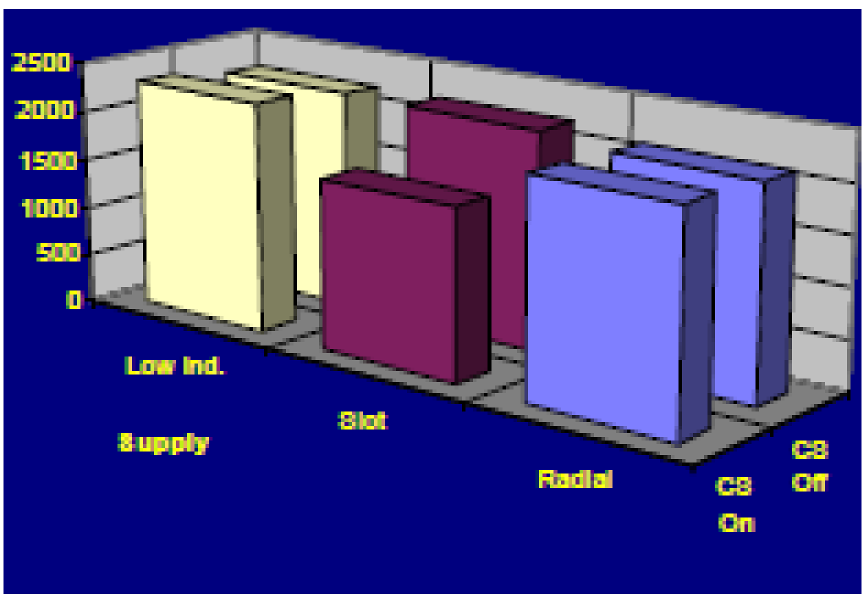

Figure 3.29 Comparison of Mean Cage CO_2 Concentrations (ppm)

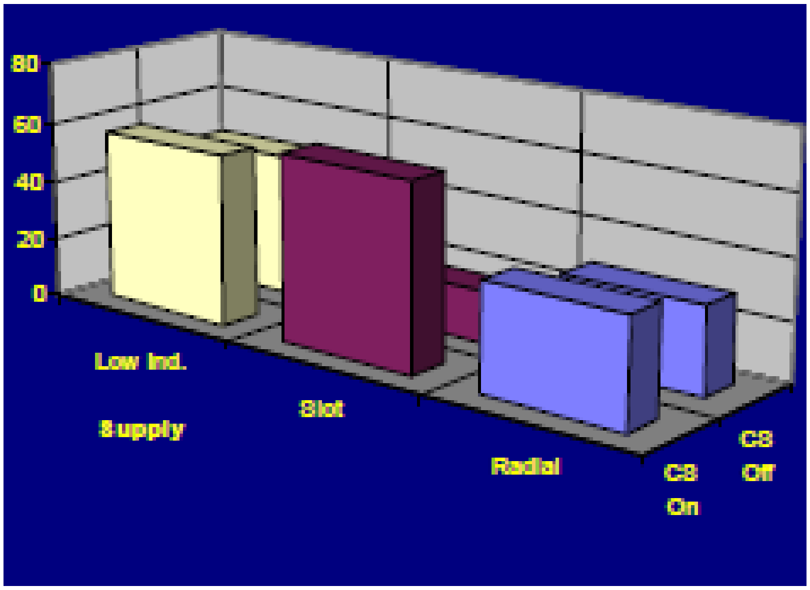

Figure 3.30 Comparison of Mean Breathing Zone CO_2 Concentrations (ppm)

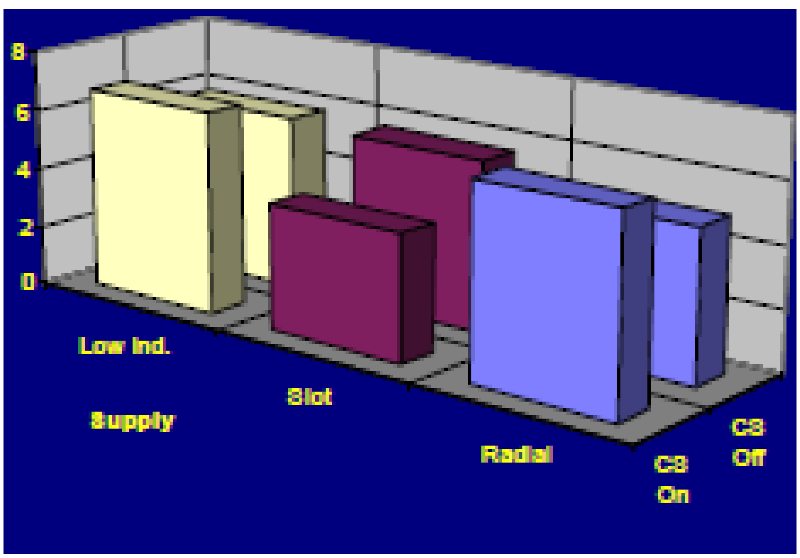

Figure 3.31 Comparison of Mean Cage NH_3 Concentrations (ppm)

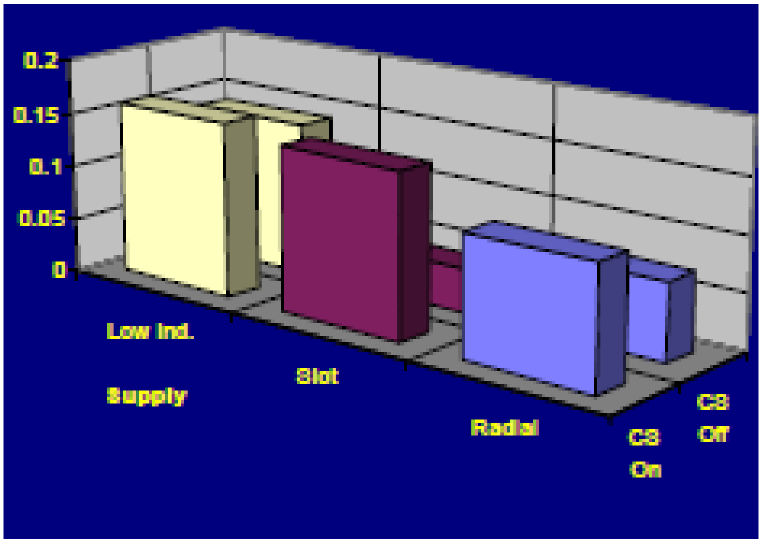

Figure 3.32 Comparison of Mean Breathing Zone NH_3 Concentrations (ppm)

Switching off the change station seems to decrease slightly the CO_2 and NH_3 concentrations in both the cages and the room for the radial and low induction supplies. The slot diffuser shows a small increase in both CO_2 and NH_3 concentrations in the cages, although the room values show a large decrease. This indicates the difficulty in making generalizations because the effect of making a change is very dependent on the case under consideration.

The change station produces a strong airflow upwards when active (see figure 3.33), which acts to mix dirty air from the cages with the fresh air from the supplies.

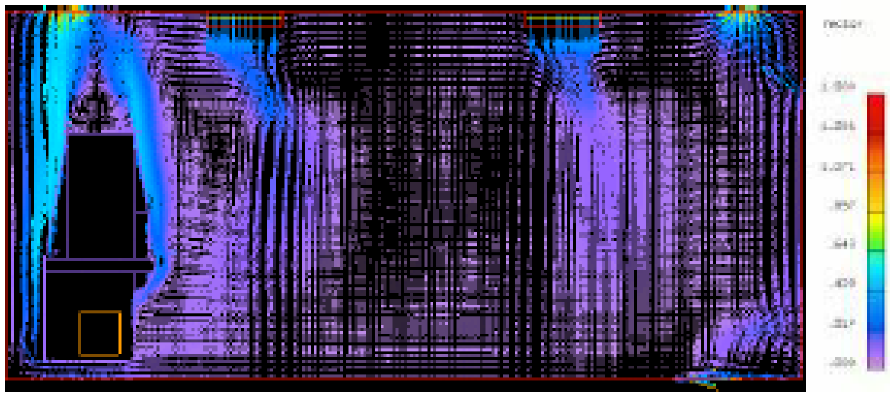

Figure 3.33 Velocity Vectors on the Centerline for the Basecase Showing the Strong Upward Flow from the Change Station

Cases 53 to 61 were run with an alternative change station design that had similar heat dissipation but a higher amount of recirculated air. This design seems to produce results very similar to those of the original change station.

It is interesting that two of the best performances for the room breathing zone CO_2 and NH_3 concentrations come out of this group of tests. Case 12 (slot supply, ceiling exhaust, change station off) and case 59 (slot supply, low level exhaust, alternative change station) produce the lowest CO_2 and NH_3 concentrations in the room. That there is no obvious link between these cases, and since other slot supply cases do not appear to be so good, this information serves to confirm that such complex airflows take place in animal rooms, it is difficult to predict how they will perform without detailed analysis.

3.1.4 Pressurization of Room relative to Corridor

Cases 16 to 18 were run with positive pressurization in the room instead of negative, with 100cfm (4.72e-2 m^3/s) air leaving rather than entering the room via the door. These cases should be compared with cases 1, 4 and 7, which are all cases with ceiling exhausts. Cases 45 to 47 varied the amount of air flowing in or out (50cfm in, 0cfm, and 50cfm out) of the door cracks and should be compared with cases 1 and 16.

Figures 3.34 to 3.37 show comparisons of CO_2 and NH_3 concentrations for different room pressurizations.

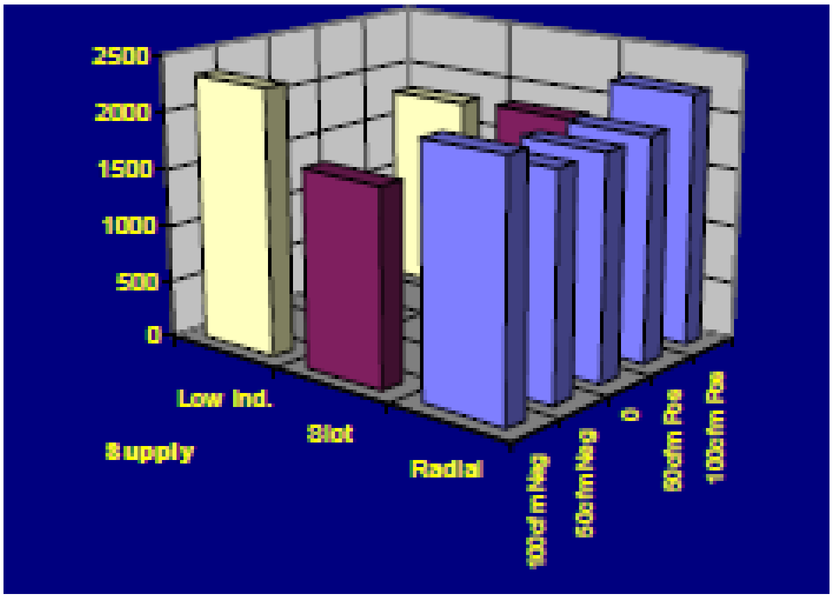

Figure 3.34 Comparison of Mean Cage CO_2 Concentrations (ppm)

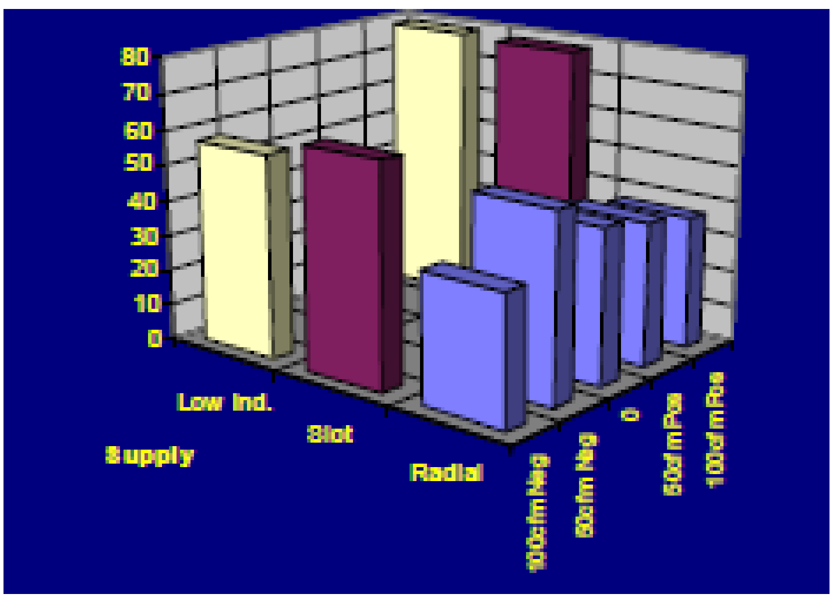

Figure 3.35 Comparison of Mean Breathing Zone CO_2 Concentrations (ppm)

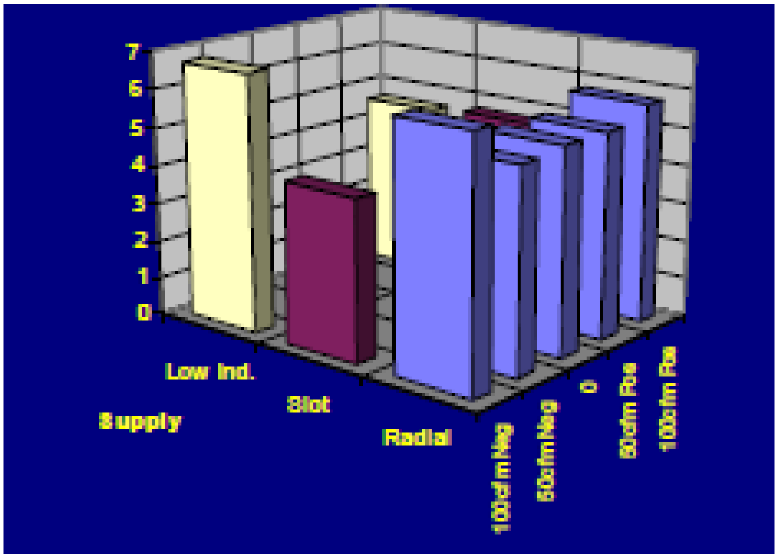

Figure 3.36 Comparison of Mean Cage NH_3 Concentrations (ppm)

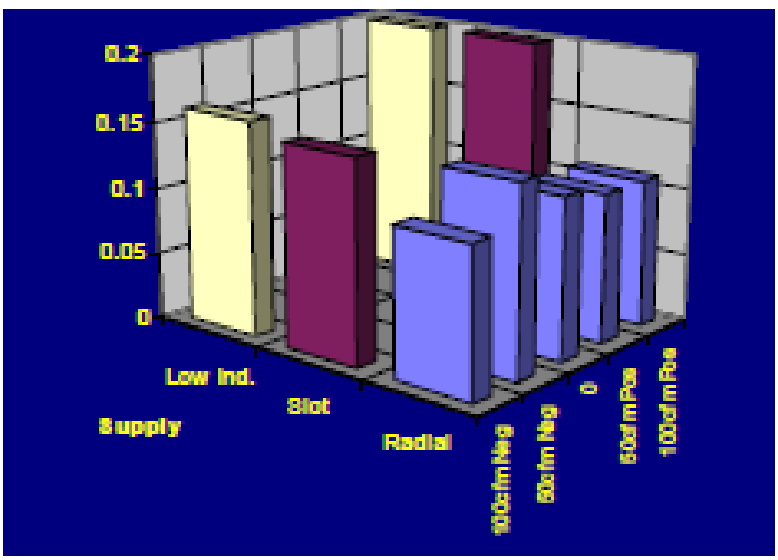

Figure 3.37 Comparison of Mean Breathing Zone NH_3 Concentrations (ppm)

100cfm inflow makeup air (negative pressurization) and 100cfm outflow makeup air (positive pressurization) represents around 18 percent of the supply diffuser flow rate at 15 ACH. Changing the direction of the makeup airflow has different effects on the CO_2 and NH_3 concentrations depending on the diffuser type. The radial diffuser, which was also run at 50 cfm positive and negative as well as neutral 0cfm, shows only small variations in both the room and cages.

The slot diffuser also shows little variation, with a small increase in cage concentrations and slightly larger increases in room concentrations, going from negative to positive pressurization. The low induction diffuser shows increases in room concentration but decreases in cage concentrations.

Again it is difficult to make a general recommendation. The effects seem small and dependant on the actual details of the configuration under study.

3.1.5 Orientation of Cage Racks in Room and Rack Grouping

Cases 19 to 24 were run with the five racks positioned perpendicular to the side walls rather than parallel to them. They should be compared with cases 1, 3, 4, 6, 7, and 9. This orientation removes the central open area in the room for the scientists as the racks overlap. However, data for the scientist's breathing zone are still reported although this is somewhat smaller. The analysis excluded a 0.15m (6") space around each cage.

Figures 3.38 to 3.41 show comparisons for the three diffuser types with ceiling level exhausts for single density racks parallel and perpendicular to the walls.

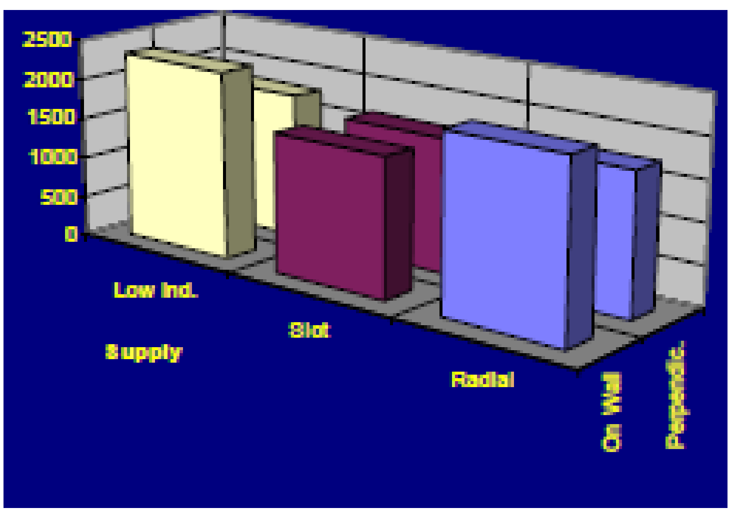

Figure 3.38 Comparison of Mean Cage CO_2 Concentrations (ppm)

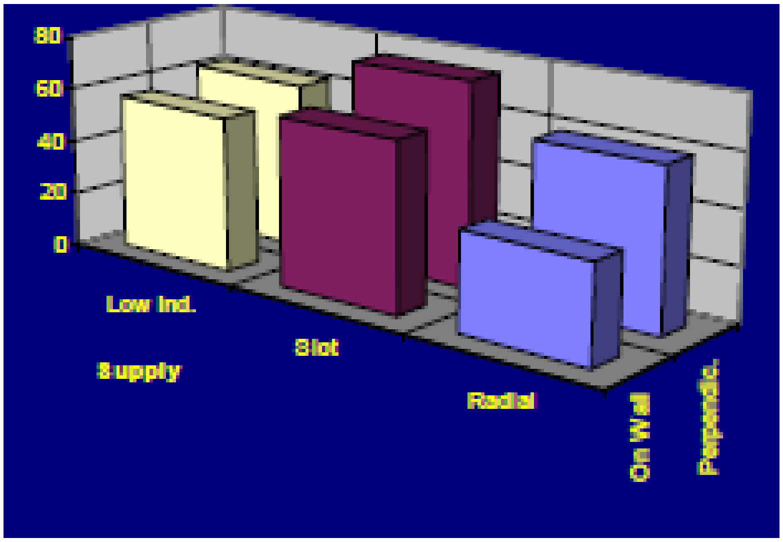

Figure 3.39 Comparison of Mean Breathing Zone CO_2 Concentrations (ppm)

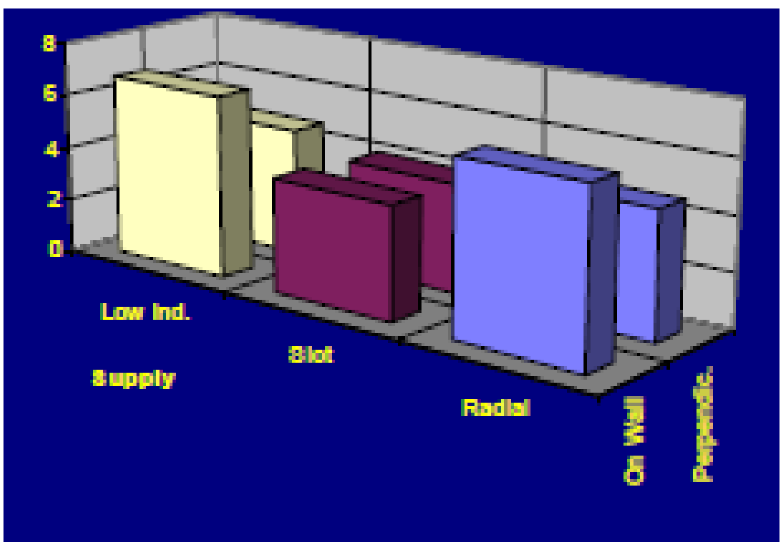

Figure 3.40 Comparison of Mean Cage NH_3 Concentrations (ppm)

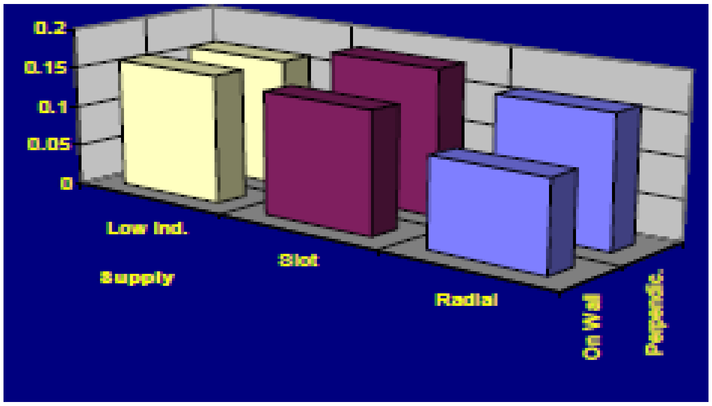

Figure 3.41 *Comparison of Mean Breathing Zone NH_3 Concentrations (ppm)*

The radial and low induction diffusers show a reduction in cage CO_2 and NH_3 concentrations in the cages with clearly better ventilation through the racks (and cages) in this perpendicular orientation. The in-room breathing zone values show similar or slightly increased CO_2 and NH_3 concentrations.

Cases 48 to 52 were run with different positions for the change station (swapped with particular racks) and cases 90 to 92 were run with all five racks positioned on one wall rather than split two on one wall and three on the other. Again, variations in CO_2 and NH_3 concentrations for both the cages and the room are small.

In conclusion, apart from the improvement in cage ventilation for the radial and low induction diffusers when the racks are perpendicular to the walls, no particular advantage or disadvantage in any orientation or rack layout can be seen.

3.1.6 Density of Cages

Cases 31 to 36 were run with double the number of cages on each rack. This meant a total of 420 cages were present in the room. To provide easy access to all the cages it was necessary to use only rack orientations that were perpendicular to the side wall (i.e., into the room not parallel to the side walls).

Figures 3.42 to 3.45 show comparisons of CO_2 and NH_3 concentrations for the three supply diffuser types with ceiling and low level exhausts.

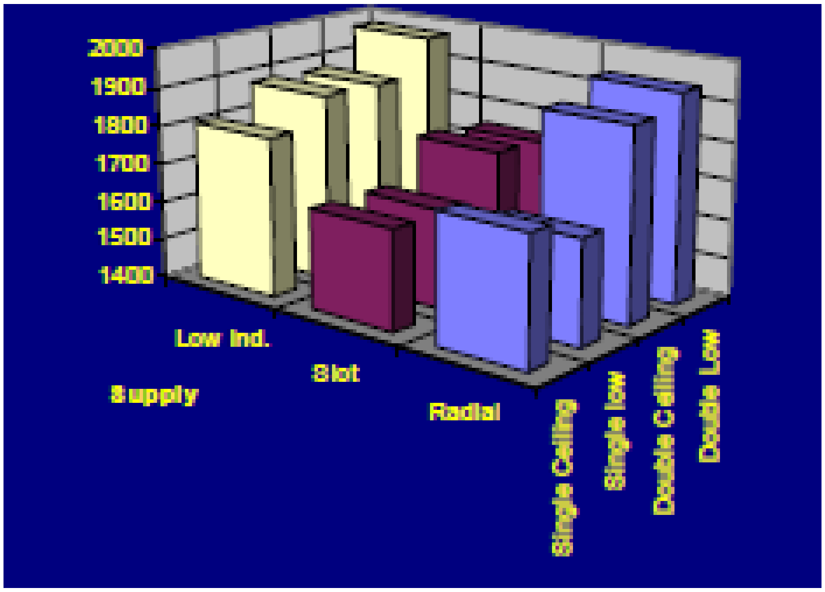

Figure 3.42 Comparison of Mean Cage CO_2 Concentrations (ppm)

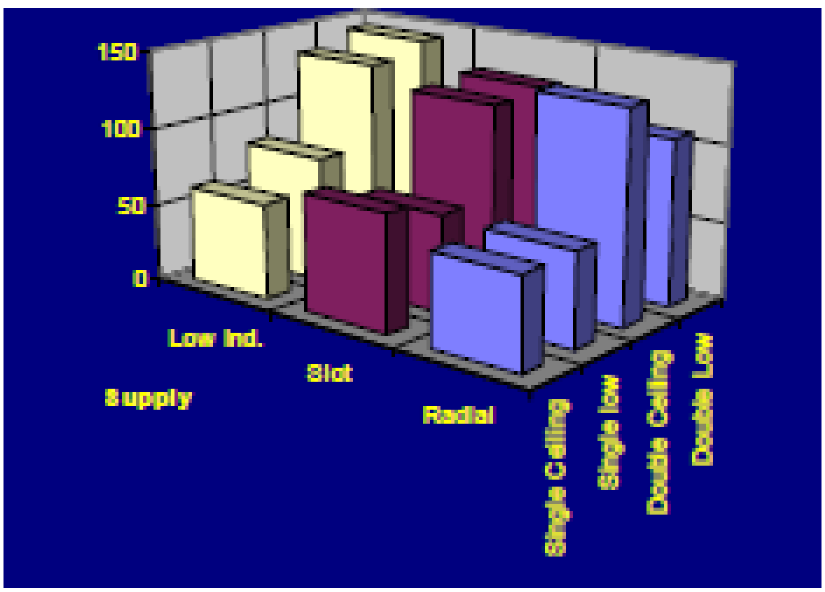

Figure 3.43 Comparison of Mean Breathing Zone CO_2 Concentrations (ppm)

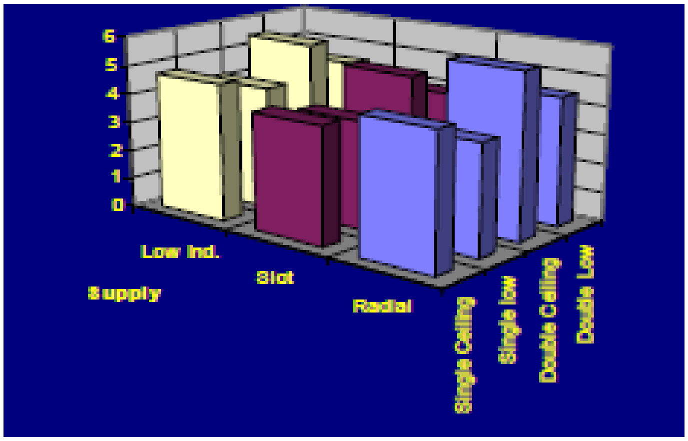

Figure 3.44 Comparison of Mean Cage NH_3 Concentrations (ppm)

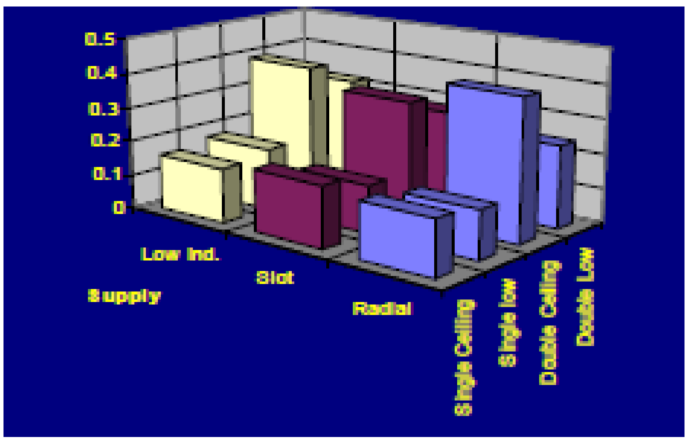

Figure 3.45 Comparison of Mean Breathing Zone NH_3 Concentrations (ppm)

The in-cage values for these runs are not very different from the single density rack. The in-room breathing zone values are much higher. They are about double the CO_2 and NH_3 concentrations of the single density (compare with cases 19 to 24).

Cases 62 to 68 were also double density runs with variation in air change rate. These cases were discussed in section 3.1.2. These cases were the worst, run with 5 ACH producing very high NH_3 concentrations in the scientist's breathing zone.

Cases 87 to 89 were run with a reduced number of cages on each rack (28 instead of 42) for each supply type with low level exhausts. Apart from the slight reduction in room breathing zone CO_2 and NH_3 concentration, no particular changes can be seen. The radial supply seems the best in the room and the low induction the worst, as is the case with the normal racks (42 cages).

3.1.7 Side Cracks of Cages Sealed instead of Open

Where the bonnet filter top sits on the bottom of the microisolator cage the CFD model allowed for an imperfect fit, i.e., air could enter or leave the cage via small cracks. To investigate this effect, three cases were run with sealed cracks, i.e., no air could enter or leave the cages except through the filter.

Cases 25 to 27 were run with sealed cages instead of leaky ones for the three supply types and ceiling exhausts (compare with cases 1, 4 and 7).

Figure 3.46 shows the comparison of in-cage mean temperatures and shows very little change difference between the normal cage model and the fully sealed one.

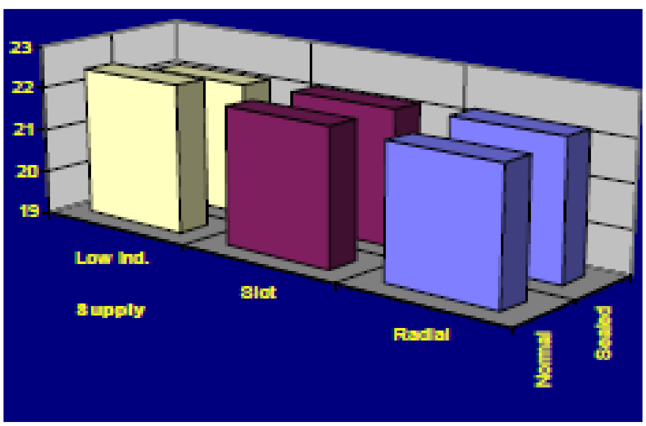

Figure 3.46 Comparison of Mean Cage Temperatures (°C)

Figures 3.47 to 3.50 show comparisons of CO_2 and NH_3 concentrations for the three supply diffuser types with ceiling exhausts for the normal and sealed cage.

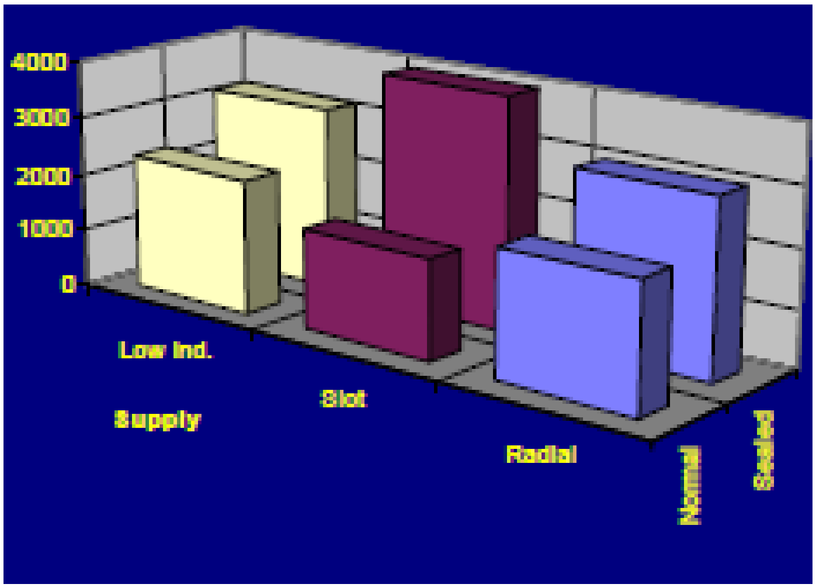

Figure 3.47 Comparison of Mean Cage CO_2 Concentrations (ppm)

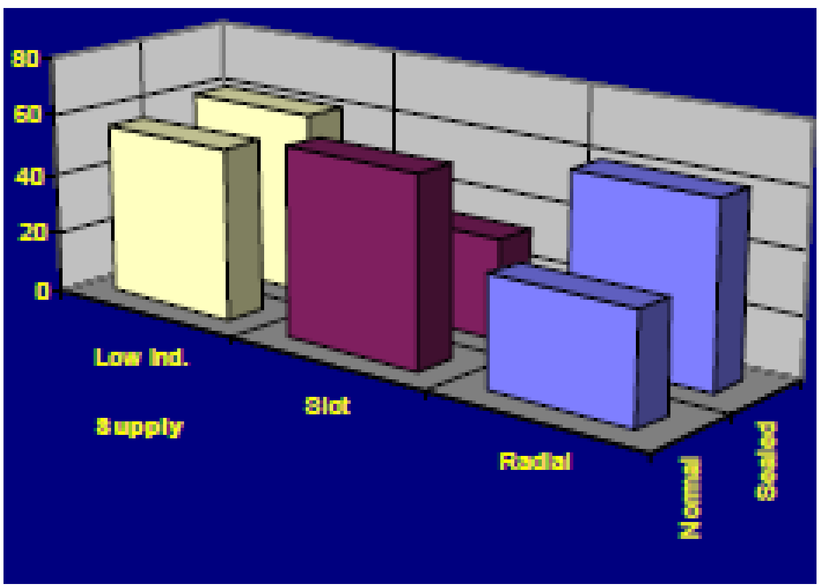

Figure 3.48 Comparison of Mean Breathing Zone CO_2 Concentrations (ppm)

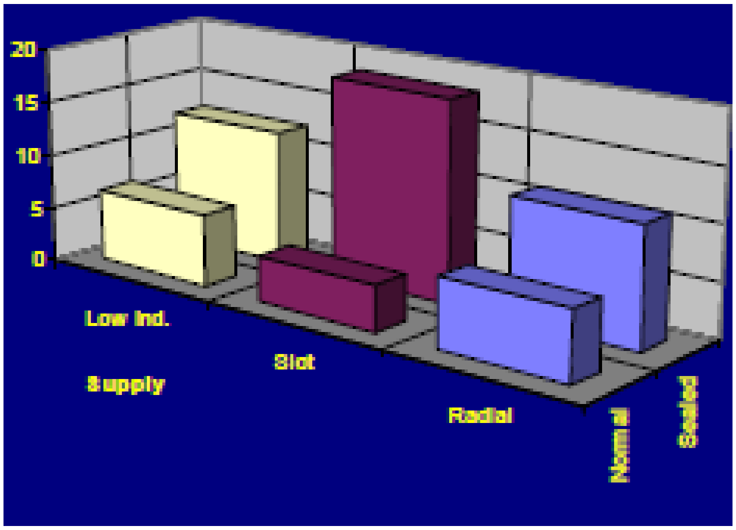

Figure 3.49 Comparison of Mean Cage NH_3 Concentrations (ppm)

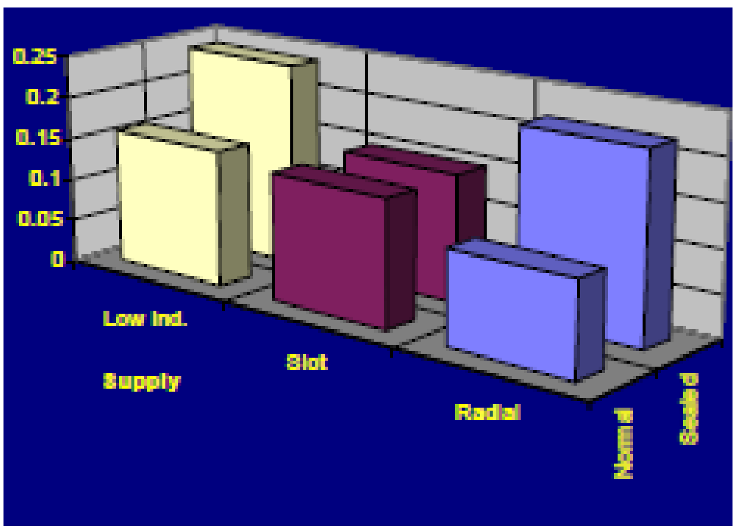

Figure 3.50 Comparison of Mean Breathing Zone NH_3 Concentrations (ppm)

The cages show large increases in both CO_2 and NH_3 concentrations. The room values show little variation in CO_2 concentration but an increase in NH_3 concentration. This is due to the increased cage relative humidities (see figure 3.51) which causes an increased NH_3 generation.

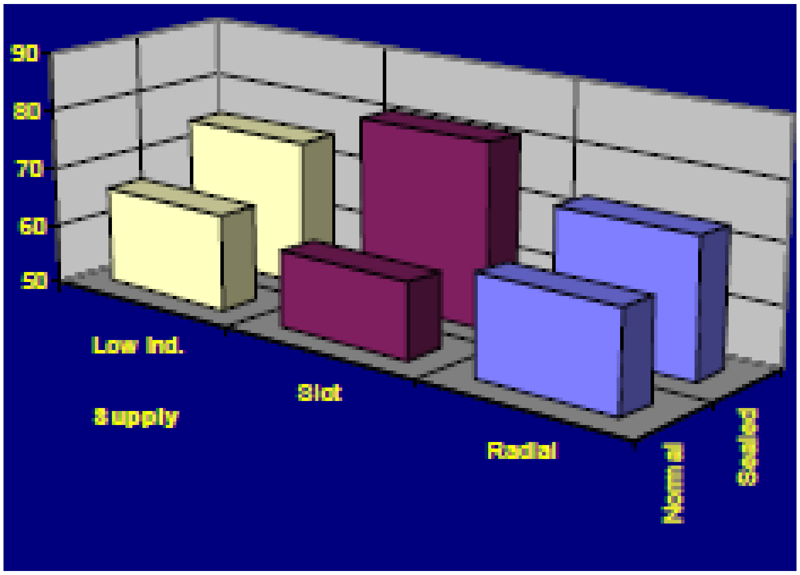

Figure 3.51 Comparison of Mean Cage Relative Humidity (percent)

Although the ventilation of the cages is much worse, which leads to the high concentrations, the temperatures within the cages are not noticeably different. This is partly to be expected, as the CFD model of the mice is a constant temperature model. Even if there was no ventilation of the cages, the temperature in the cage cannot exceed the 30.0 °C (86.0 °F), which is the surface temperature of the mice.

3.1.8 Room Width

Cases 76 to 78 were run with an increased room width 4.26m (14’ 0”) instead of the original width of 3.66m (12’ 0”), with ceiling exhausts for the three supply types. They should be compared with cases 1, 4 and 7. Figures 3.52 to 3.55 show comparisons of CO_2 and NH_3 concentrations.

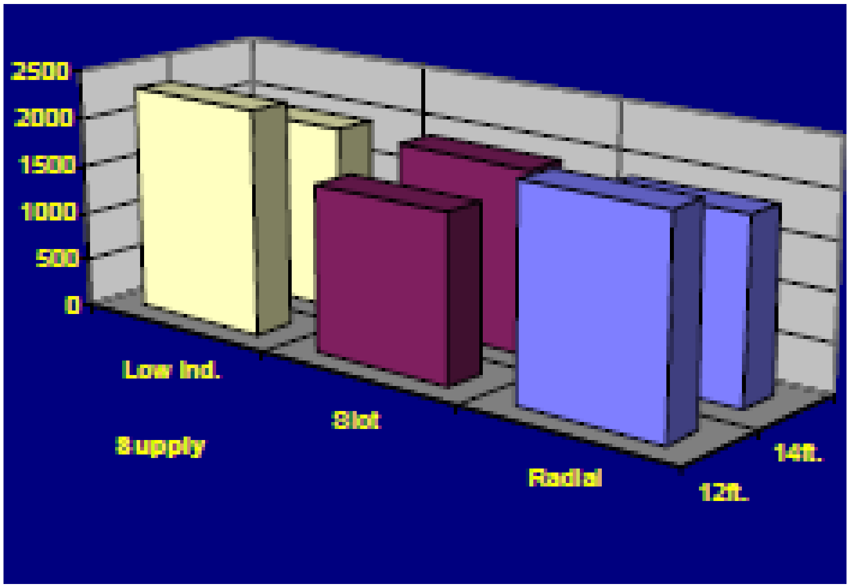

Figure 3.52 Comparison of Mean Cage CO_2 Concentrations (ppm)

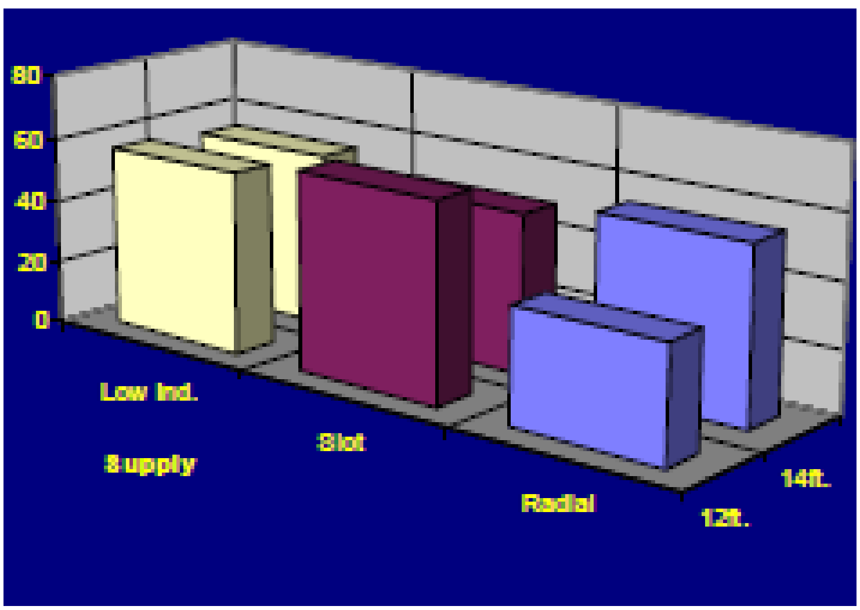

Figure 3.53 Comparison of Mean Breathing Zone CO_2 Concentrations (ppm)

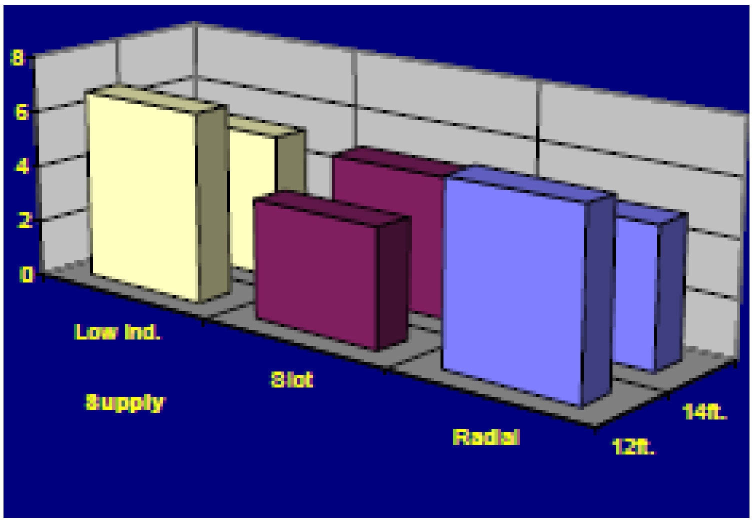

Figure 3.54 *Comparison of Mean Cage NH_3 Concentrations (ppm)*

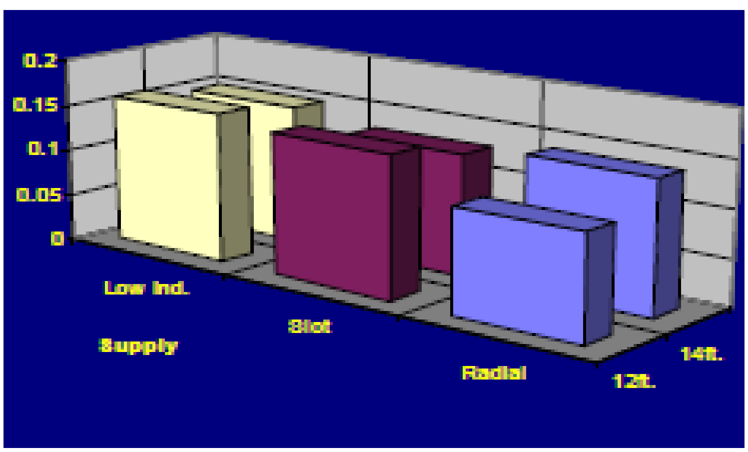

Figure 3.55 *Comparison of Mean Breathing Zone NH_3 Concentrations (ppm)*

The in-cage values are slightly reduced for both the radial and low-induction supply diffusers, while the room values show little change or some increase. As is often the case, improving the cage ventilation seems to degrade the room performance.

3.1.9 Supply Temperature

The experimental data for the generation of NH_3 indicate that NH_3 is produced at a higher rate when the relative humidity is high. As the relative humidity decreases with increasing temperature it was expected that the NH_3 concentrations in the cages and room would be related to the supply temperature.

Figures 3.56 and 3.57 show the cage and room temperatures plotted against the supply temperature. As expected, the higher the supply temperature the higher the cage and room temperatures, although there is a wide variation as was noted previously. The choice of exhaust location has a strong influence on the room and cage temperature.

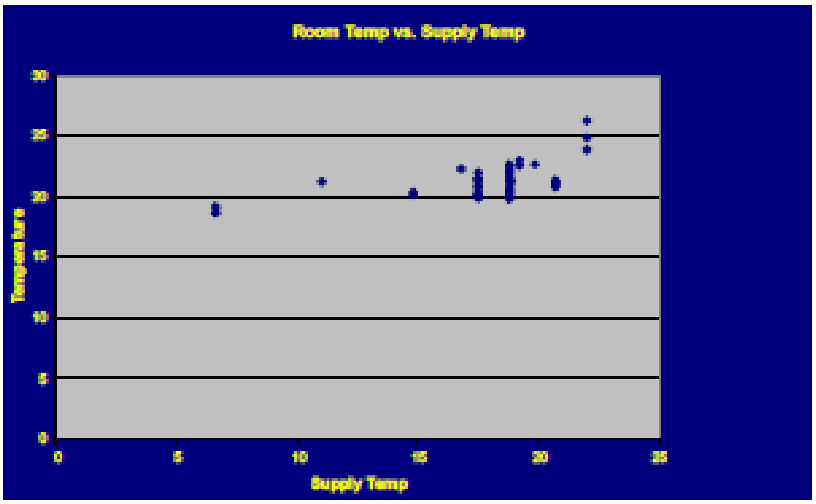

Figure 3.56 *Room Breathing Zone Temperature vs. Supply Discharge Temperature*

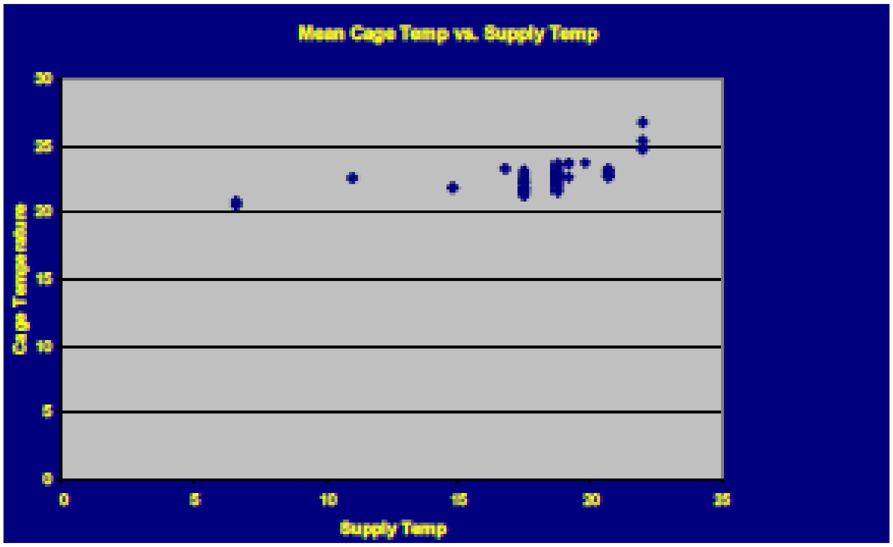

Figure 3.57 *Mean Cage Temperatures vs. Supply Discharge Temperature*

Figures 3.58 and 3.59 show the cage and room NH_3 concentrations on day 4 plotted against supply relative humidity (RH). The cage values show no notable trend with quite a wide variation at the standard supply RH of 61 percent. However, even though there is some scatter in the data, the room NH_3 concentration plot shows a clear trend to higher values at higher supply RH.

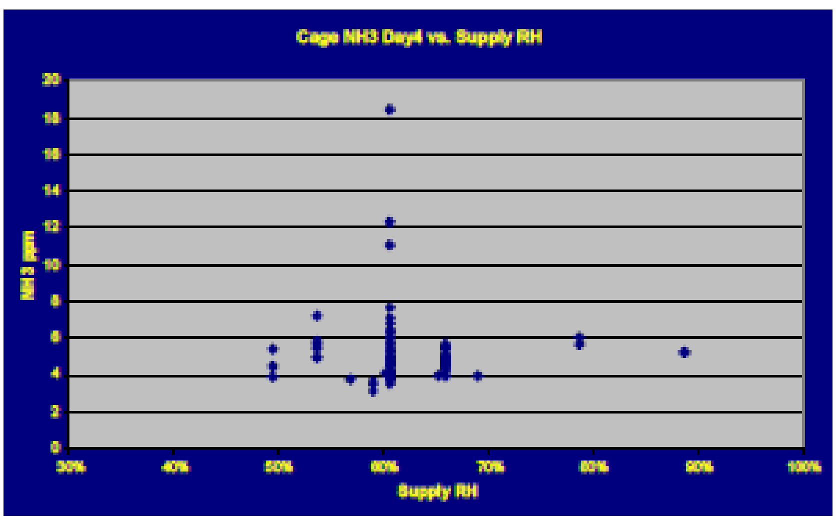

Figure 3.58 *Cage NH_3 Concentration vs. Supply Relative Humidity*

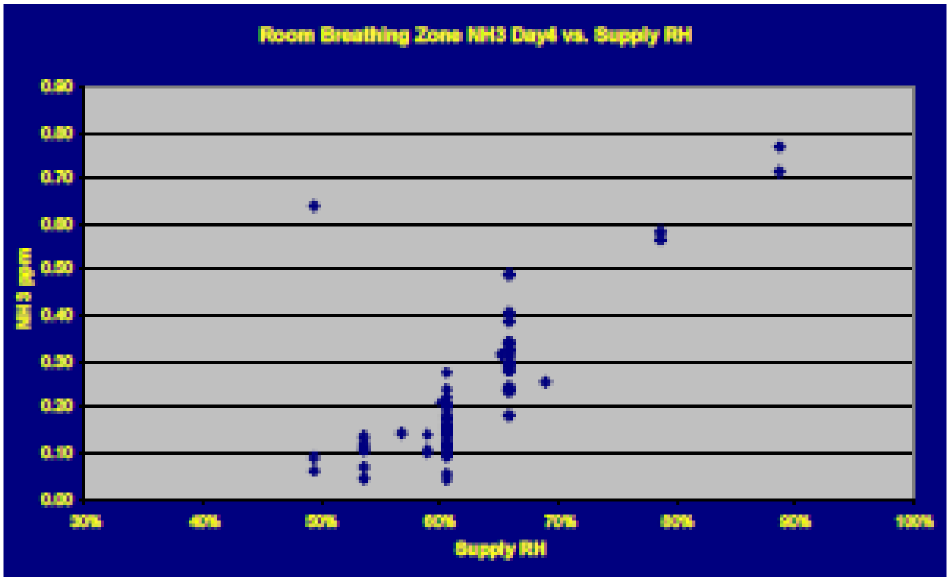

Figure 3.59 *Room Breathing Zone NH_3 Concentration vs. Supply Relative Humidity*

Cases 99 to 101 were run with a supply temperature of 22.2 °C (72.0 °F). Case 99 was the same as the basecase (radial supply ceiling exhaust), case 100 was the same as case 3 (radial supply low level exhaust) and case 101 was the same as case 66 (low induction supply, low level exhaust, 5 ACH). These cases were run to investigate the effect of increased temperatures in the room, in particular the reduction of relative humidity and NH_3 generation that should result.

Raising the supply temperature for these cases produces an increase in both room and cage temperature as shown in table 3.02

Table 3.02 Comparison of Temperatures ^oC (^oF)

	Case 01	Case 99	Case 03	Case 100	Case 66	Case 101
Room BZ	20.3 (68.5)	23.9 (75.0)	22.7 (72.9)	24.8 (76.6)	18.6 (65.5)	26.2 (79.2)
Cage Mean	22.1 (71.8)	24.8 (76.6)	23.4 (74.1)	25.4 (77.7)	20.6 (69.1)	26.8 (80.2)
Cage Max	23.0 (73.4)	25.7 (78.3)	24.6 (76.3)	26.8 (80.2)	21.9 (71.4)	28.3 (82.9)

Cases 99 and 100 represent an increase of 3.2 ^oC (5.8 °F) in the supply temperature and produce an increase of around 2.5 ^oC (4.5 °F) in both room and cage temperature. Case 101 represents an increase of 15.4 ^oC (27.7 °F) in the supply temperature. This raises the room and cage temperature by nearly 8.0 ^oC (14.4 °F). The maximum temperature in a cage is increased to around 28.0 °C (82.4 °F). Although it is high, is still likely to be more than acceptable to the mice.

Case 99 produces an improvement in NH_3 concentration in the room of nearly 50 percent and nearly 30 percent in the cage.

Cases 100 and 101 do not produce the same level of improvement as the original cases 3 and 66, which already have very low humidity values (below the 61 percent minimum from the experimental data), and so the reduction in humidity does not produce a lower NH_3 generation rate.

To further investigate the effect of increasing supply temperature (without re-running all 101 cases) the data was "post-processed" by adding 3.2 ^{o}C (5.8 °F) to the mean temperature for each cage. This is equivalent to raising the supply temperature by approximately 4.0 ^{o}C (7.2 °F).

Figures 3.60 and 3.61 show the resulting bar charts for the day 4 cage and room NH_3 concentrations together with the original data. These charts clearly show the reduction in NH_3 concentrations that can be expected when an increased supply temperature is used. A few of the cases do not show significant improvements. These are cases where the original run is already at the minimum RH (61 percent) used in the generation rate calculation.

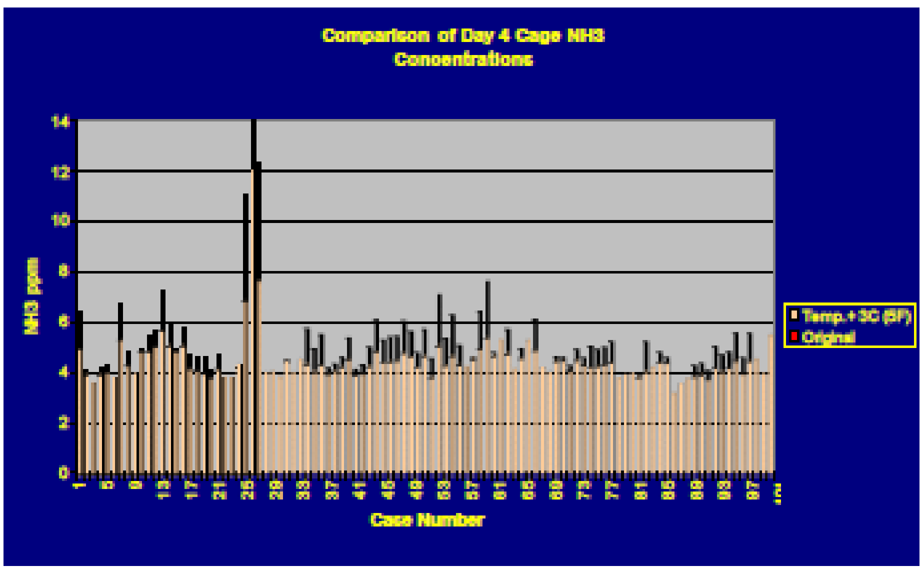

Figure 3.60 *Comparison of Cage Day 4 NH_3 Concentrations*

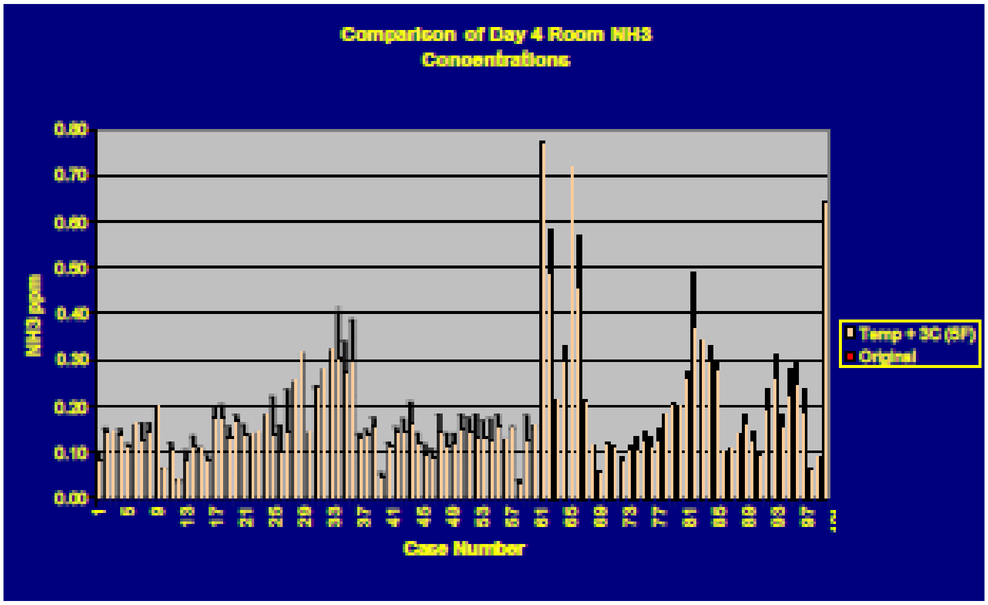

Figure 3.61 *Comparison of Room Day 4 NH_3 Concentrations*

3.2 NH_3 Concentrations for 10-day cycle

Table 3.03 shows a summary of mean and maximum NH_3 concentrations in the room's breathing zone over 10 days using the different generation rates measured in the experiments. In the summary, values between 0.5ppm and 1ppm have been colored blue, and values above 1 ppm are colored red. Smyth (1956) found 1ppm detected and identified by 10 subjects. In addition, analysis of data obtained in plant surveys conducted from 1965 to 1970 by the Bureau of Industrial Hygiene, Detroit Department of Health, found the limit of detection to be below 5 ppm and the complaint level to be 20 ppm to 25 ppm. Therefore, 1ppm was chosen as a conservative level at which people might be able to detect a smell in the room.

With the exception of the very low flow rates (5 ACH) for the double density rooms, all the room configurations show an acceptable NH_3 concentration, on average, in the breathing zone up to day 5. The maximum value in the breathing zone, present in just one small location, is generally all right up to day 5. By day 5 and day 6 virtually all rooms had at least one spot above 1ppm. This indicates that changing the bedding every 5 days should leave most rooms with an acceptable atmosphere.

Table 3.04 shows a summary of mean and maximum NH_3 concentrations in the cages over 10 days using the different generation rates measured in the experiments. In the summary, values over 25 ppm have been colored red, as such high levels are likely to cause problems for the mice.

See Schoeb, Davidson and Lindsey (1982) who indicated that NH_3 concentrations above 25 ppm promote the growth of infective agents in the respiratory tract of rats in cages.

In cases 25-27, in which sealed edge cages with particularly poor ventilation are used (the only airflow is through the filter), the mean concentration did not rise above 25 ppm until day 7 for any of the rooms studied. The "maximum" part of the table shows that the worst cage in the room did go over 25 ppm on day 6 (see cases 73, 75, 77 and 78). By day 7 most rooms have at least one cage with NH_3 concentrations over 25 ppm.

As indicated previously, a supply rate of 0.85 cfm (4.01e-4 m^3/s) per 100g mouse body weight will provide good room conditions up to day 4 or day 5. To go beyond this time before changing the bedding the flow rate must be increased to 1.28 cfm (6.04e-4 m^3/s) per 100g, although a few rooms will be 1 ppm, on average, by day 7. Even increasing to 1.70 cfm (8.02e-4 m^3/s) per 100g will only extend this to eight days, although even then the maximum NH_3 concentration in the breathing zone will rise to 3 ppm and some parts of the room will be noticeably smelly.

Even at 1.70 cfm (8.02e-4 m^3/s) per 100g (20 ACH in the double density rooms) the cages are unacceptable by day 8 as the NH_3 concentration is around 25ppm. The very small amount of improvement that 20 ACH gives over 15 ACH for the cages makes it unlikely that further increases in supply flow rates will change this situation.

Tables 3.05 and 3.06 are repeats of 3.03 and 3.04 with the cage temperatures increased by 3.0 ^{o}C (5.4 ^{o}F). The increase in temperature reduces the relative humidity as well as the NH_3 generation rate leading to lower NH_3 concentrations.

Increasing the temperature is also recommended by Gordon, Becker and Ali (1997) who indicate that the "standard housing temperature of 22.0-24.0 ^{o}C (72.0-75.0 ^{o}F) is significantly below the thermoneutral zone of groups of mice suggesting that they are subjected to varying degrees of cold stress under standard housing conditions."

The increase in temperature shows the rooms improve in approximately one day. Considering the average NH_3 concentration, the rooms are acceptable up to day 7 apart from the very low flow rates that fail on day 6. The maximum NH_3 concentration shows an improvement with many more rooms acceptable on day 5 with most starting to fail on day 6.

The cages show nearly a two day improvement with the average cage going over 25 ppm on day 10, although the worst cages with the maximum NH_3 concentration start to fail in a few rooms on day 8, with most failing on day 9.

Note on use of tables 3.03 to 3.06:
The tables show mean NH_3 concentrations for the cages and scientist's breathing zone (1.5m-1.8m, 4'11" – 5' 11") and the maximum value (in one cage or one spot in the room breathing zone). The color coding allows both good (black) and poor (red) cases to be quickly identified. It

is also possible to see how quickly the NH_3 *concentrations deteriorate over the 10-day cycle for the particular case.*

	Day by day room breathing zone average NH3										Day by day room breathing zone maximum NH3									
Case Name	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
Basecase	0.02	0.04	0.06	0.11	0.18	0.26	0.40	0.49	0.59	0.63	0.07	0.14	0.21	0.40	0.68	1.01	1.51	1.88	2.25	2.43
Case 02	0.03	0.07	0.10	0.15	0.23	0.32	0.45	0.59	0.76	0.95	0.09	0.18	0.28	0.43	0.63	0.88	1.24	1.64	2.12	2.65
Case 03	0.03	0.06	0.10	0.14	0.20	0.28	0.38	0.52	0.69	0.90	0.09	0.17	0.27	0.38	0.54	0.75	1.02	1.38	1.83	2.39
Case 04	0.03	0.06	0.10	0.15	0.23	0.32	0.46	0.60	0.77	0.94	0.09	0.17	0.26	0.42	0.62	0.89	1.27	1.65	2.10	2.56
Case 05	0.03	0.05	0.08	0.12	0.18	0.25	0.36	0.47	0.60	0.74	0.08	0.16	0.24	0.37	0.56	0.79	1.12	1.47	1.88	2.30
Case 06	0.04	0.07	0.11	0.16	0.23	0.31	0.43	0.58	0.77	1.01	0.08	0.16	0.25	0.35	0.50	0.69	0.94	1.27	1.69	2.21
Case 07	0.03	0.06	0.09	0.16	0.27	0.41	0.61	0.76	0.91	0.99	0.20	0.38	0.58	1.07	1.79	2.65	3.97	4.94	5.94	6.46
Case 08	0.03	0.06	0.10	0.16	0.26	0.37	0.54	0.69	0.86	1.01	0.12	0.23	0.35	0.58	0.91	1.31	1.90	2.43	3.04	3.56
Case 09	0.05	0.09	0.14	0.20	0.28	0.38	0.53	0.71	0.94	1.23	0.14	0.28	0.43	0.62	0.88	1.21	1.66	2.24	2.98	3.89
Case 10	0.02	0.03	0.05	0.07	0.10	0.14	0.19	0.26	0.33	0.42	0.08	0.16	0.25	0.37	0.53	0.75	1.05	1.39	1.81	2.29
Case 11	0.03	0.05	0.07	0.12	0.19	0.27	0.39	0.51	0.63	0.75	0.12	0.23	0.35	0.57	0.88	1.27	1.84	2.36	2.96	3.49
Case 12	0.01	0.02	0.03	0.04	0.07	0.10	0.14	0.18	0.23	0.27	0.12	0.23	0.36	0.59	0.92	1.32	1.92	2.46	3.08	3.63
Case 13	0.02	0.04	0.06	0.11	0.18	0.26	0.39	0.49	0.59	0.64	0.15	0.28	0.44	0.81	1.36	2.01	3.02	3.75	4.51	4.90
Case 14	0.03	0.05	0.08	0.14	0.21	0.31	0.45	0.58	0.72	0.83	0.12	0.22	0.34	0.58	0.91	1.32	1.93	2.45	3.04	3.52
Case 15	0.03	0.05	0.07	0.11	0.16	0.23	0.32	0.42	0.55	0.70	0.16	0.31	0.48	0.71	1.03	1.45	2.02	2.69	3.50	4.43
Case 16	0.02	0.04	0.06	0.10	0.15	0.22	0.31	0.40	0.50	0.58	0.13	0.25	0.39	0.65	1.02	1.48	2.16	2.76	3.43	4.00
Case 17	0.04	0.08	0.12	0.20	0.32	0.46	0.66	0.85	1.06	1.23	0.10	0.18	0.28	0.47	0.73	1.06	1.54	1.97	2.46	2.87
Case 18	0.04	0.08	0.12	0.20	0.32	0.46	0.67	0.85	1.06	1.25	0.10	0.18	0.28	0.47	0.73	1.05	1.53	1.96	2.44	2.86
Case 19	0.03	0.06	0.09	0.16	0.25	0.36	0.54	0.68	0.84	0.96	0.12	0.22	0.35	0.59	0.95	1.38	2.03	2.57	3.16	3.62
Case 20	0.04	0.08	0.12	0.18	0.27	0.39	0.55	0.72	0.92	1.13	0.09	0.18	0.27	0.43	0.64	0.91	1.29	1.68	2.15	2.62
Case 21	0.03	0.06	0.10	0.16	0.26	0.37	0.54	0.69	0.85	0.99	0.10	0.19	0.29	0.49	0.77	1.11	1.62	2.06	2.56	2.98
Case 22	0.03	0.06	0.10	0.14	0.20	0.27	0.37	0.50	0.66	0.86	0.11	0.22	0.34	0.49	0.69	0.97	1.33	1.78	2.36	3.06
Case 23	0.03	0.06	0.10	0.14	0.20	0.28	0.38	0.51	0.68	0.89	0.09	0.18	0.28	0.41	0.57	0.79	1.08	1.46	1.94	2.54
Case 24	0.04	0.08	0.13	0.18	0.26	0.36	0.49	0.66	0.88	1.15	0.22	0.43	0.67	0.96	1.35	1.87	2.56	3.46	4.59	6.00
Case 25	0.03	0.06	0.09	0.22	0.41	0.63	0.99	1.19	1.36	1.30	0.13	0.24	0.36	0.86	1.60	2.45	3.83	4.59	5.23	5.01
Case 26	0.02	0.04	0.05	0.16	0.32	0.51	0.81	0.95	1.05	0.92	0.08	0.15	0.23	0.69	1.39	2.18	3.50	4.10	4.52	3.96
Case 27	0.03	0.06	0.10	0.24	0.45	0.70	1.10	1.31	1.48	1.39	0.13	0.24	0.37	0.93	1.77	2.72	4.29	5.11	5.77	5.40
Case 28	0.06	0.11	0.18	0.25	0.36	0.50	0.68	0.92	1.22	1.59	0.16	0.31	0.48	0.69	0.97	1.35	1.84	2.48	3.30	4.31
Case 29	0.07	0.14	0.22	0.32	0.44	0.62	0.84	1.14	1.51	1.97	0.14	0.27	0.42	0.60	0.85	1.17	1.60	2.16	2.88	3.76
Case 30	0.03	0.06	0.10	0.14	0.20	0.28	0.38	0.52	0.68	0.89	0.13	0.25	0.39	0.57	0.80	1.10	1.51	2.04	2.71	3.54
Case 31	0.06	0.11	0.17	0.24	0.35	0.49	0.68	0.90	1.19	1.52	0.16	0.32	0.49	0.72	1.04	1.45	2.00	2.68	3.51	4.51
Case 32	0.06	0.13	0.19	0.28	0.39	0.55	0.75	1.01	1.34	1.75	0.18	0.34	0.53	0.76	1.07	1.48	2.02	2.73	3.63	4.74
Case 33	0.07	0.14	0.22	0.32	0.45	0.63	0.86	1.16	1.54	2.01	0.22	0.44	0.67	0.97	1.37	1.90	2.60	3.50	4.65	6.08
Case 34	0.07	0.14	0.21	0.41	0.69	1.03	1.55	1.92	2.29	2.44	0.17	0.32	0.50	0.95	1.61	2.40	3.63	4.49	5.35	5.70
Case 35	0.06	0.12	0.19	0.34	0.56	0.82	1.21	1.52	1.85	2.06	0.15	0.29	0.45	0.81	1.32	1.95	2.89	3.63	4.41	4.91
Case 36	0.07	0.14	0.21	0.39	0.65	0.96	1.44	1.79	2.15	2.34	0.16	0.31	0.47	0.88	1.47	2.18	3.26	4.06	4.88	5.30
Case 37	0.03	0.06	0.09	0.14	0.21	0.30	0.42	0.55	0.71	0.87	0.09	0.18	0.28	0.43	0.64	0.90	1.28	1.68	2.15	2.66
Case 38	0.03	0.06	0.10	0.15	0.22	0.32	0.45	0.59	0.75	0.93	0.10	0.20	0.31	0.47	0.70	1.00	1.41	1.85	2.38	2.93
Case 39	0.04	0.07	0.11	0.18	0.27	0.38	0.55	0.71	0.90	1.08	0.13	0.25	0.39	0.62	0.94	1.34	1.91	2.48	3.15	3.80
Case 40	0.01	0.02	0.03	0.06	0.09	0.13	0.20	0.25	0.31	0.35	0.05	0.09	0.13	0.23	0.37	0.54	0.79	1.00	1.23	1.40
Case 41	0.03	0.05	0.08	0.12	0.18	0.26	0.36	0.47	0.61	0.75	0.07	0.14	0.22	0.34	0.50	0.70	0.99	1.30	1.68	2.08
Case 42	0.03	0.06	0.10	0.16	0.23	0.33	0.48	0.62	0.79	0.96	0.10	0.19	0.30	0.47	0.70	1.00	1.43	1.85	2.36	2.87
Case 43	0.03	0.07	0.10	0.17	0.28	0.40	0.59	0.75	0.93	1.06	0.09	0.17	0.26	0.44	0.70	1.01	1.49	1.89	2.33	2.66
Case 44	0.04	0.07	0.11	0.21	0.35	0.51	0.76	0.95	1.15	1.27	0.13	0.24	0.37	0.67	1.11	1.65	2.46	3.07	3.71	4.07
Case 45	0.03	0.05	0.08	0.14	0.23	0.33	0.49	0.62	0.76	0.86	0.13	0.25	0.38	0.67	1.07	1.56	2.30	2.91	3.57	4.05
Case 46	0.02	0.04	0.07	0.12	0.19	0.28	0.42	0.53	0.64	0.72	0.11	0.20	0.31	0.55	0.89	1.31	1.94	2.44	2.98	3.34
Case 47	0.02	0.04	0.06	0.11	0.18	0.26	0.38	0.48	0.58	0.66	0.09	0.18	0.27	0.48	0.78	1.14	1.68	2.12	2.59	2.92
Case 48	0.03	0.07	0.10	0.18	0.30	0.45	0.67	0.84	1.01	1.11	0.16	0.31	0.47	0.86	1.42	2.10	3.14	3.92	4.73	5.19
Case 49	0.03	0.05	0.08	0.14	0.23	0.34	0.50	0.63	0.77	0.86	0.13	0.25	0.38	0.68	1.10	1.61	2.38	3.00	3.66	4.11
Case 50	0.03	0.06	0.09	0.14	0.22	0.32	0.46	0.59	0.74	0.86	0.10	0.20	0.31	0.51	0.79	1.14	1.65	2.12	2.65	3.11
Case 51	0.04	0.07	0.10	0.18	0.30	0.44	0.65	0.82	1.00	1.12	0.12	0.23	0.36	0.63	1.03	1.51	2.23	2.81	3.42	3.83
Case 52	0.03	0.07	0.10	0.18	0.28	0.41	0.60	0.76	0.94	1.07	0.19	0.37	0.57	0.98	1.57	2.29	3.37	4.26	5.24	5.95
Case 53	0.03	0.06	0.09	0.18	0.32	0.49	0.74	0.91	1.07	1.10	0.09	0.17	0.26	0.53	0.93	1.40	2.14	2.62	3.08	3.18
Case 54	0.03	0.06	0.09	0.17	0.28	0.42	0.62	0.78	0.94	1.03	0.15	0.29	0.44	0.81	1.33	1.97	2.94	3.67	4.43	4.87
Case 55	0.03	0.06	0.09	0.17	0.30	0.45	0.68	0.84	0.99	1.04	0.13	0.24	0.38	0.74	1.26	1.89	2.86	3.53	4.18	4.40
Case 56	0.04	0.07	0.11	0.18	0.29	0.42	0.62	0.79	0.98	1.12	0.08	0.16	0.25	0.42	0.66	0.96	1.41	1.79	2.21	2.54
Case 57	0.03	0.06	0.09	0.13	0.18	0.25	0.34	0.46	0.62	0.81	0.15	0.28	0.44	0.63	0.88	1.22	1.68	2.26	3.00	3.92
Case 58	0.04	0.07	0.11	0.16	0.22	0.31	0.43	0.58	0.76	0.97	0.13	0.26	0.40	0.58	0.84	1.17	1.62	2.16	2.83	3.63
Case 59	0.01	0.01	0.02	0.04	0.07	0.11	0.16	0.20	0.24	0.26	0.05	0.09	0.14	0.27	0.45	0.67	1.01	1.25	1.49	1.60
Case 60	0.03	0.06	0.09	0.18	0.32	0.48	0.74	0.90	1.05	1.08	0.09	0.18	0.27	0.56	0.99	1.48	2.27	2.77	3.25	3.33
Case 61	0.04	0.07	0.11	0.16	0.23	0.32	0.45	0.59	0.78	0.99	0.16	0.31	0.48	0.72	1.03	1.45	2.01	2.68	3.50	4.47
Case 62	0.18	0.35	0.53	0.77	1.08	1.50	2.05	2.77	3.68	4.81	0.47	0.91	1.40	2.02	2.84	3.94	5.39	7.27	9.65	12.61
Case 63	0.11	0.22	0.34	0.58	0.94	1.37	2.02	2.55	3.13	3.54	0.34	0.66	1.01	1.76	2.83	4.14	6.10	7.71	9.46	10.71
Case 64	0.05	0.09	0.15	0.21	0.29	0.41	0.56	0.75	1.00	1.31	0.17	0.33	0.51	0.73	1.02	1.42	1.94	2.62	3.48	4.55
Case 65	0.07	0.14	0.21	0.33	0.49	0.70	0.99	1.30	1.65	2.01	0.17	0.32	0.50	0.79	1.18	1.68	2.39	3.12	3.97	4.85
Case 66	0.17	0.32	0.50	0.72	1.01	1.40	1.91	2.58	3.42	4.47	0.43	0.83	1.28	1.84	2.59	3.59	4.91	6.63	8.81	11.51
Case 67	0.11	0.20	0.31	0.57	0.93	1.37	2.04	2.55	3.10	3.42	0.33	0.63	0.97	1.75	2.88	4.25	6.32	7.92	9.60	10.61
Case 68	0.05	0.09	0.15	0.21	0.29	0.41	0.56	0.75	1.00	1.31	0.14	0.26	0.41	0.59	0.83	1.15	1.57	2.12	2.81	3.68
Case 69	0.03	0.05	0.08	0.12	0.16	0.22	0.31	0.41	0.55	0.72	0.14	0.26	0.41	0.59	0.82	1.14	1.56	2.11	2.80	3.66
Case 70	0.01	0.02	0.04	0.06	0.08	0.11	0.16	0.21	0.28	0.35	0.06	0.12	0.19	0.29	0.42	0.58	0.82	1.08	1.41	1.78
Case 71	0.03	0.05	0.08	0.12	0.17	0.24	0.34	0.45	0.58	0.74	0.16	0.31	0.48	0.71	1.02	1.43	1.99	2.65	3.46	4.40
Case 72	0.03	0.05	0.07	0.11	0.17	0.23	0.33	0.43	0.56	0.70	0.13	0.26	0.40	0.60	0.87	1.23	1.72	2.27	2.95	3.70
Case 73	0.02	0.04	0.06	0.09	0.14	0.20	0.28	0.37	0.47	0.56	0.08	0.15	0.23	0.36	0.55	0.78	1.12	1.45	1.84	2.22
Case 74	0.02	0.05	0.07	0.11	0.17	0.24	0.34	0.45	0.57	0.71	0.13	0.25	0.39	0.59	0.88	1.25	1.77	2.32	2.98	3.68
Case 75	0.03	0.05	0.07	0.13	0.21	0.30	0.45	0.57	0.69	0.79	0.13	0.25	0.39	0.67	1.08	1.57	2.32	2.93	3.60	4.07
Case 76	0.03	0.06	0.09	0.14	0.23	0.33	0.48	0.61	0.76	0.88	0.12	0.24	0.37	0.62	0.97	1.40	2.04	2.61	3.24	3.77
Case 77	0.03	0.05	0.08	0.13	0.21	0.30	0.44	0.56	0.70	0.81	0.10	0.19	0.30	0.50	0.79	1.14	1.67	2.13	2.64	3.06
Case 78	0.03	0.06	0.09	0.15	0.24	0.35	0.51	0.64	0.79	0.90	0.11	0.21	0.33	0.57	0.91	1.33	1.95	2.47	3.04	3.46
Case 79	0.04	0.08	0.13	0.18	0.26	0.36	0.49	0.66	0.87	1.14	0.10	0.20	0.30	0.44	0.62	0.86	1.17	1.58	2.10	2.74
Case 80	0.05	0.09	0.14	0.20	0.29	0.40	0.54	0.73	0.97	1.27	0.11	0.21	0.32	0.47	0.65	0.91	1.24	1.68	2.23	2.91
Case 81	0.05	0.09	0.14	0.20	0.28	0.39	0.54	0.72	0.96	1.25	0.14	0.28	0.43	0.63	0.88	1.22	1.67	2.25	2.99	3.91
Case 82	0.06	0.12	0.18	0.27	0.40	0.56	0.79	1.04	1.35	1.70	0.17	0.34	0.52	0.78	1.14	1.61	2.25	2.97	3.86	4.86
Case 83	0.09	0.17	0.26	0.49	0.82	1.22	1.84	2.28	2.73	2.94	0.21	0.41	0.63	1.18	1.99	2.95	4.44	5.51	6.60	7.11
Case 84	0.08	0.15	0.24	0.34	0.48	0.67	0.91	1.23	1.64	2.14	0.20	0.38	0.59	0.85	1.20	1.67	2.28	3.07	4.08	5.34
Case 85	0.07	0.13	0.21	0.33	0.49	0.70	1.00	1.30	1.65	2.00	0.23	0.45	0.69	1.10	1.66	2.36	3.37	4.38	5.57	6.75
Case 86	0.06	0.13	0.19	0.29	0.43	0.61	0.85	1.13	1.46	1.82	0.20	0.38	0.58	0.89	1.30	1.83	2.57	3.39	4.39	5.49
Case 87	0.02	0.05	0.07	0.10	0.14	0.20	0.27	0.36	0.48	0.63	0.07	0.14	0.21	0.30	0.42	0.59	0.81	1.09	1.44	1.89
Case 88	0.02	0.05	0.07	0.11	0.15	0.21	0.29	0.39	0.51	0.67	0.04	0.09	0.13	0.19	0.27	0.38	0.51	0.69	0.92	1.21
Case 89	0.03	0.06	0.10	0.14	0.20	0.27	0.37	0.50	0.67	0.87	0.11	0.22	0.34	0.49	0.69	0.95	1.30	1.75	2.33	3.04
Case 90	0.04	0.07	0.11	0.18	0.28	0.40	0.57	0.74	0.93	1.11	0.15	0.28	0.44	0.70	1.08	1.55	2.24	2.89	3.63	4.33
Case 91	0.03	0.06	0.09	0.14	0.22	0.32	0.46	0.59	0.75	0.89	0.10	0.19	0.29	0.46	0.71	1.03	1.48	1.90	2.39	2.85
Case 92	0.02	0.04	0.06	0.10	0.15	0.22	0.31	0.41	0.52	0.63	0.08	0.15	0.24	0.37	0.56	0.80	1.14	1.48	1.88	2.29
Case 93	0.05	0.09	0.13	0.24	0.38	0.56	0.82	1.04	1.27	1.43	0.19	0.37	0.56	0.98	1.59	2.33	3.43	4.33	5.30	5.98
Case 94	0.06	0.12	0.18	0.31	0.49	0.71	1.04	1.33	1.64	1.89	0.17	0.33	0.51	0.87	1.38	2.01	2.94	3.73	4.61	5.31
Case 95	0.04	0.07	0.11	0.18	0.29	0.41	0.60	0.77	0.96	1.11	0.15	0.28	0.44	0.74	1.16	1.68	2.44	3.12	3.87	4.49
Case 96	0.05	0.10	0.16	0.28	0.46	0.68	1.01	1.27	1.54	1.70	0.15	0.28	0.44	0.79	1.30	1.91	2.85	3.56	4.32	4.77
Case 97	0.06	0.11	0.17	0.29	0.46	0.67	0.98	1.25	1.54	1.79	0.15	0.30	0.46	0.77	1.22	1.77	2.59	3.29	4.08	4.72
Case 98	0.04	0.08	0.13	0.23	0.39	0.57	0.85	1.06	1.29	1.42	0.18	0.34	0.52	0.94	1.54	2.28	3.39	4.24	5.14	5.68
Case 99	0.01	0.03	0.04	0.06	0.09	0.12	0.16	0.22	0.29	0.38	0.06	0.12	0.19	0.28	0.39	0.54	0.74	1.00	1.33	1.73
Case 100	0.02	0.04	0.06	0.09	0.13	0.18	0.24	0.32	0.43	0.56	0.10	0.19	0.30	0.43	0.61	0.84	1.16	1.56	2.07	2.71
Case 101	0.15	0.29	0.44	0.64	0.90	1.25	1.71	2.30	3.06	4.00	0.41	0.80	1.24	1.78	2.51	3.48	4.76	6.42	8.53	11.15

Table 3.03 Room Breathing Zone NH_3 Mean and Maximum Concentrations for 10 Days

Day by day cage average NH3										
Case Name	1	2	3	4	5	6	7	8	9	10
Basecase	1.15	2.18	3.37	6.33	10.66	15.82	23.78	29.51	35.35	38.09
Case 02	0.89	1.72	2.66	4.03	5.92	8.35	11.72	15.45	19.99	25.01
Case 03	0.82	1.59	2.45	3.53	4.96	6.88	9.41	12.70	16.87	22.05
Case 04	0.90	1.73	2.67	4.18	6.29	8.96	12.75	16.61	21.17	25.80
Case 05	0.91	1.76	2.72	4.23	6.32	8.99	12.75	16.66	21.31	26.14
Case 06	0.86	1.67	2.58	3.72	5.22	7.24	9.92	13.37	17.76	23.22
Case 07	1.24	2.35	3.62	6.71	11.21	16.60	24.87	30.95	37.22	40.46
Case 08	0.98	1.89	2.92	4.83	7.53	10.88	15.79	20.22	25.23	29.56
Case 09	0.90	1.75	2.69	3.88	5.46	7.57	10.36	13.97	18.55	24.25
Case 10	1.11	2.14	3.31	4.94	7.17	10.06	14.03	18.61	24.25	30.72
Case 11	1.11	2.14	3.30	5.42	8.40	12.10	17.51	22.48	28.16	33.21
Case 12	1.16	2.23	3.45	5.66	8.78	12.66	18.32	23.52	29.43	34.67
Case 13	1.33	2.52	3.89	7.21	12.05	17.85	26.75	33.29	40.02	43.47
Case 14	1.17	2.24	3.46	5.82	9.17	13.30	19.40	24.73	30.67	35.51
Case 15	1.11	2.14	3.31	4.94	7.17	10.06	14.03	18.61	24.25	30.72
Case 16	1.17	2.24	3.45	5.76	9.02	13.05	18.99	24.26	30.19	35.20
Case 17	0.96	1.84	2.83	4.71	7.38	10.67	15.52	19.84	24.70	28.82
Case 18	0.94	1.81	2.79	4.62	7.19	10.39	15.07	19.30	24.10	28.27
Case 19	0.91	1.75	2.69	4.61	7.36	10.72	15.74	19.95	24.59	28.11
Case 20	0.87	1.68	2.58	4.04	6.06	8.62	12.26	15.98	20.40	24.94
Case 21	0.95	1.83	2.82	4.73	7.44	10.79	15.72	20.05	24.90	28.90
Case 22	0.87	1.69	2.60	3.77	5.34	7.42	10.20	13.71	18.13	23.55
Case 23	0.86	1.67	2.58	3.71	5.22	7.24	9.91	13.37	17.76	23.22
Case 24	0.98	1.91	2.94	4.24	5.96	8.26	11.30	15.25	20.25	26.47
Case 25	1.64	3.04	4.69	11.05	20.64	31.63	49.49	59.31	67.59	64.80
Case 26	2.25	4.02	6.20	18.42	37.17	58.21	93.38	109.47	120.68	105.66
Case 27	1.75	3.21	4.95	12.31	23.47	36.19	57.03	67.91	76.69	71.78
Case 28	0.91	1.77	2.73	3.93	5.53	7.67	10.50	14.16	18.81	24.59
Case 29	0.92	1.79	2.75	3.97	5.58	7.74	10.59	14.28	18.97	24.80
Case 30	0.87	1.69	2.60	3.75	5.27	7.31	10.01	13.50	17.93	23.44
Case 31	1.01	1.96	3.02	4.45	6.37	8.89	12.30	16.44	21.59	27.73
Case 32	0.91	1.77	2.73	3.93	5.53	7.66	10.49	14.15	18.79	24.57
Case 33	1.03	2.00	3.08	4.44	6.24	8.66	11.85	15.98	21.23	27.75
Case 34	1.01	1.92	2.96	5.66	9.63	14.34	21.65	26.77	31.90	34.00
Case 35	0.93	1.78	2.75	4.90	8.01	11.77	17.46	21.92	26.67	29.69
Case 36	1.00	1.90	2.93	5.44	9.09	13.47	20.19	25.12	30.19	32.78
Case 37	0.90	1.74	2.68	4.13	6.14	8.70	12.31	16.12	20.70	25.55
Case 38	0.93	1.80	2.77	4.28	6.36	9.02	12.75	16.71	21.45	26.46
Case 39	0.97	1.87	2.88	4.58	6.94	9.92	14.18	18.39	23.33	28.19
Case 40	1.04	2.00	3.08	5.33	8.55	12.48	18.36	23.22	28.53	32.42
Case 41	0.88	1.71	2.64	4.06	6.01	8.51	12.02	15.77	20.28	25.10
Case 42	0.91	1.75	2.70	4.25	6.41	9.14	13.03	16.94	21.56	26.19
Case 43	0.98	1.88	2.90	4.96	7.90	11.50	16.87	21.40	26.38	30.19
Case 44	1.13	2.14	3.31	6.03	9.97	14.71	21.96	27.43	33.15	36.40
Case 45	1.02	1.95	3.01	5.22	8.40	12.27	18.08	22.84	28.03	31.77
Case 46	1.03	1.97	3.03	5.35	8.68	12.72	18.82	23.69	28.92	32.44
Case 47	1.04	1.98	3.06	5.36	8.67	12.68	18.73	23.62	28.89	32.55
Case 48	1.12	2.12	3.28	5.98	9.91	14.62	21.83	27.26	32.92	36.12
Case 49	1.07	2.05	3.16	5.56	9.02	13.21	19.54	24.61	30.06	33.76
Case 50	0.97	1.86	2.87	4.73	7.36	10.62	15.40	19.74	24.67	28.99
Case 51	1.08	2.07	3.19	5.64	9.17	13.45	19.91	25.05	30.56	34.22
Case 52	0.88	1.69	2.60	4.49	7.20	10.51	15.47	19.57	24.04	27.33
Case 53	1.19	2.24	3.45	7.02	12.29	18.48	28.24	34.54	40.56	41.81
Case 54	0.99	1.89	2.92	5.32	8.80	12.98	19.37	24.20	29.24	32.12
Case 55	1.09	2.06	3.18	6.22	10.69	15.97	24.22	29.83	35.36	37.24
Case 56	1.00	1.91	2.94	5.01	7.95	11.56	16.93	21.50	26.57	30.53
Case 57	0.96	1.88	2.89	4.17	5.87	8.14	11.13	15.02	19.95	26.08
Case 58	1.04	2.01	3.10	4.58	6.56	9.16	12.68	16.93	22.23	28.50
Case 59	1.15	2.19	3.37	6.38	10.78	16.02	24.13	29.90	35.75	38.37
Case 60	1.27	2.38	3.67	7.56	13.31	20.05	30.71	37.49	43.90	44.97
Case 61	1.06	2.07	3.19	4.73	6.81	9.54	13.26	17.64	23.08	29.42
Case 62	1.21	2.35	3.63	5.23	7.36	10.20	13.96	18.83	25.01	32.69
Case 63	1.10	2.11	3.25	5.64	9.08	13.26	19.55	24.69	30.29	34.30
Case 64	0.94	1.83	2.82	4.07	5.72	7.93	10.85	14.64	19.44	25.42
Case 65	1.05	2.03	3.12	4.90	7.36	10.48	14.92	19.44	24.79	30.23
Case 66	1.21	2.35	3.62	5.21	7.33	10.17	13.91	18.77	24.92	32.58
Case 67	1.14	2.17	3.34	6.03	9.92	14.61	21.75	27.23	33.01	36.49
Case 68	0.96	1.86	2.87	4.13	5.81	8.06	11.03	14.89	19.77	25.84
Case 69	0.91	1.77	2.73	3.94	5.54	7.68	10.51	14.17	18.82	24.61
Case 70	1.02	1.98	3.05	4.58	6.66	9.36	13.08	17.32	22.53	28.44
Case 71	1.03	1.99	3.07	4.56	6.58	9.22	12.82	17.06	22.30	28.39
Case 72	0.93	1.81	2.79	4.22	6.15	8.67	12.14	16.04	20.81	26.16
Case 73	1.03	1.99	3.07	4.87	7.39	10.57	15.12	19.61	24.86	30.01
Case 74	0.99	1.91	2.94	4.53	6.72	9.53	13.46	17.65	22.68	28.03
Case 75	0.97	1.86	2.87	4.98	8.01	11.70	17.24	21.79	26.73	30.30
Case 76	0.98	1.88	2.90	4.85	7.61	11.03	16.07	20.51	25.49	29.63
Case 77	0.99	1.90	2.93	4.94	7.78	11.29	16.47	20.98	26.03	30.15
Case 78	1.01	1.94	2.99	5.16	8.25	12.03	17.67	22.38	27.54	31.38
Case 79	0.86	1.67	2.57	3.70	5.21	7.22	9.88	13.33	17.71	23.15
Case 80	0.89	1.73	2.66	3.84	5.40	7.49	10.24	13.82	18.35	23.99
Case 81	0.91	1.76	2.72	3.92	5.51	7.64	10.45	14.10	18.72	24.47
Case 82	0.87	1.69	2.60	3.92	5.72	8.06	11.28	14.91	19.35	24.34
Case 83	0.94	1.78	2.74	5.15	8.67	12.87	19.34	24.01	28.75	30.99
Case 84	0.96	1.88	2.89	4.17	5.86	8.13	11.12	15.00	19.93	26.05
Case 85	1.01	1.95	3.01	4.76	7.19	10.26	14.64	19.02	24.18	29.32
Case 86	1.00	1.94	2.99	4.54	6.66	9.39	13.19	17.39	22.50	28.15
Case 87	0.72	1.41	2.17	3.13	4.40	6.10	8.35	11.26	14.96	19.55
Case 88	0.81	1.57	2.42	3.49	4.90	6.80	9.30	12.55	16.67	21.78
Case 89	0.85	1.66	2.55	3.68	5.17	7.17	9.82	13.25	17.59	23.00
Case 90	0.88	1.69	2.61	4.22	6.48	9.32	13.41	17.29	21.77	25.93
Case 91	0.90	1.73	2.67	4.33	6.65	9.57	13.79	17.76	22.33	26.55
Case 92	0.86	1.65	2.55	4.02	6.06	8.65	12.33	16.04	20.39	24.75
Case 93	0.96	1.84	2.84	4.97	8.02	11.74	17.32	21.85	26.75	30.18
Case 94	0.93	1.78	2.74	4.66	7.38	10.73	15.71	19.97	24.68	28.40
Case 95	0.96	1.84	2.84	4.77	7.50	10.87	15.84	20.21	25.09	29.12
Case 96	1.04	1.98	3.05	5.51	9.06	13.35	19.87	24.88	30.15	33.32
Case 97	0.91	1.75	2.69	4.54	7.16	10.39	15.18	19.33	23.96	27.70
Case 98	1.04	1.98	3.05	5.50	9.05	13.33	19.85	24.85	30.12	33.29
Case 99	1.03	2.01	3.10	4.46	6.28	8.70	11.91	16.07	21.34	27.89
Case 100	0.90	1.75	2.70	3.89	5.47	7.59	10.38	14.01	18.61	24.32
Case 101	1.25	2.43	3.74	5.40	7.59	10.53	14.40	19.43	25.81	33.74

Day by day cage maximum NH3										
Case Name	1	2	3	4	5	6	7	8	9	10
Basecase	1.67	3.17	4.89	9.19	15.47	22.96	34.53	42.84	51.32	55.30
Case 02	1.29	2.51	3.87	5.87	8.61	12.14	17.05	22.48	29.08	36.39
Case 03	1.34	2.61	4.03	5.81	8.16	11.32	15.50	20.90	27.76	36.29
Case 04	1.20	2.32	3.58	5.62	8.45	12.03	17.13	22.31	28.44	34.67
Case 05	1.22	2.36	3.64	5.67	8.46	12.03	17.07	22.30	28.53	34.99
Case 06	1.38	2.68	4.13	5.95	8.37	11.60	15.88	21.42	28.44	37.18
Case 07	1.80	3.43	5.28	9.79	16.35	24.20	36.26	45.13	54.28	59.00
Case 08	1.39	2.67	4.12	6.81	10.62	15.34	22.26	28.50	35.57	41.68
Case 09	1.52	2.97	4.57	6.59	9.27	12.86	17.60	23.74	31.53	41.21
Case 10	1.67	3.24	5.00	7.47	10.83	15.20	21.20	28.12	36.65	46.42
Case 11	1.53	2.94	4.53	7.43	11.51	16.59	24.01	30.82	38.60	45.52
Case 12	1.59	3.06	4.72	7.75	12.02	17.33	25.09	32.20	40.30	47.47
Case 13	1.60	3.04	4.68	8.69	14.52	21.50	32.23	40.10	48.21	52.37
Case 14	1.38	2.65	4.09	6.88	10.84	15.72	22.94	29.23	36.26	41.99
Case 15	1.67	3.24	5.00	7.47	10.83	15.20	21.20	28.12	36.65	46.42
Case 16	1.65	3.16	4.88	8.13	12.74	18.43	26.82	34.26	42.65	49.71
Case 17	1.30	2.49	3.84	6.40	10.01	14.49	21.07	26.93	33.54	39.13
Case 18	1.28	2.47	3.80	6.28	9.78	14.12	20.48	26.24	32.77	38.44
Case 19	1.24	2.38	3.67	6.29	10.04	14.63	21.46	27.21	33.53	38.34
Case 20	1.23	2.38	3.67	5.74	8.60	12.25	17.41	22.70	28.98	35.42
Case 21	1.35	2.59	3.99	6.69	10.52	15.24	22.22	28.34	35.20	40.85
Case 22	1.37	2.66	4.09	5.94	8.41	11.69	16.06	21.59	28.57	37.11
Case 23	1.33	2.58	3.98	5.74	8.07	11.19	15.32	20.67	27.45	35.88
Case 24	1.57	3.06	4.72	6.80	9.56	13.26	18.14	24.47	32.50	42.49
Case 25	2.15	3.99	6.15	14.47	27.02	41.42	64.81	77.66	88.51	84.85
Case 26	2.73	4.90	7.55	22.42	45.23	70.83	113.63	133.21	146.85	128.57
Case 27	2.51	4.61	7.11	17.70	33.74	52.03	81.98	97.63	110.26	103.19
Case 28	1.41	2.74	4.22	6.08	8.56	11.86	16.24	21.90	29.09	38.02
Case 29	1.33	2.59	3.99	5.75	8.08	11.21	15.34	20.70	27.49	35.93
Case 30	1.34	2.61	4.02	5.79	8.15	11.30	15.47	20.86	27.71	36.22
Case 31	1.48	2.87	4.43	6.52	9.33	13.03	18.02	24.08	31.63	40.61
Case 32	1.45	2.82	4.35	6.27	8.82	12.23	16.74	22.59	30.00	39.21
Case 33	1.63	3.17	4.89	7.05	9.91	13.74	18.81	25.37	33.69	44.04
Case 34	1.44	2.72	4.20	8.03	13.66	20.34	30.71	37.96	45.24	48.23
Case 35	1.43	2.72	4.20	7.49	12.24	17.99	26.70	33.51	40.76	45.38
Case 36	1.38	2.63	4.05	7.51	12.56	18.60	27.88	34.69	41.70	45.28
Case 37	1.17	2.27	3.50	5.41	8.03	11.38	16.10	21.09	27.08	33.42
Case 38	1.39	2.70	4.16	6.42	9.54	13.54	19.15	25.08	32.19	39.73
Case 39	1.41	2.72	4.19	6.65	10.08	14.40	20.59	26.72	33.89	40.94
Case 40	1.47	2.81	4.34	7.50	12.02	17.55	25.82	32.66	40.12	45.60
Case 41	1.25	2.41	3.71	5.72	8.47	11.99	16.93	22.21	28.56	35.36
Case 42	1.33	2.57	3.96	6.23	9.40	13.40	19.11	24.86	31.63	38.42
Case 43	1.28	2.46	3.79	6.49	10.34	15.06	22.09	28.02	34.54	39.52
Case 44	1.45	2.77	4.26	7.77	12.86	18.98	28.33	35.38	42.75	46.95
Case 45	1.42	2.71	4.18	7.26	11.68	17.06	25.13	31.76	38.96	44.16
Case 46	1.45	2.78	4.28	7.56	12.26	17.97	26.60	33.48	40.87	45.84
Case 47	1.48	2.84	4.38	7.67	12.40	18.15	26.80	33.79	41.34	46.57
Case 48	1.44	2.75	4.24	7.73	12.81	18.91	28.23	35.25	42.58	46.71
Case 49	1.42	2.72	4.19	7.37	11.95	17.51	25.89	32.60	39.82	44.72
Case 50	1.36	2.63	4.05	6.67	10.37	14.97	21.70	27.81	34.76	40.85
Case 51	1.44	2.74	4.23	7.48	12.15	17.82	26.39	33.19	40.49	45.34
Case 52	1.39	2.66	4.09	7.08	11.35	16.56	24.37	30.83	37.88	43.05
Case 53	1.52	2.86	4.41	8.96	15.70	23.61	36.08	44.13	51.82	53.41
Case 54	1.42	2.71	4.18	7.61	12.60	18.59	27.75	34.66	41.88	46.00
Case 55	1.40	2.66	4.09	8.00	13.75	20.55	31.16	38.38	45.49	47.92
Case 56	1.36	2.60	4.01	6.82	10.84	15.76	23.07	29.31	36.21	41.61
Case 57	1.43	2.77	4.28	6.17	8.67	12.02	16.46	22.20	29.48	38.54
Case 58	1.50	2.90	4.48	6.60	9.45	13.21	18.29	24.42	32.05	41.10
Case 59	1.46	2.77	4.27	8.09	13.66	20.30	30.57	37.89	45.30	48.62
Case 60	1.58	2.96	4.57	9.40	16.57	24.95	38.22	46.66	54.63	55.95
Case 61	1.47	2.86	4.41	6.54	9.42	13.20	18.33	24.40	31.92	40.69
Case 62	1.76	3.43	5.29	7.62	10.72	14.86	20.34	27.44	36.44	47.64
Case 63	1.80	3.44	5.31	9.23	14.84	21.69	31.96	40.37	49.52	56.09
Case 64	1.36	2.65	4.09	5.89	8.28	11.48	15.71	21.20	28.15	36.80
Case 65	1.65	3.19	4.91	7.70	11.57	16.49	23.46	30.57	38.97	47.53
Case 66	1.80	3.51	5.41	7.80	10.97	15.21	20.82	28.08	37.30	48.76
Case 67	1.81	3.45	5.31	9.58	15.76	23.20	34.53	43.24	52.41	57.95
Case 68	1.51	2.93	4.52	6.52	9.17	12.71	17.40	23.47	31.17	40.75
Case 69	1.34	2.61	4.03	5.81	8.17	11.33	15.50	20.91	27.77	36.30
Case 70	1.43	2.77	4.28	6.42	9.33	13.12	18.33	24.28	31.58	39.88
Case 71	1.40	2.72	4.19	6.22	8.97	12.58	17.48	23.26	30.40	38.70
Case 72	1.39	2.69	4.15	6.27	9.16	12.90	18.06	23.87	30.96	38.92
Case 73	1.42	2.73	4.22	6.70	10.16	14.53	20.78	26.95	34.17	41.25
Case 74	1.38	2.66	4.11	6.33	9.39	13.31	18.81	24.66	31.69	39.17
Case 75	1.39	2.65	4.09	7.10	11.42	16.69	24.58	31.06	38.11	43.20
Case 76	1.28	2.46	3.80	6.36	9.98	14.46	21.07	26.89	33.42	38.85
Case 77	1.40	2.68	4.14	6.96	10.97	15.91	23.22	29.59	36.70	42.51
Case 78	1.39	2.66	4.10	7.05	11.28	16.45	24.17	30.61	37.66	42.92
Case 79	1.22	2.38	3.67	5.30	7.45	10.33	14.13	19.07	25.32	33.10
Case 80	1.40	2.72	4.19	6.05	8.50	11.79	16.14	21.77	28.91	37.79
Case 81	1.41	2.75	4.24	6.12	8.60	11.93	16.33	22.03	29.25	38.24
Case 82	1.46	2.83	4.36	6.58	9.59	13.51	18.91	25.00	32.45	40.81
Case 83	1.61	3.06	4.72	8.87	14.92	22.15	33.31	41.33	49.50	53.35
Case 84	1.54	3.00	4.62	6.67	9.37	13.00	17.79	24.00	31.87	41.66
Case 85	1.49	2.87	4.43	7.00	10.57	15.09	21.54	27.99	35.58	43.14
Case 86	1.70	3.29	5.07	7.70	11.28	15.92	22.35	29.47	38.13	47.71
Case 87	1.37	2.67	4.12	5.93	8.34	11.57	15.84	21.36	28.37	37.09
Case 88	1.31	2.55	3.93	5.66	7.96	11.04	15.10	20.37	27.06	35.37
Case 89	1.35	2.63	4.05	5.85	8.22	11.40	15.60	21.04	27.95	36.53
Case 90	1.32	2.54	3.92	6.34	9.73	13.98	20.13	25.96	32.68	38.92
Case 91	1.39	2.68	4.12	6.69	10.29	14.79	21.32	27.47	34.54	41.07
Case 92	1.26	2.43	3.75	5.92	8.93	12.74	18.18	23.63	30.06	36.48
Case 93	1.47	2.81	4.34	7.58	12.24	17.91	26.44	33.35	40.83	46.07
Case 94	1.44	2.77	4.27	7.24	11.49	16.70	24.44	31.06	38.40	44.18
Case 95	1.47	2.81	4.34	7.28	11.44	16.59	24.18	30.84	38.30	44.45
Case 96	1.47	2.80	4.31	7.78	12.80	18.85	28.06	35.12	42.57	47.05
Case 97	1.52	2.92	4.50	7.59	11.98	17.39	25.38	32.33	40.07	46.34
Case 98	1.44	2.74	4.23	7.64	12.56	18.50	27.54	34.48	41.79	46.19
Case 99	1.54	3.00	4.62	6.66	9.36	12.98	17.76	23.96	31.82	41.60
Case 100	1.72	3.35	5.16	7.43	10.46	14.50	19.84	26.77	35.55	46.47
Case 101	1.83	3.56	5.50	7.92	11.14	15.45	21.14	28.51	37.87	49.50

Table 3.04 Cage NH_3 Mean and Maximum Concentrations for 10 Days

	Day by day room breathing zone average NH3										Day by day room breathing zone maximum NH3									
Case Name	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
Basecase	0.02	0.04	0.06	0.08	0.11	0.16	0.22	0.29	0.39	0.51	0.07	0.14	0.21	0.31	0.43	0.60	0.83	1.11	1.48	1.93
Case 02	0.03	0.07	0.10	0.15	0.21	0.28	0.39	0.53	0.70	0.91	0.09	0.18	0.28	0.41	0.57	0.79	1.08	1.46	1.94	2.53
Case 03	0.03	0.06	0.10	0.14	0.20	0.28	0.38	0.52	0.69	0.90	0.09	0.17	0.27	0.38	0.54	0.75	1.02	1.38	1.83	2.39
Case 04	0.03	0.06	0.10	0.14	0.20	0.27	0.37	0.50	0.67	0.87	0.09	0.17	0.26	0.38	0.54	0.74	1.02	1.37	1.83	2.39
Case 05	0.03	0.05	0.08	0.11	0.16	0.22	0.30	0.40	0.53	0.69	0.08	0.16	0.24	0.35	0.49	0.67	0.92	1.24	1.65	2.16
Case 06	0.04	0.07	0.11	0.16	0.23	0.31	0.43	0.58	0.77	1.01	0.08	0.16	0.25	0.35	0.50	0.69	0.94	1.27	1.69	2.21
Case 07	0.03	0.06	0.09	0.13	0.18	0.25	0.34	0.46	0.61	0.80	0.19	0.38	0.58	0.83	1.17	1.63	2.23	3.00	3.99	5.21
Case 08	0.03	0.06	0.10	0.14	0.20	0.28	0.38	0.52	0.68	0.89	0.12	0.23	0.35	0.51	0.71	0.99	1.35	1.82	2.42	3.16
Case 09	0.05	0.09	0.14	0.20	0.28	0.38	0.53	0.71	0.94	1.23	0.14	0.28	0.43	0.62	0.88	1.21	1.66	2.24	2.98	3.89
Case 10	0.02	0.03	0.05	0.07	0.09	0.13	0.18	0.24	0.31	0.41	0.08	0.16	0.25	0.36	0.50	0.69	0.95	1.28	1.70	2.22
Case 11	0.02	0.05	0.07	0.11	0.15	0.21	0.29	0.39	0.51	0.67	0.12	0.23	0.35	0.50	0.70	0.98	1.34	1.80	2.39	3.13
Case 12	0.01	0.02	0.03	0.04	0.05	0.07	0.10	0.14	0.18	0.24	0.12	0.23	0.36	0.52	0.73	1.01	1.39	1.87	2.48	3.25
Case 13	0.02	0.04	0.06	0.08	0.12	0.16	0.22	0.30	0.39	0.52	0.15	0.28	0.44	0.63	0.89	1.23	1.69	2.27	3.02	3.95
Case 14	0.03	0.05	0.08	0.12	0.16	0.23	0.31	0.42	0.56	0.73	0.11	0.22	0.34	0.49	0.70	0.96	1.32	1.78	2.36	3.09
Case 15	0.02	0.05	0.07	0.11	0.15	0.21	0.29	0.39	0.52	0.67	0.16	0.31	0.48	0.69	0.97	1.34	1.83	2.48	3.29	4.30
Case 16	0.02	0.04	0.06	0.08	0.12	0.16	0.22	0.30	0.39	0.52	0.13	0.25	0.39	0.57	0.80	1.10	1.51	2.04	2.70	3.53
Case 17	0.04	0.08	0.12	0.17	0.25	0.34	0.47	0.63	0.83	1.09	0.09	0.18	0.28	0.41	0.57	0.79	1.08	1.46	1.94	2.54
Case 18	0.04	0.08	0.12	0.18	0.25	0.35	0.47	0.64	0.85	1.11	0.09	0.18	0.28	0.41	0.57	0.80	1.09	1.47	1.95	2.55
Case 19	0.03	0.06	0.09	0.13	0.19	0.26	0.35	0.48	0.63	0.83	0.12	0.22	0.35	0.50	0.70	0.97	1.33	1.80	2.39	3.12
Case 20	0.04	0.08	0.12	0.17	0.24	0.33	0.45	0.61	0.80	1.05	0.09	0.18	0.27	0.39	0.55	0.76	1.05	1.41	1.87	2.45
Case 21	0.03	0.06	0.10	0.14	0.20	0.27	0.37	0.50	0.67	0.87	0.10	0.19	0.29	0.42	0.59	0.82	1.12	1.51	2.00	2.62
Case 22	0.03	0.06	0.10	0.14	0.19	0.27	0.37	0.49	0.66	0.86	0.11	0.22	0.34	0.49	0.69	0.95	1.30	1.75	2.33	3.04
Case 23	0.03	0.06	0.10	0.14	0.20	0.28	0.38	0.51	0.68	0.89	0.09	0.18	0.28	0.41	0.57	0.79	1.08	1.46	1.94	2.54
Case 24	0.04	0.08	0.13	0.18	0.26	0.36	0.49	0.66	0.88	1.15	0.22	0.43	0.67	0.96	1.35	1.87	2.56	3.46	4.59	6.00
Case 25	0.03	0.06	0.09	0.14	0.19	0.26	0.36	0.49	0.65	0.85	0.12	0.24	0.36	0.52	0.74	1.02	1.40	1.88	2.50	3.27
Case 26	0.02	0.04	0.05	0.10	0.18	0.26	0.40	0.49	0.59	0.62	0.08	0.15	0.23	0.45	0.76	1.13	1.71	2.12	2.52	2.68
Case 27	0.03	0.06	0.10	0.15	0.21	0.30	0.42	0.56	0.72	0.90	0.12	0.24	0.37	0.57	0.83	1.18	1.65	2.18	2.81	3.51
Case 28	0.06	0.11	0.18	0.25	0.36	0.50	0.68	0.92	1.22	1.59	0.16	0.31	0.48	0.69	0.97	1.35	1.84	2.48	3.30	4.31
Case 29	0.07	0.14	0.22	0.32	0.44	0.62	0.84	1.14	1.51	1.97	0.14	0.27	0.42	0.60	0.85	1.17	1.60	2.16	2.88	3.76
Case 30	0.03	0.06	0.10	0.14	0.20	0.28	0.38	0.52	0.68	0.89	0.13	0.25	0.39	0.57	0.80	1.10	1.51	2.04	2.71	3.54
Case 31	0.06	0.11	0.17	0.24	0.34	0.47	0.64	0.86	1.15	1.50	0.16	0.32	0.49	0.71	1.00	1.38	1.89	2.55	3.39	4.43
Case 32	0.06	0.13	0.19	0.28	0.39	0.55	0.75	1.01	1.34	1.75	0.18	0.34	0.53	0.76	1.07	1.48	2.02	2.73	3.63	4.74
Case 33	0.07	0.14	0.22	0.32	0.45	0.63	0.86	1.16	1.54	2.01	0.22	0.44	0.67	0.97	1.37	1.90	2.60	3.50	4.65	6.08
Case 34	0.07	0.14	0.21	0.31	0.43	0.60	0.82	1.10	1.46	1.91	0.17	0.32	0.50	0.71	1.01	1.39	1.91	2.57	3.42	4.47
Case 35	0.06	0.12	0.19	0.27	0.39	0.54	0.73	0.99	1.31	1.72	0.15	0.29	0.45	0.65	0.92	1.28	1.75	2.36	3.13	4.09
Case 36	0.07	0.14	0.21	0.30	0.42	0.59	0.80	1.08	1.44	1.88	0.16	0.31	0.47	0.68	0.96	1.33	1.82	2.46	3.26	4.27
Case 37	0.03	0.06	0.09	0.13	0.19	0.26	0.35	0.47	0.63	0.82	0.09	0.18	0.28	0.40	0.56	0.78	1.07	1.44	1.92	2.51
Case 38	0.03	0.06	0.10	0.14	0.20	0.27	0.37	0.50	0.67	0.88	0.10	0.20	0.31	0.44	0.62	0.86	1.18	1.59	2.12	2.77
Case 39	0.04	0.07	0.11	0.16	0.22	0.31	0.43	0.58	0.76	1.00	0.13	0.25	0.39	0.56	0.79	1.09	1.50	2.02	2.68	3.51
Case 40	0.01	0.02	0.03	0.05	0.07	0.09	0.13	0.17	0.23	0.30	0.04	0.09	0.13	0.19	0.27	0.37	0.51	0.69	0.92	1.20
Case 41	0.03	0.05	0.08	0.11	0.16	0.22	0.30	0.41	0.55	0.71	0.07	0.14	0.22	0.31	0.44	0.61	0.84	1.13	1.50	1.97
Case 42	0.03	0.06	0.10	0.14	0.20	0.28	0.38	0.51	0.68	0.89	0.10	0.19	0.30	0.43	0.60	0.83	1.14	1.53	2.03	2.66
Case 43	0.03	0.07	0.10	0.15	0.21	0.29	0.39	0.53	0.70	0.91	0.09	0.17	0.26	0.37	0.52	0.72	0.98	1.32	1.76	2.30
Case 44	0.04	0.07	0.11	0.17	0.23	0.32	0.44	0.60	0.79	1.04	0.12	0.24	0.37	0.53	0.75	1.04	1.42	1.92	2.55	3.33
Case 45	0.03	0.05	0.08	0.12	0.17	0.23	0.31	0.42	0.56	0.74	0.13	0.25	0.38	0.55	0.78	1.08	1.48	1.99	2.64	3.46
Case 46	0.02	0.04	0.07	0.10	0.14	0.19	0.26	0.35	0.47	0.61	0.10	0.20	0.31	0.45	0.63	0.88	1.20	1.62	2.15	2.81
Case 47	0.02	0.04	0.06	0.09	0.13	0.17	0.24	0.32	0.43	0.56	0.09	0.18	0.27	0.40	0.56	0.77	1.06	1.43	1.89	2.48
Case 48	0.03	0.07	0.10	0.15	0.20	0.28	0.39	0.52	0.69	0.91	0.16	0.31	0.47	0.68	0.95	1.32	1.81	2.44	3.25	4.24
Case 49	0.03	0.05	0.08	0.12	0.16	0.23	0.31	0.42	0.56	0.73	0.13	0.25	0.38	0.55	0.78	1.08	1.48	2.00	2.65	3.47
Case 50	0.03	0.06	0.09	0.12	0.17	0.24	0.33	0.44	0.59	0.77	0.10	0.20	0.31	0.44	0.62	0.87	1.19	1.60	2.12	2.78
Case 51	0.03	0.07	0.10	0.15	0.21	0.29	0.40	0.54	0.72	0.94	0.12	0.23	0.36	0.52	0.72	1.00	1.37	1.85	2.46	3.22
Case 52	0.03	0.07	0.10	0.15	0.21	0.28	0.39	0.53	0.70	0.91	0.19	0.37	0.57	0.82	1.15	1.59	2.18	2.94	3.90	5.10
Case 53	0.03	0.06	0.09	0.13	0.18	0.26	0.35	0.47	0.63	0.82	0.09	0.17	0.26	0.38	0.53	0.74	1.01	1.36	1.81	2.36
Case 54	0.03	0.06	0.09	0.13	0.19	0.26	0.36	0.49	0.64	0.84	0.15	0.29	0.44	0.64	0.90	1.24	1.70	2.30	3.05	3.98
Case 55	0.03	0.06	0.09	0.13	0.18	0.25	0.34	0.46	0.61	0.80	0.13	0.24	0.38	0.54	0.76	1.06	1.45	1.95	2.59	3.39
Case 56	0.04	0.07	0.11	0.16	0.22	0.30	0.42	0.56	0.74	0.97	0.08	0.16	0.25	0.35	0.50	0.69	0.94	1.27	1.69	2.21
Case 57	0.03	0.06	0.09	0.13	0.18	0.25	0.34	0.46	0.62	0.81	0.15	0.28	0.44	0.63	0.88	1.22	1.68	2.26	3.00	3.92
Case 58	0.04	0.07	0.11	0.15	0.21	0.30	0.41	0.55	0.73	0.95	0.13	0.26	0.40	0.57	0.80	1.11	1.52	2.05	2.73	3.57
Case 59	0.01	0.01	0.02	0.03	0.05	0.06	0.09	0.12	0.16	0.21	0.05	0.09	0.14	0.20	0.29	0.40	0.54	0.73	0.97	1.27
Case 60	0.03	0.06	0.09	0.13	0.18	0.25	0.34	0.46	0.61	0.80	0.09	0.18	0.27	0.39	0.55	0.76	1.05	1.41	1.87	2.45
Case 61	0.04	0.07	0.11	0.15	0.22	0.30	0.41	0.56	0.74	0.97	0.16	0.31	0.48	0.70	0.98	1.36	1.86	2.51	3.33	4.36
Case 62	0.18	0.35	0.53	0.77	1.08	1.50	2.05	2.77	3.68	4.81	0.47	0.91	1.40	2.02	2.84	3.94	5.39	7.27	9.65	12.61
Case 63	0.11	0.22	0.34	0.48	0.68	0.94	1.29	1.74	2.31	3.02	0.34	0.66	1.01	1.46	2.06	2.85	3.90	5.26	6.99	9.13
Case 64	0.05	0.09	0.15	0.21	0.29	0.41	0.56	0.75	1.00	1.31	0.17	0.33	0.51	0.73	1.02	1.42	1.94	2.62	3.48	4.55
Case 65	0.07	0.14	0.21	0.30	0.42	0.59	0.80	1.08	1.44	1.88	0.17	0.32	0.50	0.72	1.02	1.41	1.93	2.60	3.45	4.51
Case 66	0.17	0.32	0.50	0.72	1.01	1.40	1.91	2.58	3.42	4.47	0.43	0.83	1.28	1.84	2.59	3.59	4.91	6.63	8.81	11.51
Case 67	0.10	0.20	0.31	0.45	0.64	0.88	1.21	1.63	2.16	2.83	0.32	0.63	0.97	1.40	1.97	2.73	3.74	5.05	6.70	8.76
Case 68	0.05	0.09	0.15	0.21	0.29	0.41	0.56	0.75	1.00	1.31	0.14	0.26	0.41	0.59	0.83	1.15	1.57	2.12	2.81	3.68
Case 69	0.03	0.05	0.08	0.12	0.16	0.22	0.31	0.41	0.55	0.72	0.14	0.26	0.41	0.59	0.82	1.14	1.56	2.11	2.80	3.66
Case 70	0.01	0.02	0.04	0.05	0.08	0.10	0.14	0.19	0.26	0.34	0.06	0.12	0.19	0.27	0.39	0.54	0.73	0.99	1.31	1.72
Case 71	0.03	0.05	0.08	0.12	0.16	0.23	0.31	0.42	0.55	0.72	0.16	0.31	0.48	0.69	0.97	1.34	1.83	2.47	3.28	4.29
Case 72	0.02	0.05	0.07	0.11	0.15	0.21	0.29	0.39	0.52	0.68	0.13	0.26	0.40	0.57	0.80	1.11	1.52	2.05	2.73	3.56
Case 73	0.02	0.04	0.06	0.08	0.12	0.16	0.22	0.30	0.40	0.52	0.08	0.15	0.23	0.33	0.46	0.64	0.87	1.18	1.57	2.05
Case 74	0.02	0.05	0.07	0.11	0.15	0.21	0.29	0.39	0.51	0.67	0.13	0.25	0.39	0.56	0.78	1.08	1.48	2.00	2.66	3.48
Case 75	0.02	0.05	0.07	0.11	0.15	0.21	0.29	0.39	0.51	0.67	0.13	0.25	0.39	0.56	0.78	1.08	1.48	2.00	2.66	3.48
Case 76	0.03	0.06	0.09	0.12	0.17	0.24	0.33	0.45	0.59	0.78	0.12	0.24	0.37	0.53	0.75	1.04	1.42	1.91	2.54	3.32
Case 77	0.03	0.05	0.08	0.11	0.16	0.22	0.30	0.41	0.54	0.71	0.10	0.19	0.30	0.43	0.60	0.84	1.14	1.54	2.05	2.68
Case 78	0.03	0.06	0.09	0.12	0.17	0.24	0.33	0.45	0.59	0.78	0.11	0.21	0.33	0.48	0.67	0.93	1.27	1.71	2.28	2.98
Case 79	0.04	0.08	0.13	0.18	0.26	0.36	0.49	0.66	0.87	1.14	0.10	0.20	0.30	0.44	0.62	0.86	1.17	1.58	2.10	2.74
Case 80	0.05	0.09	0.14	0.20	0.29	0.40	0.54	0.73	0.97	1.27	0.11	0.21	0.32	0.47	0.65	0.91	1.24	1.68	2.23	2.91
Case 81	0.05	0.09	0.14	0.20	0.28	0.39	0.54	0.72	0.96	1.25	0.14	0.28	0.43	0.63	0.88	1.22	1.67	2.25	2.99	3.91
Case 82	0.06	0.12	0.18	0.26	0.37	0.51	0.70	0.94	1.25	1.63	0.17	0.34	0.52	0.75	1.05	1.46	2.00	2.69	3.58	4.67
Case 83	0.09	0.17	0.26	0.38	0.53	0.73	1.00	1.35	1.79	2.34	0.21	0.41	0.63	0.91	1.27	1.77	2.42	3.26	4.33	5.67
Case 84	0.08	0.15	0.24	0.34	0.48	0.67	0.91	1.23	1.64	2.14	0.20	0.38	0.59	0.85	1.20	1.67	2.28	3.07	4.08	5.34
Case 85	0.07	0.13	0.21	0.30	0.42	0.58	0.79	1.07	1.42	1.86	0.23	0.45	0.69	1.00	1.41	1.95	2.67	3.60	4.78	6.25
Case 86	0.06	0.13	0.19	0.28	0.39	0.55	0.75	1.01	1.34	1.75	0.19	0.38	0.58	0.84	1.18	1.64	2.24	3.03	4.02	5.26
Case 87	0.02	0.05	0.07	0.10	0.14	0.20	0.27	0.36	0.48	0.63	0.07	0.14	0.21	0.30	0.42	0.59	0.81	1.09	1.44	1.89
Case 88	0.02	0.05	0.07	0.11	0.15	0.21	0.29	0.39	0.51	0.67	0.04	0.09	0.13	0.19	0.27	0.38	0.51	0.69	0.92	1.21
Case 89	0.03	0.06	0.10	0.14	0.20	0.27	0.37	0.50	0.67	0.87	0.11	0.22	0.34	0.49	0.69	0.95	1.30	1.75	2.33	3.04
Case 90	0.04	0.07	0.11	0.16	0.23	0.31	0.43	0.58	0.77	1.01	0.15	0.28	0.44	0.63	0.88	1.22	1.68	2.26	3.00	3.92
Case 91	0.03	0.06	0.09	0.13	0.18	0.25	0.34	0.46	0.61	0.80	0.10	0.19	0.29	0.41	0.58	0.80	1.10	1.48	1.97	2.57
Case 92	0.02	0.04	0.06	0.09	0.13	0.18	0.25	0.33	0.44	0.58	0.08	0.15	0.24	0.34	0.48	0.66	0.90	1.22	1.62	2.12
Case 93	0.04	0.09	0.13	0.19	0.27	0.38	0.52	0.70	0.93	1.21	0.19	0.37	0.56	0.81	1.14	1.58	2.17	2.92	3.88	5.08
Case 94	0.06	0.12	0.18	0.26	0.37	0.51	0.70	0.95	1.26	1.64	0.17	0.33	0.51	0.74	1.04	1.44	1.97	2.66	3.53	4.62
Case 95	0.04	0.07	0.11	0.16	0.22	0.30	0.42	0.56	0.75	0.98	0.15	0.28	0.44	0.63	0.89	1.23	1.69	2.27	3.02	3.95
Case 96	0.05	0.10	0.16	0.22	0.32	0.44	0.60	0.81	1.07	1.40	0.15	0.28	0.44	0.63	0.89	1.23	1.68	2.27	3.01	3.94
Case 97	0.06	0.11	0.17	0.25	0.35	0.49	0.67	0.90	1.20	1.56	0.15	0.30	0.46	0.66	0.93	1.29	1.76	2.38	3.16	4.13
Case 98	0.04	0.08	0.13	0.19	0.26	0.37	0.50	0.68	0.90	1.17	0.17	0.34	0.52	0.75	1.06	1.46	2.00	2.70	3.59	4.69
Case 99	0.01	0.03	0.04	0.06	0.09	0.12	0.16	0.22	0.29	0.38	0.06	0.12	0.19	0.28	0.39	0.54	0.74	1.00	1.33	1.73
Case 100	0.02	0.04	0.06	0.09	0.13	0.18	0.24	0.32	0.43	0.56	0.10	0.19	0.30	0.43	0.61	0.84	1.16	1.56	2.07	2.71
Case 101	0.15	0.29	0.44	0.64	0.90	1.25	1.71	2.30	3.06	4.00	0.41	0.80	1.24	1.78	2.51	3.48	4.76	6.42	8.53	11.15

Table 3.05 Room NH_3 Concentrations for 10 Days with Increased Cage Temperature

	Day by day cage average NH_3										Day by day cage maximum NH_3									
Case Name	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
Basecase	1.12	2.18	3.37	4.85	6.83	9.47	12.96	17.48	23.21	30.34	1.63	3.17	4.89	7.05	9.91	13.74	18.81	25.37	33.70	44.05
Case 02	0.89	1.72	2.66	3.83	5.39	7.47	10.22	13.79	18.31	23.94	1.29	2.51	3.87	5.57	7.84	10.87	14.87	20.06	26.65	34.83
Case 03	0.82	1.59	2.45	3.53	4.96	6.88	9.41	12.70	16.87	22.05	1.34	2.61	4.03	5.81	8.16	11.32	15.50	20.90	27.76	36.29
Case 04	0.89	1.73	2.67	3.84	5.40	7.49	10.26	13.84	18.38	24.02	1.19	2.32	3.58	5.16	7.26	10.07	13.78	18.59	24.69	32.27
Case 05	0.91	1.76	2.72	3.92	5.51	7.64	10.46	14.11	18.74	24.50	1.21	2.36	3.64	5.25	7.38	10.23	14.00	18.89	25.09	32.80
Case 06	0.86	1.67	2.58	3.72	5.22	7.24	9.92	13.37	17.76	23.22	1.38	2.68	4.13	5.95	8.37	11.60	15.88	21.42	28.44	37.18
Case 07	1.21	2.35	3.62	5.22	7.34	10.18	13.94	18.80	24.97	32.63	1.76	3.43	5.28	7.61	10.71	14.85	20.32	27.41	36.40	47.59
Case 08	0.97	1.89	2.92	4.21	5.92	8.21	11.23	15.15	20.12	26.30	1.37	2.67	4.12	5.93	8.34	11.57	15.83	21.36	28.37	37.08
Case 09	0.90	1.75	2.69	3.88	5.46	7.57	10.36	13.97	18.55	24.25	1.52	2.97	4.57	6.59	9.27	12.86	17.60	23.74	31.53	41.21
Case 10	1.10	2.14	3.31	4.77	6.70	9.29	12.72	17.15	22.78	29.78	1.67	3.24	5.00	7.20	10.13	14.04	19.22	25.92	34.43	45.00
Case 11	1.10	2.14	3.30	4.76	6.70	9.29	12.71	17.15	22.78	29.77	1.51	2.94	4.53	6.53	9.18	12.73	17.43	23.51	31.22	40.81
Case 12	1.15	2.23	3.45	4.97	6.98	9.68	13.25	17.88	23.75	31.04	1.57	3.06	4.72	6.80	9.56	13.26	18.15	24.48	32.52	42.50
Case 13	1.30	2.52	3.89	5.60	7.88	10.93	14.95	20.17	26.79	35.02	1.56	3.04	4.68	6.75	9.49	13.16	18.01	24.30	32.27	42.19
Case 14	1.15	2.24	3.46	4.98	7.01	9.72	13.30	17.94	23.82	31.14	1.36	2.65	4.09	5.89	8.28	11.49	15.72	21.21	28.16	36.82
Case 15	1.10	2.14	3.31	4.77	6.70	9.29	12.72	17.15	22.78	29.78	1.67	3.24	5.00	7.20	10.13	14.04	19.22	25.92	34.43	45.00
Case 16	1.15	2.24	3.45	4.98	7.00	9.71	13.29	17.92	23.80	31.11	1.63	3.16	4.88	7.03	9.89	13.71	18.76	25.31	33.62	43.95
Case 17	0.94	1.84	2.83	4.08	5.74	7.96	10.89	14.69	19.52	25.51	1.28	2.49	3.84	5.54	7.79	10.81	14.79	19.95	26.49	34.63
Case 18	0.93	1.81	2.79	4.03	5.67	7.86	10.75	14.50	19.26	25.18	1.27	2.47	3.80	5.48	7.70	10.68	14.62	19.72	26.19	34.24
Case 19	0.90	1.75	2.69	3.88	5.46	7.57	10.36	13.97	18.56	24.26	1.22	2.38	3.67	5.29	7.44	10.32	14.13	19.06	25.31	33.08
Case 20	0.86	1.68	2.58	3.72	5.24	7.26	9.94	13.41	17.81	23.28	1.22	2.38	3.67	5.29	7.44	10.32	14.12	19.05	25.30	33.07
Case 21	0.94	1.83	2.82	4.07	5.72	7.93	10.85	14.64	19.44	25.42	1.33	2.59	3.99	5.75	8.08	11.21	15.34	20.69	27.48	35.92
Case 22	0.87	1.69	2.60	3.75	5.27	7.30	10.00	13.48	17.91	23.41	1.36	2.66	4.09	5.90	8.30	11.51	15.75	21.24	28.21	36.88
Case 23	0.86	1.67	2.58	3.71	5.22	7.24	9.91	13.37	17.76	23.22	1.33	2.58	3.98	5.74	8.07	11.19	15.32	20.67	27.45	35.88
Case 24	0.98	1.91	2.94	4.24	5.96	8.26	11.30	15.25	20.25	26.47	1.57	3.06	4.72	6.80	9.56	13.26	18.14	24.47	32.50	42.49
Case 25	1.56	3.04	4.69	6.77	9.51	13.19	18.05	24.35	32.35	42.28	2.05	3.99	6.15	8.86	12.46	17.28	23.64	31.89	42.36	55.37
Case 26	2.12	4.02	6.20	11.92	20.30	30.25	45.71	56.48	67.24	71.52	2.58	4.90	7.55	14.51	24.70	36.81	55.62	68.72	81.82	87.03
Case 27	1.66	3.21	4.95	7.53	11.06	15.62	21.95	28.91	37.36	46.66	2.38	4.61	7.11	10.82	15.90	22.45	31.55	41.57	53.72	67.08
Case 28	0.91	1.77	2.73	3.93	5.53	7.67	10.50	14.16	18.81	24.59	1.41	2.74	4.22	6.08	8.56	11.86	16.24	21.90	29.09	38.02
Case 29	0.92	1.79	2.75	3.97	5.58	7.74	10.59	14.28	18.97	24.80	1.33	2.59	3.99	5.75	8.08	11.21	15.34	20.70	27.49	35.93
Case 30	0.87	1.69	2.60	3.75	5.27	7.31	10.01	13.50	17.93	23.44	1.34	2.61	4.02	5.79	8.15	11.30	15.47	20.86	27.71	36.22
Case 31	1.01	1.96	3.02	4.36	6.13	8.50	11.63	15.69	20.84	27.25	1.48	2.87	4.43	6.38	8.98	12.45	17.04	22.99	30.53	39.90
Case 32	0.91	1.77	2.73	3.93	5.53	7.66	10.49	14.15	18.79	24.57	1.45	2.82	4.35	6.27	8.82	12.23	16.74	22.59	30.00	39.21
Case 33	1.03	2.00	3.08	4.44	6.24	8.66	11.85	15.98	21.23	27.75	1.63	3.17	4.89	7.05	9.91	13.74	18.81	25.37	33.69	44.04
Case 34	0.99	1.92	2.96	4.26	6.00	8.31	11.38	15.35	20.39	26.65	1.40	2.72	4.20	6.05	8.50	11.79	16.14	21.77	28.91	37.80
Case 35	0.92	1.78	2.75	3.96	5.57	7.72	10.57	14.26	18.93	24.75	1.40	2.72	4.20	6.05	8.51	11.80	16.16	21.79	28.94	37.83
Case 36	0.98	1.90	2.93	4.22	5.94	8.24	11.27	15.20	20.19	26.40	1.35	2.63	4.05	5.83	8.20	11.38	15.57	21.00	27.89	36.46
Case 37	0.89	1.74	2.68	3.86	5.43	7.52	10.30	13.89	18.45	24.11	1.17	2.27	3.50	5.05	7.10	9.84	13.47	18.17	24.13	31.54
Case 38	0.92	1.80	2.77	3.99	5.62	7.79	10.66	14.38	19.10	24.96	1.39	2.70	4.16	6.00	8.43	11.69	16.00	21.58	28.67	37.47
Case 39	0.96	1.87	2.88	4.16	5.85	8.11	11.09	14.96	19.88	25.98	1.40	2.72	4.19	6.04	8.49	11.77	16.11	21.73	28.87	37.73
Case 40	1.03	2.00	3.08	4.44	6.25	8.66	11.86	16.00	21.24	27.77	1.45	2.81	4.34	6.25	8.79	12.19	16.68	22.50	29.88	39.06
Case 41	0.88	1.71	2.64	3.80	5.35	7.41	10.15	13.69	18.18	23.76	1.24	2.41	3.71	5.35	7.53	10.44	14.29	19.28	25.60	33.47
Case 42	0.90	1.75	2.70	3.89	5.47	7.58	10.37	13.99	18.58	24.29	1.32	2.57	3.96	5.70	8.02	11.12	15.22	20.52	27.26	35.63
Case 43	0.97	1.88	2.90	4.17	5.87	8.14	11.14	15.02	19.95	26.08	1.26	2.46	3.79	5.46	7.68	10.65	14.58	19.67	26.12	34.15
Case 44	1.10	2.14	3.31	4.76	6.70	9.29	12.71	17.15	22.78	29.77	1.42	2.77	4.26	6.15	8.64	11.98	16.40	22.12	29.38	38.41
Case 45	1.00	1.95	3.01	4.34	6.10	8.46	11.58	15.62	20.74	27.11	1.39	2.71	4.18	6.03	8.48	11.76	16.09	21.71	28.83	37.69
Case 46	1.01	1.97	3.03	4.37	6.14	8.52	11.66	15.73	20.89	27.31	1.43	2.78	4.28	6.18	8.68	12.04	16.48	22.23	29.53	38.60
Case 47	1.02	1.98	3.06	4.41	6.20	8.60	11.77	15.88	21.09	27.56	1.46	2.84	4.38	6.31	8.87	12.30	16.84	22.72	30.17	39.44
Case 48	1.09	2.12	3.28	4.72	6.64	9.21	12.60	17.00	22.57	29.51	1.41	2.75	4.24	6.11	8.59	11.91	16.29	21.98	29.19	38.16
Case 49	1.05	2.05	3.16	4.55	6.41	8.88	12.16	16.40	21.78	28.47	1.40	2.72	4.19	6.03	8.49	11.77	16.10	21.72	28.85	37.71
Case 50	0.96	1.86	2.87	4.14	5.82	8.07	11.05	14.90	19.79	25.87	1.35	2.63	4.05	5.83	8.20	11.38	15.57	21.00	27.89	36.46
Case 51	1.06	2.07	3.19	4.60	6.47	8.97	12.27	16.56	21.99	28.75	1.41	2.74	4.23	6.09	8.57	11.88	16.26	21.94	29.14	38.09
Case 52	0.87	1.69	2.60	3.75	5.27	7.30	10.00	13.48	17.91	23.41	1.36	2.66	4.09	5.90	8.30	11.51	15.75	21.24	28.21	36.88
Case 53	1.15	2.24	3.45	4.97	7.00	9.70	13.28	17.91	23.79	31.09	1.47	2.86	4.41	6.36	8.94	12.39	16.96	22.88	30.39	39.72
Case 54	0.97	1.89	2.92	4.20	5.91	8.20	11.22	15.14	20.10	26.28	1.39	2.71	4.18	6.02	8.47	11.74	16.07	21.68	28.79	37.64
Case 55	1.06	2.06	3.18	4.59	6.45	8.94	12.24	16.51	21.93	28.67	1.36	2.66	4.09	5.90	8.30	11.51	15.75	21.24	28.21	36.88
Case 56	0.98	1.91	2.94	4.24	5.96	8.27	11.32	15.27	20.28	26.51	1.34	2.60	4.01	5.78	8.13	11.27	15.43	20.81	27.64	36.14
Case 57	0.96	1.88	2.89	4.17	5.87	8.14	11.13	15.02	19.95	26.08	1.43	2.77	4.28	6.17	8.67	12.02	16.46	22.20	29.48	38.54
Case 58	1.03	2.01	3.10	4.47	6.29	8.73	11.94	16.11	21.40	27.97	1.49	2.90	4.48	6.45	9.07	12.58	17.22	23.23	30.85	40.33
Case 59	1.12	2.19	3.37	4.86	6.84	9.48	12.97	17.50	23.24	30.39	1.42	2.77	4.27	6.16	8.66	12.01	16.44	22.18	29.45	38.50
Case 60	1.22	2.38	3.67	5.29	7.45	10.32	14.13	19.06	25.32	33.09	1.52	2.96	4.57	6.59	9.27	12.85	17.58	23.72	31.50	41.18
Case 61	1.06	2.07	3.19	4.59	6.46	8.96	12.26	16.54	21.96	28.71	1.47	2.86	4.41	6.35	8.93	12.39	16.95	22.87	30.37	39.70
Case 62	1.21	2.35	3.63	5.23	7.36	10.20	13.96	18.83	25.01	32.69	1.76	3.43	5.29	7.62	10.72	14.86	20.34	27.44	36.44	47.64
Case 63	1.08	2.11	3.25	4.68	6.58	9.13	12.49	16.85	22.38	29.25	1.77	3.44	5.31	7.65	10.76	14.92	20.42	27.55	36.59	47.83
Case 64	0.94	1.83	2.82	4.07	5.72	7.93	10.85	14.64	19.44	25.42	1.36	2.65	4.09	5.89	8.28	11.48	15.71	21.20	28.15	36.80
Case 65	1.04	2.03	3.12	4.50	6.33	8.78	12.02	16.21	21.53	28.15	1.64	3.19	4.91	7.08	9.96	13.81	18.90	25.49	33.86	44.26
Case 66	1.21	2.35	3.62	5.21	7.33	10.17	13.91	18.77	24.92	32.58	1.80	3.51	5.41	7.80	10.97	15.21	20.82	28.08	37.30	48.76
Case 67	1.11	2.17	3.34	4.82	6.78	9.40	12.87	17.36	23.05	30.13	1.77	3.45	5.31	7.66	10.77	14.93	20.43	27.57	36.61	47.86
Case 68	0.96	1.86	2.87	4.13	5.81	8.06	11.03	14.89	19.77	25.84	1.51	2.93	4.52	6.52	9.17	12.71	17.40	23.47	31.17	40.75
Case 69	0.91	1.77	2.73	3.94	5.54	7.68	10.51	14.17	18.82	24.61	1.34	2.61	4.03	5.81	8.17	11.33	15.50	20.91	27.77	36.30
Case 70	1.02	1.98	3.05	4.40	6.18	8.58	11.74	15.83	21.03	27.49	1.43	2.77	4.28	6.16	8.67	12.02	16.45	22.19	29.48	38.53
Case 71	1.02	1.99	3.07	4.43	6.22	8.63	11.81	15.93	21.16	27.66	1.40	2.72	4.19	6.03	8.49	11.77	16.10	21.72	28.85	37.71
Case 72	0.93	1.81	2.79	4.03	5.66	7.85	10.74	14.49	19.25	25.16	1.38	2.69	4.15	5.99	8.42	11.68	15.98	21.56	28.63	37.43
Case 73	1.02	1.99	3.07	4.42	6.22	8.62	11.80	15.92	21.14	27.63	1.41	2.73	4.22	6.08	8.54	11.85	16.22	21.87	29.05	37.98
Case 74	0.98	1.91	2.94	4.24	5.96	8.27	11.31	15.26	20.27	26.49	1.37	2.66	4.11	5.92	8.33	11.55	15.80	21.32	28.32	37.01
Case 75	0.96	1.86	2.87	4.14	5.82	8.07	11.04	14.89	19.78	25.85	1.36	2.65	4.09	5.90	8.29	11.50	15.74	21.23	28.20	36.86
Case 76	0.97	1.88	2.90	4.18	5.87	8.15	11.15	15.04	19.97	26.11	1.27	2.46	3.80	5.48	7.70	10.68	14.62	19.72	26.19	34.23
Case 77	0.98	1.90	2.93	4.23	5.95	8.25	11.29	15.23	20.23	26.44	1.38	2.68	4.14	5.97	8.39	11.63	15.92	21.47	28.52	37.28
Case 78	1.00	1.94	2.99	4.32	6.07	8.42	11.52	15.54	20.64	26.98	1.37	2.66	4.10	5.90	8.30	11.51	15.76	21.25	28.23	36.90
Case 79	0.86	1.67	2.57	3.70	5.21	7.22	9.88	13.33	17.71	23.15	1.22	2.38	3.67	5.30	7.45	10.33	14.13	19.07	25.32	33.10
Case 80	0.89	1.73	2.66	3.84	5.40	7.49	10.24	13.82	18.35	23.99	1.40	2.72	4.19	6.05	8.50	11.79	16.14	21.77	28.91	37.79
Case 81	0.91	1.76	2.72	3.92	5.51	7.64	10.45	14.10	18.72	24.47	1.41	2.75	4.24	6.12	8.60	11.93	16.33	22.03	29.25	38.24
Case 82	0.87	1.69	2.60	3.75	5.27	7.31	10.00	13.50	17.92	23.43	1.45	2.83	4.36	6.29	8.84	12.26	16.77	22.63	30.05	39.28
Case 83	0.91	1.78	2.74	3.95	5.55	7.70	10.54	14.22	18.88	24.68	1.57	3.06	4.72	6.80	9.56	13.26	18.14	24.48	32.51	42.49
Case 84	0.96	1.88	2.89	4.17	5.86	8.13	11.12	15.00	19.93	26.05	1.54	3.00	4.62	6.67	9.37	13.00	17.79	24.00	31.87	41.66
Case 85	1.00	1.95	3.01	4.34	6.11	8.47	11.59	15.63	20.76	27.14	1.48	2.87	4.43	6.39	8.98	12.46	17.05	23.00	30.54	39.93
Case 86	1.00	1.94	2.99	4.31	6.06	8.41	11.51	15.52	20.62	26.95	1.69	3.29	5.07	7.31	10.28	14.25	19.50	26.31	34.94	45.67
Case 87	0.72	1.41	2.17	3.13	4.40	6.10	8.35	11.26	14.96	19.55	1.37	2.67	4.12	5.93	8.34	11.57	15.84	21.36	28.37	37.09
Case 88	0.81	1.57	2.42	3.49	4.90	6.80	9.30	12.55	16.67	21.78	1.31	2.55	3.93	5.66	7.96	11.04	15.10	20.37	27.06	35.37
Case 89	0.85	1.66	2.55	3.68	5.17	7.17	9.82	13.25	17.59	23.00	1.35	2.63	4.05	5.85	8.22	11.40	15.60	21.04	27.95	36.53
Case 90	0.87	1.69	2.61	3.76	5.29	7.34	10.04	13.55	17.99	23.52	1.31	2.54	3.92	5.65	7.94	11.01	15.07	20.33	27.00	35.30
Case 91	0.89	1.73	2.67	3.84	5.41	7.50	10.26	13.84	18.38	24.02	1.37	2.68	4.12	5.95	8.36	11.59	15.87	21.40	28.43	37.16
Case 92	0.85	1.65	2.55	3.67	5.16	7.16	9.79	13.21	17.54	22.93	1.25	2.43	3.75	5.41	7.60	10.55	14.43	19.47	25.86	33.80
Case 93	0.95	1.84	2.84	4.10	5.76	7.99	10.93	14.75	19.59	25.61	1.45	2.81	4.34	6.25	8.79	12.19	16.69	22.51	29.90	39.08
Case 94	0.91	1.78	2.74	3.95	5.56	7.71	10.55	14.23	18.90	24.70	1.42	2.77	4.27	6.15	8.65	11.99	16.41	22.14	29.40	38.43
Case 95	0.95	1.84	2.84	4.10	5.76	7.99	10.93	14.75	19.59	25.61	1.45	2.81	4.34	6.25	8.79	12.19	16.69	22.51	29.90	39.08
Case 96	1.02	1.98	3.05	4.40	6.19	8.58	11.74	15.84	21.04	27.51	1.44	2.80	4.31	6.21	8.74	12.12	16.58	22.37	29.71	38.84
Case 97	0.90	1.75	2.69	3.88	5.46	7.57	10.35	13.97	18.55	24.25	1.50	2.92	4.50	6.49	9.13	12.65	17.32	23.36	31.03	40.56
Case 98	1.02	1.98	3.05	4.40	6.18	8.57	11.73	15.83	21.02	27.48	1.41	2.74	4.23	6.10	8.58	11.89	16.28	21.96	29.17	38.12
Case 99	1.03	2.01	3.10	4.46	6.28	8.70	11.91	16.07	21.34	27.89	1.54	3.00	4.62	6.66	9.36	12.98	17.76	23.96	31.82	41.60
Case 100	0.90	1.75	2.70	3.89	5.47	7.59	10.38	14.01	18.61	24.32	1.72	3.35	5.16	7.43	10.46	14.50	19.84	26.77	35.55	46.47
Case 101	1.25	2.43	3.74	5.40	7.59	10.53	14.40	19.43	25.81	33.74	1.83	3.56	5.50	7.92	11.14	15.45	21.14	28.51	37.87	49.50

Table 3.06 Cage NH_3 Concentrations for 10 Days with Increased Cage Temperature

3.3 Ranking of Whole Room Simulations

The following tables (3.07 to 3.14) present rankings of the results of the CFD room simulations based on room (scientist's breathing zone) and cage mean values for temperature, relative humidity, and CO_2 and NH_3 (day 4) concentrations. The tables start with the case with the lowest value and list the rest in ascending order. In addition to the case number, which should be used to identify all details of the case, the supply diffuser type, exhaust location, supply flow rate, and supply discharge temperature are given to provide a quick overview of the case.

Tables 3.07 and 3.08 for temperature show the ceiling exhausts produce lower temperatures in both the room and cages, ignoring the two 5 ACH cases which start with very low supply temperatures. Tables 3.09 and 3.10 for relative humidity show that the low exhaust cases seem to dominate the table producing low humidity. This is also a consequence of the low exhaust rooms and cages being warmer than the ceiling and high level exhausts.

Table 3.11 showing room breathing zone CO_2 concentration shows the ceiling and high level exhausts producing the lowest values. The overall variation is very small in absolute terms. It is interesting to see that the first 20 ACH case comes 50th in the list. This indicates that with the right design it is possible to ventilate a room better than by simply providing more air.

Table 3.12 showing CO_2 concentration in the cages also shows relatively small variations across the cases. No particular configuration presents itself as always performing better than the others.

Tables 3.13 and 3.14 show NH_3 concentrations in the room and cages on day 4. The room data shows no particular pattern. The cage data shows rather more low exhaust cases giving low values, which is due to the higher temperature and related lower relative humidity reducing the actual NH_3 generation rate.

In all of the ranking tables, no single configuration proves to be superior in all respects. This further illustrates that the airflow patterns and thus the ventilation of the room and the cages depends on the complex interaction of all of features in the room.

Table 3.07 Ranking of Cases with respect to Room Temperature

Case Name	Supply Diffuser Type	Exhaust Location and Number	Supply ACH	Supply Temperature (°C)	Supply Temperature (°F)	Room Temp (°C)	Room Temp (°F)
Case 66	Low Ind	Low	5	6.6	43.9	18.6	65.6
Case 62	Low Ind	Low	5	6.6	43.9	19.1	66.5
Case 53	Radial	Ceiling	15	18.8	65.8	19.8	67.6
Case 55	Low Ind	Ceiling	15	18.8	65.8	19.8	67.6
Case 54	Slot	Ceiling	15	18.8	65.8	19.8	67.6
Case 36	Low Ind	Ceiling	15	17.5	63.5	19.9	67.8
Case 35	Slot	Ceiling	15	17.5	63.5	20.0	67.9
Case 34	Radial	Ceiling	15	17.5	63.5	20.0	67.9
Case 07	Low Ind	Ceiling	15	18.8	65.8	20.0	67.9
Case 98	Low ind	Ceiling	15	17.5	63.5	20.0	68.0
Case 96	Radial	Ceiling	15	17.5	63.5	20.0	68.0
Case 97	Slot	Ceiling	15	17.5	63.5	20.0	68.0
Case 16	Radial	Ceiling	15	18.8	65.8	20.1	68.1
Case 46	Radial	Ceiling	15	18.8	65.8	20.2	68.3
Case 67	Low Ind	Low	10	14.8	58.6	20.2	68.3
Case 19	Radial	Ceiling	15	18.8	65.8	20.2	68.4
Case 18	Low Ind	Ceiling	15	18.8	65.8	20.2	68.4
Case 17	Slot	Ceiling	15	18.8	65.8	20.2	68.4
Case 94	Slot	Ceiling	15	17.5	63.5	20.2	68.4
Case 95	Low Ind	Ceiling	15	17.5	63.5	20.2	68.4
Case 43	Low Ind (rot 90°)	Ceiling	15	18.8	65.8	20.2	68.4
Case 47	Radial	Ceiling	15	18.8	65.8	20.3	68.5
Case 93	Radial	Ceiling	15	17.5	63.5	20.3	68.5
Case 45	Radial	Ceiling	15	18.8	65.8	20.3	68.5
Case 60	Low Ind	High	15	18.8	65.8	20.3	68.5
Basecase	Radial	Ceiling	15	18.8	65.8	20.3	68.5
Case 25	Radial	Ceiling	15	18.8	65.8	20.3	68.5
Case 27	Low Ind	Ceiling	15	18.8	65.8	20.3	68.6
Case 56	Radial	High	15	18.8	65.8	20.3	68.6
Case 59	Slot	Low	15	18.8	65.8	20.3	68.6
Case 63	Low Ind	Low	10	14.8	58.6	20.3	68.6
Case 90	Radial	Ceiling	15	18.8	65.8	20.4	68.7
Case 77	Slot	Ceiling	15	18.8	65.8	20.4	68.7
Case 76	Radial	Ceiling	15	18.8	65.8	20.4	68.7
Case 21	Low Ind	Ceiling	15	18.8	65.8	20.4	68.7
Case 92	Low Ind	Ceiling	15	18.8	65.8	20.4	68.7
Case 26	Slot	Ceiling	15	18.8	65.8	20.4	68.7
Case 78	Low Ind	Ceiling	15	18.8	65.8	20.4	68.7
Case 04	Slot	Ceiling	15	18.8	65.8	20.4	68.8
Case 44	Radial (rot 90°)	Ceiling	15	18.8	65.8	20.4	68.8
Case 91	Slot	Ceiling	15	18.8	65.8	20.5	68.8
Case 50	Radial	Ceiling	15	18.8	65.8	20.5	68.8
Case 52	Radial	Ceiling	15	18.8	65.8	20.5	68.8
Case 08	Low Ind	High	15	18.8	65.8	20.5	68.9
Case 42	Low Ind	Ceiling x4	15	18.8	65.8	20.5	68.9
Case 51	Radial	Ceiling	15	18.8	65.8	20.5	69.0
Case 05	Slot	High	15	18.8	65.8	20.5	69.0
Case 41	Slot	Ceiling x4	15	18.8	65.8	20.5	69.0
Case 40	Radial	Ceiling x4	15	18.8	65.8	20.5	69.0
Case 49	Radial	Ceiling	15	18.8	65.8	20.5	69.0
Case 20	Slot	Ceiling	15	18.8	65.8	20.6	69.0

Case Name	Supply Diffuser Type	Exhaust Location and Number	Supply ACH	Supply Temperature (°C)	Supply Temperature (°F)	Room Temp (°C)	Room Temp (°F)
Case 48	Radial	Ceiling	15	18.8	65.8	20.6	69.1
Case 02	Radial	High	15	18.8	65.8	20.7	69.2
Case 37	Radial	Ceiling/Low 50/50	15	18.8	65.8	20.7	69.3
Case 85	Radial	Low	15	17.5	63.5	20.7	69.3
Case 38	Slot	Ceiling/Low 50/50	15	18.8	65.8	20.8	69.4
Case 39	Low Ind	Ceiling/Low 50/50	15	18.8	65.8	20.8	69.4
Case 65	Low Ind	Low	15	17.5	63.5	20.8	69.5
Case 13	Slot	Low	15	20.7	69.3	20.8	69.5
Case 10	Radial	Ceiling	15	20.7	69.3	20.9	69.7
Case 72	Radial	High x4 / Low x2	15	18.8	65.8	21.1	69.9
Case 74	Low Ind	High x4 / Low x2	15	18.8	65.8	21.1	70.0
Case 75	Radial	Ceiling/Low 50/50	15	18.8	65.8	21.1	70.0
Case 73	Slot	High x4 / Low x2	15	18.8	65.8	21.1	70.0
Case 14	Low Ind	Ceiling	15	20.7	69.3	21.1	70.0
Case 12	Slot	Ceiling	15	20.7	69.3	21.1	70.0
Case 64	Low Ind	Low	20	18.9	66.0	21.2	70.1
Case 86	Slot	Low	15	17.5	63.5	21.2	70.1
Case 29	Low Ind	Low	5	11	51.8	21.2	70.1
Case 15	Low Ind	Low	15	20.7	69.3	21.2	70.2
Case 68	Low Ind	Low	20	18.9	66.0	21.2	70.2
Case 22	Radial	Low	15	18.8	65.8	21.2	70.2
Case 69	Radial	High x4 / Low x4	15	18.8	65.8	21.3	70.3
Case 82	Radial	2 Door exhausts	15	18.8	65.8	21.3	70.3
Case 11	Radial	Low	15	20.7	69.3	21.3	70.4
Case 31	Radial	Low	15	17.5	63.5	21.4	70.5
Case 83	Slot	2 Door exhausts	15	17.5	63.5	21.4	70.6
Case 70	Slot	High x4 / Low x4	15	18.8	65.8	21.4	70.6
Case 84	Low Ind	2 Door exhausts	15	17.5	63.5	21.5	70.7
Case 71	Low Ind	High x4 / Low x4	15	18.8	65.8	21.6	70.8
Case 57	Radial	Low	15	18.8	65.8	21.7	71.1
Case 23	Slot	Low	15	18.8	65.8	21.8	71.2
Case 58	Slot	High	15	18.8	65.8	21.8	71.2
Case 79	Radial	2 Door exhausts	15	18.8	65.8	21.9	71.5
Case 32	Slot	Low	15	17.5	63.5	22.0	71.5
Case 33	Low Ind	Low	15	17.5	63.5	22.0	71.5
Case 61	Low Ind	Low	15	18.8	65.8	22.0	71.7
Case 03	Radial	Low	15	18.8	65.8	22.1	71.7
Case 80	Slot	2 Door exhausts	15	18.8	65.8	22.1	71.8
Case 24	Low Ind	Low	15	18.8	65.8	22.1	71.8
Case 06	Slot	Low	15	18.8	65.8	22.3	72.1
Case 28	Low Ind	Low	10	16.8	62.2	22.3	72.1
Case 81	Low Ind	2 Door exhausts	15	18.8	65.8	22.5	72.4
Case 87	Radial	Low	15	19.2	66.6	22.5	72.4
Case 88	Slot	Low	15	19.2	66.6	22.6	72.6
Case 09	Low Ind	Low	15	18.8	65.8	22.6	72.6
Case 30	Low Ind	Low	20	19.8	67.6	22.6	72.6
Case 89	Low Ind	Low	15	19.2	66.6	22.9	73.3

Table 3.08 Ranking of Cases with respect to Cage Temperature

Case Name	Supply Diffuser Type	Exhaust Location and Number	Supply ACH	Supply Temperature (°C)	Supply Temperature (°F)	Cage Temp (°C)	Cage Temp (°F)
Case 66	Low Ind	Low	5	6.6	43.9	20.6	69.1
Case 62	Low Ind	Low	5	6.6	43.9	20.9	69.6
Case 35	Slot	Ceiling	15	17.5	63.5	21.3	70.4
Case 34	Radial	Ceiling	15	17.5	63.5	21.4	70.4
Case 36	Low Ind	Ceiling	15	17.5	63.5	21.5	70.6
Case 55	Low Ind	Ceiling	15	18.8	65.8	21.6	70.9
Case 97	Slot	Ceiling	15	17.5	63.5	21.6	71.0
Case 54	Slot	Ceiling	15	18.8	65.8	21.7	71.0
Case 53	Radial	Ceiling	15	18.8	65.8	21.7	71.0
Case 98	Low ind	Ceiling	15	17.5	63.5	21.7	71.1
Case 19	Radial	Ceiling	15	18.8	65.8	21.7	71.1
Case 96	Radial	Ceiling	15	17.5	63.5	21.8	71.2
Case 94	Slot	Ceiling	15	17.5	63.5	21.9	71.3
Case 67	Low Ind	Low	10	14.8	58.6	21.9	71.4
Case 75	Radial	Ceiling/Low 50/50	15	18.8	65.8	21.9	71.4
Case 60	Low Ind	High	15	18.8	65.8	21.9	71.4
Case 63	Low Ind	Low	10	14.8	58.6	21.9	71.4
Case 90	Radial	Ceiling	15	18.8	65.8	21.9	71.5
Case 95	Low Ind	Ceiling	15	17.5	63.5	21.9	71.5
Case 93	Radial	Ceiling	15	17.5	63.5	21.9	71.5
Case 92	Low Ind	Ceiling	15	18.8	65.8	22.0	71.6
Case 91	Slot	Ceiling	15	18.8	65.8	22.0	71.6
Case 43	Low Ind (rot 90°)	Ceiling	15	18.8	65.8	22.0	71.6
Case 46	Radial	Ceiling	15	18.8	65.8	22.0	71.6
Case 21	Low Ind	Ceiling	15	18.8	65.8	22.0	71.6
Case 59	Slot	Low	15	18.8	65.8	22.0	71.6
Basecase	Radial	Ceiling	15	18.8	65.8	22.1	71.7
Case 18	Low Ind	Ceiling	15	18.8	65.8	22.1	71.7
Case 45	Radial	Ceiling	15	18.8	65.8	22.1	71.7
Case 17	Slot	Ceiling	15	18.8	65.8	22.1	71.7
Case 20	Slot	Ceiling	15	18.8	65.8	22.1	71.7
Case 47	Radial	Ceiling	15	18.8	65.8	22.1	71.7
Case 78	Low Ind	Ceiling	15	18.8	65.8	22.1	71.8
Case 56	Radial	High	15	18.8	65.8	22.1	71.8
Case 27	Low Ind	Ceiling	15	18.8	65.8	22.1	71.8
Case 48	Radial	Ceiling	15	18.8	65.8	22.1	71.8
Case 76	Radial	Ceiling	15	18.8	65.8	22.1	71.8
Case 26	Slot	Ceiling	15	18.8	65.8	22.1	71.8
Case 77	Slot	Ceiling	15	18.8	65.8	22.1	71.9
Case 44	Radial (rot 90°)	Ceiling	15	18.8	65.8	22.2	71.9
Case 04	Slot	Ceiling	15	18.8	65.8	22.2	71.9
Case 50	Radial	Ceiling	15	18.8	65.8	22.2	71.9
Case 49	Radial	Ceiling	15	18.8	65.8	22.2	71.9
Case 40	Radial	Ceiling x4	15	18.8	65.8	22.2	71.9
Case 42	Low Ind	Ceiling x4	15	18.8	65.8	22.2	71.9
Case 51	Radial	Ceiling	15	18.8	65.8	22.2	71.9
Case 25	Radial	Ceiling	15	18.8	65.8	22.2	72.0
Case 83	Slot	2 Door exhausts	15	17.5	63.5	22.2	72.0
Case 08	Low Ind	High	15	18.8	65.8	22.2	72.0
Case 41	Slot	Ceiling x4	15	18.8	65.8	22.2	72.0
Case 37	Radial	Ceiling/Low 50/50	15	18.8	65.8	22.3	72.1

Case Name	Supply Diffuser Type	Exhaust Location and Number	Supply ACH	Supply Temperature (°C)	Supply Temperature (°F)	Cage Temp (°C)	Cage Temp (°F)
Case 05	Slot	High	15	18.8	65.8	22.3	72.1
Case 82	Radial	2 Door exhausts	15	18.8	65.8	22.3	72.1
Case 86	Slot	Low	15	17.5	63.5	22.3	72.1
Case 02	Radial	High	15	18.8	65.9	22.3	72.2
Case 85	Radial	Low	15	17.5	63.5	22.4	72.3
Case 38	Slot	Ceiling/Low 50/50	15	18.8	65.8	22.4	72.3
Case 39	Low Ind	Ceiling/Low 50/50	15	18.8	65.8	22.4	72.3
Case 65	Low Ind	Low	15	17.5	63.5	22.4	72.4
Case 07	Low Ind	Ceiling	15	18.8	65.8	22.5	72.4
Case 52	Radial	Ceiling	15	18.8	65.8	22.5	72.5
Case 22	Radial	Low	15	18.8	65.8	22.5	72.5
Case 84	Low Ind	2 Door exhausts	15	17.5	63.5	22.5	72.5
Case 72	Radial	High x4 / Low x2	15	18.8	65.8	22.5	72.6
Case 73	Slot	High x4 / Low x2	15	18.8	65.8	22.6	72.7
Case 74	Low Ind	High x4 / Low x2	15	18.8	65.8	22.6	72.7
Case 29	Low Ind	Low	5	11	51.8	22.6	72.8
Case 87	Radial	Low	15	19.2	66.6	22.7	72.8
Case 64	Low Ind	Low	20	18.9	66.0	22.7	72.8
Case 31	Radial	Low	15	17.5	63.5	22.7	72.8
Case 23	Slot	Low	15	18.8	65.8	22.7	72.9
Case 69	Radial	High x4 / Low x4	15	18.8	65.8	22.7	72.9
Case 11	Radial	Low	15	20.7	69.3	22.7	72.9
Case 68	Low Ind	Low	20	18.9	66.0	22.8	73.0
Case 13	Slot	Low	15	20.7	69.3	22.8	73.0
Case 14	Low Ind	Ceiling	15	20.7	69.3	22.8	73.0
Case 16	Radial	Ceiling	15	18.8	65.8	22.9	73.1
Case 70	Slot	High x4 / Low x4	15	18.8	65.8	22.9	73.2
Case 32	Slot	Low	15	17.5	63.5	22.9	73.2
Case 12	Slot	Ceiling	15	20.7	69.3	22.9	73.2
Case 71	Low Ind	High x4 / Low x4	15	18.8	65.8	23.0	73.3
Case 57	Radial	Low	15	18.8	65.8	23.0	73.4
Case 58	Slot	High	15	18.8	65.8	23.1	73.5
Case 79	Radial	2 Door exhausts	15	18.8	65.8	23.1	73.6
Case 61	Low Ind	Low	15	18.8	65.8	23.1	73.6
Case 33	Low Ind	Low	15	17.5	63.5	23.2	73.7
Case 24	Low Ind	Low	15	18.8	65.8	23.2	73.7
Case 80	Slot	2 Door exhausts	15	18.8	65.8	23.2	73.8
Case 10	Radial	Ceiling	15	20.7	69.3	23.2	73.8
Case 15	Low Ind	Low	15	20.7	69.3	23.2	73.8
Case 28	Low Ind	Low	10	16.8	62.2	23.3	74.0
Case 03	Radial	Low	15	18.8	65.8	23.4	74.0
Case 81	Low Ind	2 Door exhausts	15	18.8	65.8	23.4	74.1
Case 06	Slot	Low	15	18.8	65.8	23.4	74.2
Case 88	Slot	Low	15	19.2	66.6	23.5	74.4
Case 09	Low Ind	Low	15	18.8	65.8	23.6	74.5
Case 30	Low Ind	Low	20	19.8	67.6	23.6	74.6
Case 89	Low Ind	Low	15	19.2	66.6	23.7	74.6

Table 3.09 Ranking of Cases with respect to Room Relative Humidity

Case Name	Supply Diffuser Type	Exhaust Location and Number	Supply ACH	Supply Temperature (°C)	Supply Temperature (°F)	Room RH (percent)
Case 89	Low Ind	Low	15	19.2	66.6	47.1
Case 88	Slot	Low	15	19.2	66.6	48.1
Case 30	Low Ind	Low	20	19.8	67.6	48.2
Case 09	Low Ind	Low	15	18.8	65.8	48.4
Case 87	Radial	Low	15	19.2	66.6	48.4
Case 81	Low Ind	2 Door exhausts	15	18.8	65.8	48.7
Case 06	Slot	Low	15	18.8	65.8	49.2
Case 28	Low Ind	Low	10	16.8	62.2	49.5
Case 03	Radial	Low	15	18.8	65.8	49.7
Case 24	Low Ind	Low	15	18.8	65.8	49.8
Case 80	Slot	2 Door exhausts	15	18.8	65.8	49.8
Case 61	Low Ind	Low	15	18.8	65.8	49.8
Case 79	Radial	2 Door exhausts	15	18.8	65.8	50.3
Case 32	Slot	Low	15	17.5	63.5	50.5
Case 58	Slot	High	15	18.8	65.8	50.6
Case 33	Low Ind	Low	15	17.5	63.5	50.7
Case 23	Slot	Low	15	18.8	65.8	50.7
Case 57	Radial	Low	15	18.8	65.8	50.7
Case 71	Low Ind	High x4 / Low x4	15	18.8	65.8	51.2
Case 70	Slot	High x4 / Low x4	15	18.8	65.8	51.4
Case 11	Radial	Low	15	20.7	69.3	52.0
Case 69	Radial	High x4 / Low x4	15	18.8	65.8	52.2
Case 31	Radial	Low	15	17.5	63.5	52.3
Case 15	Low Ind	Low	15	20.7	69.3	52.3
Case 84	Low Ind	2 Door exhausts	15	17.5	63.5	52.3
Case 22	Radial	Low	15	18.8	65.8	52.3
Case 12	Slot	Ceiling	15	20.7	69.3	52.3
Case 73	Slot	High x4 / Low x2	15	18.8	65.8	52.6
Case 83	Slot	2 Door exhausts	15	17.5	63.5	52.6
Case 68	Low Ind	Low	20	18.9	66.0	52.7
Case 14	Low Ind	Ceiling	15	20.7	69.3	52.7
Case 74	Low Ind	High x4 / Low x2	15	18.8	65.8	52.7
Case 75	Radial	Ceiling/Low 50/50	15	18.8	65.8	52.7
Case 82	Radial	2 Door exhausts	15	18.8	65.8	52.8
Case 72	Radial	High x4 / Low x2	15	18.8	65.8	52.8
Case 64	Low Ind	Low	20	18.9	66.0	52.9
Case 86	Slot	Low	15	17.5	63.5	53.1
Case 10	Radial	Ceiling	15	20.7	69.3	53.1
Case 29	Low Ind	Low	5	11	51.8	53.2
Case 13	Slot	Low	15	20.7	69.3	53.5
Case 38	Slot	Ceiling/Low 50/50	15	18.8	65.8	53.9
Case 39	Low Ind	Ceiling/Low 50/50	15	18.8	65.8	54.0
Case 37	Radial	Ceiling/Low 50/50	15	18.8	65.8	54.2
Case 02	Radial	High	15	18.8	65.8	54.3
Case 40	Radial	Ceiling x4	15	18.8	65.8	54.4
Case 65	Low Ind	Low	15	17.5	63.5	54.4
Case 48	Radial	Ceiling	15	18.8	65.8	54.5
Case 49	Radial	Ceiling	15	18.8	65.8	54.6
Case 05	Slot	High	15	18.8	65.8	54.6
Case 41	Slot	Ceiling x4	15	18.8	65.8	54.6
Case 85	Radial	Low	15	17.5	63.5	54.7

Case Name	Supply Diffuser Type	Exhaust Location and Number	Supply ACH	Supply Temperature (°C)	Supply Temperature (°F)	Room RH (percent)
Case 20	Slot	Ceiling	15	18.8	65.8	54.8
Case 42	Low Ind	Ceiling x4	15	18.8	65.8	54.8
Case 51	Radial	Ceiling	15	18.8	65.8	54.8
Case 50	Radial	Ceiling	15	18.8	65.8	54.9
Case 91	Slot	Ceiling	15	18.8	65.8	55.0
Case 08	Low Ind	High	15	18.8	65.8	55.0
Case 26	Slot	Ceiling	15	18.8	65.8	55.0
Case 59	Slot	Low	15	18.8	65.8	55.0
Case 52	Radial	Ceiling	15	18.8	65.8	55.0
Case 92	Low Ind	Ceiling	15	18.8	65.8	55.0
Case 78	Low Ind	Ceiling	15	18.8	65.8	55.1
Case 04	Slot	Ceiling	15	18.8	65.8	55.1
Case 77	Slot	Ceiling	15	18.8	65.8	55.2
Case 44	Radial (rot 90°)	Ceiling	15	18.8	65.8	55.2
Case 76	Radial	Ceiling	15	18.8	65.8	55.2
Case 21	Low Ind	Ceiling	15	18.8	65.8	55.2
Case 90	Radial	Ceiling	15	18.8	65.8	55.4
Basecase	Radial	Ceiling	15	18.8	65.8	55.4
Case 56	Radial	High	15	18.8	65.8	55.5
Case 47	Radial	Ceiling	15	18.8	65.8	55.5
Case 27	Low Ind	Ceiling	15	18.8	65.8	55.5
Case 25	Radial	Ceiling	15	18.8	65.8	55.6
Case 45	Radial	Ceiling	15	18.8	65.8	55.6
Case 60	Low Ind	High	15	18.8	65.8	55.6
Case 43	Low Ind (rot 90°)	Ceiling	15	18.8	65.8	55.8
Case 95	Low Ind	Ceiling	15	17.5	63.5	55.9
Case 46	Radial	Ceiling	15	18.8	65.8	55.9
Case 19	Radial	Ceiling	15	18.8	65.8	55.9
Case 93	Radial	Ceiling	15	17.5	63.5	55.9
Case 17	Slot	Ceiling	15	18.8	65.8	56.0
Case 18	Low Ind	Ceiling	15	18.8	65.8	56.0
Case 16	Radial	Ceiling	15	18.8	65.8	56.2
Case 94	Slot	Ceiling	15	17.5	63.5	56.3
Case 07	Low Ind	Ceiling	15	18.8	65.8	56.7
Case 63	Low Ind	Low	10	14.8	58.6	56.8
Case 98	Low ind	Ceiling	15	17.5	63.5	56.9
Case 96	Radial	Ceiling	15	17.5	63.5	57.0
Case 97	Slot	Ceiling	15	17.5	63.5	57.0
Case 67	Low Ind	Low	10	14.8	58.6	57.2
Case 35	Slot	Ceiling	15	17.5	63.5	57.4
Case 55	Low Ind	Ceiling	15	18.8	65.8	57.4
Case 54	Slot	Ceiling	15	18.8	65.8	57.4
Case 53	Radial	Ceiling	15	18.8	65.8	57.5
Case 34	Radial	Ceiling	15	17.5	63.5	57.5
Case 36	Low Ind	Ceiling	15	17.5	63.5	57.7
Case 62	Low Ind	Low	5	6.6	43.9	62.6
Case 66	Low Ind	Low	5	6.6	43.9	64.4

Table 3.10 Ranking of Cases with respect to Cage Relative Humidity

Case Name	Supply Diffuser Type	Exhaust Location and Number	Supply ACH	Supply Temperature (°C)	Supply Temperature (°F)	Cage RH (percent)
Case 62	Low Ind	Low	5	6.6	43.9	52.8
Case 66	Low Ind	Low	5	6.6	43.9	53.0
Case 84	Low Ind	2 Door exhausts	15	17.5	63.5	53.0
Case 29	Low Ind	Low	5	11	51.8	55.8
Case 87	Radial	Low	15	19.2	66.6	56.3
Case 64	Low Ind	Low	20	18.9	66.0	56.5
Case 23	Slot	Low	15	18.8	65.8	56.9
Case 69	Radial	High x4 / Low x4	15	18.8	65.8	57.1
Case 68	Low Ind	Low	20	18.9	66.0	57.5
Case 32	Slot	Low	15	17.5	63.5	57.5
Case 57	Radial	Low	15	18.8	65.8	58.3
Case 79	Radial	2 Door exhausts	15	18.8	65.8	58.6
Case 33	Low Ind	Low	15	17.5	63.5	58.7
Case 24	Low Ind	Low	15	18.8	65.8	58.7
Case 80	Slot	2 Door exhausts	15	18.8	65.8	59.1
Case 28	Low Ind	Low	10	16.8	62.2	59.1
Case 03	Radial	Low	15	18.8	65.8	60.2
Case 81	Low Ind	2 Door exhausts	15	18.8	65.8	60.2
Case 06	Slot	Low	15	18.8	65.8	60.2
Case 88	Slot	Low	15	19.2	66.6	60.4
Case 09	Low Ind	Low	15	18.8	65.8	60.6
Case 30	Low Ind	Low	20	19.8	67.6	60.9
Case 89	Low Ind	Low	15	19.2	66.6	60.9
Case 22	Radial	Low	15	18.8	65.8	61.1
Case 31	Radial	Low	15	17.5	63.5	61.4
Case 58	Slot	High	15	18.8	65.8	61.4
Case 61	Low Ind	Low	15	18.8	65.8	61.6
Case 71	Low Ind	High x4 / Low x4	15	18.8	65.8	61.6
Case 10	Radial	Ceiling	15	20.7	69.3	61.7
Case 15	Low Ind	Low	15	20.7	69.3	61.7
Case 70	Slot	High x4 / Low x4	15	18.8	65.8	61.8
Case 82	Radial	2 Door exhausts	15	18.8	65.8	61.9
Case 72	Radial	High x4 / Low x2	15	18.8	65.8	61.9
Case 86	Slot	Low	15	17.5	63.5	62.0
Case 02	Radial	High	15	18.8	65.8	62.0
Case 41	Slot	Ceiling x4	15	18.8	65.8	62.3
Case 74	Low Ind	High x4 / Low x2	15	18.8	65.8	62.3
Case 37	Radial	Ceiling/Low 50/50	15	18.8	65.8	62.4
Case 38	Slot	Ceiling/Low 50/50	15	18.8	65.8	62.4
Case 05	Slot	High	15	18.8	65.8	62.5
Case 20	Slot	Ceiling	15	18.8	65.8	62.6
Case 65	Low Ind	Low	15	17.5	63.5	62.7
Case 04	Slot	Ceiling	15	18.8	65.8	62.7
Case 42	Low Ind	Ceiling x4	15	18.8	65.8	62.8
Case 92	Low Ind	Ceiling	15	18.8	65.8	62.8
Case 85	Radial	Low	15	17.5	63.5	62.8
Case 39	Low Ind	Ceiling/Low 50/50	15	18.8	65.8	62.9
Case 73	Slot	High x4 / Low x2	15	18.8	65.8	62.9
Case 90	Radial	Ceiling	15	18.8	65.8	63.3
Case 91	Slot	Ceiling	15	18.8	65.8	63.4
Case 11	Radial	Low	15	20.7	69.3	63.6

Case Name	Supply Diffuser Type	Exhaust Location and Number	Supply ACH	Supply Temperature (°C)	Supply Temperature (°F)	Cage RH (percent)
Case 12	Slot	Ceiling	15	20.7	69.3	63.6
Case 50	Radial	Ceiling	15	18.8	65.8	63.7
Case 18	Low Ind	Ceiling	15	18.8	65.8	63.8
Case 08	Low Ind	High	15	18.8	65.8	63.8
Case 17	Slot	Ceiling	15	18.8	65.8	63.9
Case 16	Radial	Ceiling	15	18.8	65.8	64.0
Case 76	Radial	Ceiling	15	18.8	65.8	64.1
Case 21	Low Ind	Ceiling	15	18.8	65.8	64.1
Case 95	Low Ind	Ceiling	15	17.5	63.5	64.1
Case 77	Slot	Ceiling	15	18.8	65.8	64.2
Case 14	Low Ind	Ceiling	15	20.7	69.3	64.2
Case 97	Slot	Ceiling	15	17.5	63.5	64.2
Case 94	Slot	Ceiling	15	17.5	63.5	64.4
Case 56	Radial	High	15	18.8	65.8	64.4
Case 43	Low Ind (rot 90°)	Ceiling	15	18.8	65.8	64.6
Case 19	Radial	Ceiling	15	18.8	65.8	64.6
Case 78	Low Ind	Ceiling	15	18.8	65.8	64.7
Case 52	Radial	Ceiling	15	18.8	65.8	64.8
Case 40	Radial	Ceiling x4	15	18.8	65.8	64.8
Case 45	Radial	Ceiling	15	18.8	65.8	64.9
Case 75	Radial	Ceiling/Low 50/50	15	18.8	65.8	64.9
Case 63	Low Ind	Low	10	14.8	58.6	64.9
Case 93	Radial	Ceiling	15	17.5	63.5	65.0
Case 47	Radial	Ceiling	15	18.8	65.8	65.1
Case 49	Radial	Ceiling	15	18.8	65.8	65.2
Case 46	Radial	Ceiling	15	18.8	65.8	65.2
Case 51	Radial	Ceiling	15	18.8	65.8	65.3
Case 35	Slot	Ceiling	15	17.5	63.5	65.5
Case 67	Low Ind	Low	10	14.8	58.6	65.8
Case 98	Low ind	Ceiling	15	17.5	63.5	65.8
Case 96	Radial	Ceiling	15	17.5	63.5	65.8
Case 54	Slot	Ceiling	15	18.8	65.8	66.0
Case 44	Radial (rot 90°)	Ceiling	15	18.8	65.8	66.0
Case 48	Radial	Ceiling	15	18.8	65.8	66.1
Case 07	Low Ind	Ceiling	15	18.8	65.8	66.4
Case 13	Slot	Low	15	20.7	69.3	66.5
Case 36	Low Ind	Ceiling	15	17.5	63.5	66.5
Basecase	Radial	Ceiling	15	18.8	65.8	66.8
Case 83	Slot	2 Door exhausts	15	17.5	63.5	66.8
Case 59	Slot	Low	15	18.8	65.8	66.9
Case 34	Radial	Ceiling	15	17.5	63.5	67.2
Case 55	Low Ind	Ceiling	15	18.8	65.8	67.8
Case 53	Radial	Ceiling	15	18.8	65.8	68.8
Case 60	Low Ind	High	15	18.8	65.8	69.1
Case 25	Radial	Ceiling	15	18.8	65.8	73.0
Case 27	Low Ind	Ceiling	15	18.8	65.8	74.8
Case 26	Slot	Ceiling	15	18.8	65.8	81.2

Table 3.11 Ranking of Cases with respect to Room CO_2

Case Name	Supply Diffuser Type	Exhaust Location and Number	Supply ACH	Supply Temperature (°C)	Supply Temperature (°F)	Room CO_2 (ppm)
Case 59	Slot	Low	15	18.8	65.8	15
Case 12	Slot	Ceiling	15	20.7	69.3	17
Case 40	Radial	Ceiling x4	15	18.8	65.8	21
Case 70	Slot	High x4 / Low x4	15	18.8	65.8	24
Case 10	Radial	Ceiling	15	20.7	69.3	29
Case 26	Slot	Ceiling	15	18.8	65.8	35
Basecase	Radial	Ceiling	15	18.8	65.8	36
Case 13	Slot	Low	15	20.7	69.3	37
Case 16	Radial	Ceiling	15	18.8	65.8	37
Case 73	Slot	High x4 / Low x2	15	18.8	65.8	37
Case 47	Radial	Ceiling	15	18.8	65.8	40
Case 92	Low Ind	Ceiling	15	18.8	65.8	41
Case 46	Radial	Ceiling	15	18.8	65.8	43
Case 87	Radial	Low	15	19.2	66.6	45
Case 11	Radial	Low	15	20.7	69.3	48
Case 74	Low Ind	High x4 / Low x2	15	18.8	65.8	48
Case 75	Radial	Ceiling/Low 50/50	15	18.8	65.8	48
Case 88	Slot	Low	15	19.2	66.6	48
Case 15	Low Ind	Low	15	20.7	69.3	48
Case 72	Radial	High x4 / Low x2	15	18.8	65.8	48
Case 05	Slot	High	15	18.8	65.8	49
Case 77	Slot	Ceiling	15	18.8	65.8	50
Case 41	Slot	Ceiling x4	15	18.8	65.8	51
Case 69	Radial	High x4 / Low x4	15	18.8	65.8	51
Case 71	Low Ind	High x4 / Low x4	15	18.8	65.8	51
Case 49	Radial	Ceiling	15	18.8	65.8	52
Case 14	Low Ind	Ceiling	15	20.7	69.3	52
Case 45	Radial	Ceiling	15	18.8	65.8	52
Case 50	Radial	Ceiling	15	18.8	65.8	55
Case 76	Radial	Ceiling	15	18.8	65.8	55
Case 78	Low Ind	Ceiling	15	18.8	65.8	55
Case 60	Low Ind	High	15	18.8	65.8	57
Case 07	Low Ind	Ceiling	15	18.8	65.8	57
Case 55	Low Ind	Ceiling	15	18.8	65.8	57
Case 91	Slot	Ceiling	15	18.8	65.8	57
Case 57	Radial	Low	15	18.8	65.8	57
Case 53	Radial	Ceiling	15	18.8	65.8	58
Case 37	Radial	Ceiling/Low 50/50	15	18.8	65.8	59
Case 19	Radial	Ceiling	15	18.8	65.8	59
Case 54	Slot	Ceiling	15	18.8	65.8	60
Case 25	Radial	Ceiling	15	18.8	65.8	60
Case 22	Radial	Low	15	18.8	65.8	61
Case 27	Low Ind	Ceiling	15	18.8	65.8	61
Case 21	Low Ind	Ceiling	15	18.8	65.8	62
Case 04	Slot	Ceiling	15	18.8	65.8	62
Case 89	Low Ind	Low	15	19.2	66.6	62
Case 38	Slot	Ceiling/Low 50/50	15	18.8	65.8	62
Case 23	Slot	Low	15	18.8	65.8	63
Case 42	Low Ind	Ceiling x4	15	18.8	65.8	63
Case 30	Low Ind	Low	20	19.8	67.6	64
Case 08	Low Ind	High	15	18.8	65.8	64

Case Name	Supply Diffuser Type	Exhaust Location and Number	Supply ACH	Supply Temperature (°C)	Supply Temperature (°F)	Room CO_2 (ppm)
Case 03	Radial	Low	15	18.8	65.8	64
Case 48	Radial	Ceiling	15	18.8	65.8	65
Case 02	Radial	High	15	18.8	65.8	65
Case 52	Radial	Ceiling	15	18.8	65.8	65
Case 43	Low Ind (rot 90°)	Ceiling	15	18.8	65.8	65
Case 51	Radial	Ceiling	15	18.8	65.8	67
Case 58	Slot	High	15	18.8	65.8	68
Case 61	Low Ind	Low	15	18.8	65.8	69
Case 56	Radial	High	15	18.8	65.8	69
Case 95	Low Ind	Ceiling	15	17.5	63.5	69
Case 39	Low Ind	Ceiling/Low 50/50	15	18.8	65.8	71
Case 06	Slot	Low	15	18.8	65.8	72
Case 90	Radial	Ceiling	15	18.8	65.8	72
Case 44	Radial (rot 90°)	Ceiling	15	18.8	65.8	74
Case 20	Slot	Ceiling	15	18.8	65.8	75
Case 17	Slot	Ceiling	15	18.8	65.8	78
Case 18	Low Ind	Ceiling	15	18.8	65.8	79
Case 79	Radial	2 Door exhausts	15	18.8	65.8	81
Case 24	Low Ind	Low	15	18.8	65.8	81
Case 98	Low ind	Ceiling	15	17.5	63.5	83
Case 93	Radial	Ceiling	15	17.5	63.5	86
Case 09	Low Ind	Low	15	18.8	65.8	88
Case 81	Low Ind	2 Door exhausts	15	18.8	65.8	89
Case 80	Slot	2 Door exhausts	15	18.8	65.8	90
Case 68	Low Ind	Low	20	18.9	66.0	93
Case 64	Low Ind	Low	20	18.9	66.0	93
Case 96	Radial	Ceiling	15	17.5	63.5	100
Case 31	Radial	Low	15	17.5	63.5	107
Case 97	Slot	Ceiling	15	17.5	63.5	111
Case 28	Low Ind	Low	10	16.8	62.2	113
Case 82	Radial	2 Door exhausts	15	18.8	65.8	116
Case 94	Slot	Ceiling	15	17.5	63.5	117
Case 35	Slot	Ceiling	15	17.5	63.5	122
Case 86	Slot	Low	15	17.5	63.5	124
Case 32	Slot	Low	15	17.5	63.5	125
Case 85	Radial	Low	15	17.5	63.5	132
Case 65	Low Ind	Low	15	17.5	63.5	133
Case 36	Low Ind	Ceiling	15	17.5	63.5	134
Case 34	Radial	Ceiling	15	17.5	63.5	136
Case 29	Low Ind	Low	5	11	51.8	140
Case 33	Low Ind	Low	15	17.5	63.5	143
Case 84	Low Ind	2 Door exhausts	15	17.5	63.5	152
Case 83	Slot	2 Door exhausts	15	17.5	63.5	167
Case 67	Low Ind	Low	10	14.8	58.6	201
Case 63	Low Ind	Low	10	14.8	58.6	215
Case 66	Low Ind	Low	5	6.6	43.9	318
Case 62	Low Ind	Low	5	6.6	43.9	342

Table 3.12 Ranking of Cases with respect to Cage CO_2

Case Name	Supply Diffuser Type	Exhaust Location and Number	Supply ACH	Supply Temperature (°C)	Supply Temperature (°F)	Cage CO_2 (ppm)
Case 87	Radial	Low	15	19.2	66.6	1391
Case 88	Slot	Low	15	19.2	66.6	1550
Case 03	Radial	Low	15	18.8	65.8	1568
Case 92	Low Ind	Ceiling	15	18.8	65.8	1631
Case 89	Low Ind	Low	15	19.2	66.6	1636
Case 79	Radial	2 Door exhausts	15	18.8	65.8	1647
Case 23	Slot	Low	15	18.8	65.8	1652
Case 06	Slot	Low	15	18.8	65.8	1652
Case 20	Slot	Ceiling	15	18.8	65.8	1656
Case 52	Radial	Ceiling	15	18.8	65.8	1665
Case 22	Radial	Low	15	18.8	65.8	1665
Case 82	Radial	2 Door exhausts	15	18.8	65.8	1667
Case 30	Low Ind	Low	20	19.8	67.6	1667
Case 90	Radial	Ceiling	15	18.8	65.8	1673
Case 41	Slot	Ceiling x4	15	18.8	65.8	1690
Case 02	Radial	High	15	18.8	65.8	1703
Case 80	Slot	2 Door exhausts	15	18.8	65.8	1707
Case 04	Slot	Ceiling	15	18.8	65.8	1709
Case 91	Slot	Ceiling	15	18.8	65.8	1709
Case 37	Radial	Ceiling/Low 50/50	15	18.8	65.8	1715
Case 97	Slot	Ceiling	15	17.5	63.5	1725
Case 09	Low Ind	Low	15	18.8	65.8	1725
Case 19	Radial	Ceiling	15	18.8	65.8	1725
Case 42	Low Ind	Ceiling x4	15	18.8	65.8	1728
Case 81	Low Ind	2 Door exhausts	15	18.8	65.8	1741
Case 05	Slot	High	15	18.8	65.8	1742
Case 32	Slot	Low	15	17.5	63.5	1747
Case 28	Low Ind	Low	10	16.8	62.2	1749
Case 69	Radial	High x4 / Low x4	15	18.8	65.8	1750
Case 83	Slot	2 Door exhausts	15	17.5	63.5	1756
Case 94	Slot	Ceiling	15	17.5	63.5	1757
Case 35	Slot	Ceiling	15	17.5	63.5	1761
Case 29	Low Ind	Low	5	11	51.8	1764
Case 38	Slot	Ceiling/Low 50/50	15	18.8	65.8	1776
Case 72	Radial	High x4 / Low x2	15	18.8	65.8	1790
Case 18	Low Ind	Ceiling	15	18.8	65.8	1791
Case 64	Low Ind	Low	20	18.9	66.0	1808
Case 21	Low Ind	Ceiling	15	18.8	65.8	1808
Case 17	Slot	Ceiling	15	18.8	65.8	1815
Case 95	Low Ind	Ceiling	15	17.5	63.5	1822
Case 93	Radial	Ceiling	15	17.5	63.5	1822
Case 68	Low Ind	Low	20	18.9	66.0	1838
Case 75	Radial	Ceiling/Low 50/50	15	18.8	65.8	1839
Case 50	Radial	Ceiling	15	18.8	65.8	1840
Case 39	Low Ind	Ceiling/Low 50/50	15	18.8	65.8	1848
Case 84	Low Ind	2 Door exhausts	15	17.5	63.5	1853
Case 57	Radial	Low	15	18.8	65.8	1855
Case 43	Low Ind (rot 90°)	Ceiling	15	18.8	65.8	1855
Case 76	Radial	Ceiling	15	18.8	65.8	1857
Case 54	Slot	Ceiling	15	18.8	65.8	1869
Case 08	Low Ind	High	15	18.8	65.8	1871

Case Name	Supply Diffuser Type	Exhaust Location and Number	Supply ACH	Supply Temperature (°C)	Supply Temperature (°F)	Cage CO_2 (ppm)
Case 36	Low Ind	Ceiling	15	17.5	63.5	1878
Case 77	Slot	Ceiling	15	18.8	65.8	1881
Case 24	Low Ind	Low	15	18.8	65.8	1883
Case 74	Low Ind	High x4 / Low x2	15	18.8	65.8	1884
Case 56	Radial	High	15	18.8	65.8	1886
Case 34	Radial	Ceiling	15	17.5	63.5	1896
Case 86	Slot	Low	15	17.5	63.5	1917
Case 78	Low Ind	Ceiling	15	18.8	65.8	1919
Case 45	Radial	Ceiling	15	18.8	65.8	1929
Case 85	Radial	Low	15	17.5	63.5	1930
Case 31	Radial	Low	15	17.5	63.5	1938
Case 46	Radial	Ceiling	15	18.8	65.8	1943
Case 98	Low ind	Ceiling	15	17.5	63.5	1955
Case 70	Slot	High x4 / Low x4	15	18.8	65.8	1955
Case 96	Radial	Ceiling	15	17.5	63.5	1957
Case 47	Radial	Ceiling	15	18.8	65.8	1961
Case 73	Slot	High x4 / Low x2	15	18.8	65.8	1966
Case 71	Low Ind	High x4 / Low x4	15	18.8	65.8	1968
Case 33	Low Ind	Low	15	17.5	63.5	1974
Case 40	Radial	Ceiling x4	15	18.8	65.8	1975
Case 58	Slot	High	15	18.8	65.8	1990
Case 65	Low Ind	Low	15	17.5	63.5	2002
Case 49	Radial	Ceiling	15	18.8	65.8	2025
Case 55	Low Ind	Ceiling	15	18.8	65.8	2039
Case 61	Low Ind	Low	15	18.8	65.8	2042
Case 51	Radial	Ceiling	15	18.8	65.8	2045
Case 63	Low Ind	Low	10	14.8	58.6	2081
Case 48	Radial	Ceiling	15	18.8	65.8	2099
Case 11	Radial	Low	15	20.7	69.3	2118
Case 44	Radial (rot 90°)	Ceiling	15	18.8	65.8	2118
Case 10	Radial	Ceiling	15	20.7	69.3	2119
Case 15	Low Ind	Low	15	20.7	69.3	2119
Case 67	Low Ind	Low	10	14.8	58.6	2144
Basecase	Radial	Ceiling	15	18.8	65.8	2158
Case 59	Slot	Low	15	18.8	65.8	2161
Case 12	Slot	Ceiling	15	20.7	69.3	2208
Case 53	Radial	Ceiling	15	18.8	65.8	2212
Case 16	Radial	Ceiling	15	18.8	65.8	2213
Case 14	Low Ind	Ceiling	15	20.7	69.3	2215
Case 66	Low Ind	Low	5	6.6	43.9	2318
Case 07	Low Ind	Ceiling	15	18.8	65.8	2321
Case 62	Low Ind	Low	5	6.6	43.9	2325
Case 60	Low Ind	High	15	18.8	65.8	2354
Case 13	Slot	Low	15	20.7	69.3	2491
Case 25	Radial	Ceiling	15	18.8	65.8	3008
Case 27	Low Ind	Ceiling	15	18.8	65.8	3171
Case 26	Slot	Ceiling	15	18.8	65.8	3975

Table 3.13 Ranking of Cases with respect to Room NH_3

Case Name	Supply Diffuser Type	Exhaust Location and Number	Supply ACH	Supply Temperature (°C)	Supply Temperature (°F)	Room NH_3 (day 4) (ppm)
Case 59	Slot	Low	15	18.8	65.8	0.04
Case 12	Slot	Ceiling	15	20.7	69.3	0.04
Case 70	Slot	High x4 / Low x4	15	18.8	65.8	0.06
Case 40	Radial	Ceiling x4	15	18.8	65.8	0.06
Case 10	Radial	Ceiling	15	20.7	69.3	0.07
Case 73	Slot	High x4 / Low x2	15	18.8	65.8	0.09
Case 16	Radial	Ceiling	15	18.8	65.8	0.10
Case 87	Radial	Low	15	19.2	66.6	0.10
Case 92	Low Ind	Ceiling	15	18.8	65.8	0.10
Basecase	Radial	Ceiling	15	18.8	65.8	0.11
Case 13	Slot	Low	15	20.7	69.3	0.11
Case 88	Slot	Low	15	19.2	66.6	0.11
Case 47	Radial	Ceiling	15	18.8	65.8	0.11
Case 15	Low Ind	Low	15	20.7	69.3	0.11
Case 72	Radial	High x4 / Low x2	15	18.8	65.8	0.11
Case 74	Low Ind	High x4 / Low x2	15	18.8	65.8	0.11
Case 69	Radial	High x4 / Low x4	15	18.8	65.8	0.12
Case 46	Radial	Ceiling	15	18.8	65.8	0.12
Case 71	Low Ind	High x4 / Low x4	15	18.8	65.8	0.12
Case 05	Slot	High	15	18.8	65.8	0.12
Case 41	Slot	Ceiling x4	15	18.8	65.8	0.12
Case 11	Radial	Low	15	20.7	69.3	0.12
Case 57	Radial	Low	15	18.8	65.8	0.13
Case 75	Radial	Ceiling/Low 50/50	15	18.8	65.8	0.13
Case 77	Slot	Ceiling	15	18.8	65.8	0.13
Case 14	Low Ind	Ceiling	15	20.7	69.3	0.14
Case 22	Radial	Low	15	18.8	65.8	0.14
Case 89	Low Ind	Low	15	19.2	66.6	0.14
Case 50	Radial	Ceiling	15	18.8	65.8	0.14
Case 37	Radial	Ceiling/Low 50/50	15	18.8	65.8	0.14
Case 23	Slot	Low	15	18.8	65.8	0.14
Case 45	Radial	Ceiling	15	18.8	65.8	0.14
Case 49	Radial	Ceiling	15	18.8	65.8	0.14
Case 30	Low Ind	Low	20	19.8	67.6	0.14
Case 03	Radial	Low	15	18.8	65.8	0.14
Case 76	Radial	Ceiling	15	18.8	65.8	0.14
Case 91	Slot	Ceiling	15	18.8	65.8	0.14
Case 78	Low Ind	Ceiling	15	18.8	65.8	0.15
Case 38	Slot	Ceiling/Low 50/50	15	18.8	65.8	0.15
Case 04	Slot	Ceiling	15	18.8	65.8	0.15
Case 02	Radial	High	15	18.8	65.8	0.15
Case 42	Low Ind	Ceiling x4	15	18.8	65.8	0.16
Case 58	Slot	High	15	18.8	65.8	0.16
Case 19	Radial	Ceiling	15	18.8	65.8	0.16
Case 61	Low Ind	Low	15	18.8	65.8	0.16
Case 26	Slot	Ceiling	15	18.8	65.8	0.16
Case 06	Slot	Low	15	18.8	65.8	0.16
Case 21	Low Ind	Ceiling	15	18.8	65.8	0.16
Case 07	Low Ind	Ceiling	15	18.8	65.8	0.16
Case 08	Low Ind	High	15	18.8	65.8	0.16
Case 54	Slot	Ceiling	15	18.8	65.8	0.17

Case Name	Supply Diffuser Type	Exhaust Location and Number	Supply ACH	Supply Temperature (°C)	Supply Temperature (°F)	Room NH_3 (day 4) (ppm)
Case 43	Low Ind (rot 90°)	Ceiling	15	18.8	65.8	0.17
Case 55	Low Ind	Ceiling	15	18.8	65.8	0.17
Case 52	Radial	Ceiling	15	18.8	65.8	0.18
Case 39	Low Ind	Ceiling/Low 50/50	15	18.8	65.8	0.18
Case 90	Radial	Ceiling	15	18.8	65.8	0.18
Case 60	Low Ind	High	15	18.8	65.8	0.18
Case 95	Low Ind	Ceiling	15	17.5	63.5	0.18
Case 20	Slot	Ceiling	15	18.8	65.8	0.18
Case 79	Radial	2 Door exhausts	15	18.8	65.8	0.18
Case 24	Low Ind	Low	15	18.8	65.8	0.18
Case 56	Radial	High	15	18.8	65.8	0.18
Case 48	Radial	Ceiling	15	18.8	65.8	0.18
Case 51	Radial	Ceiling	15	18.8	65.8	0.18
Case 53	Radial	Ceiling	15	18.8	65.8	0.18
Case 09	Low Ind	Low	15	18.8	65.8	0.20
Case 81	Low Ind	2 Door exhausts	15	18.8	65.8	0.20
Case 17	Slot	Ceiling	15	18.8	65.8	0.20
Case 80	Slot	2 Door exhausts	15	18.8	65.8	0.20
Case 18	Low Ind	Ceiling	15	18.8	65.8	0.20
Case 68	Low Ind	Low	20	18.9	66.0	0.21
Case 64	Low Ind	Low	20	18.9	66.0	0.21
Case 44	Radial (rot 90°)	Ceiling	15	18.8	65.8	0.21
Case 25	Radial	Ceiling	15	18.8	65.8	0.22
Case 98	Low ind	Ceiling	15	17.5	63.5	0.23
Case 93	Radial	Ceiling	15	17.5	63.5	0.24
Case 27	Low Ind	Ceiling	15	18.8	65.8	0.24
Case 31	Radial	Low	15	17.5	63.5	0.24
Case 28	Low Ind	Low	10	16.8	62.2	0.25
Case 82	Radial	2 Door exhausts	15	18.8	65.8	0.27
Case 32	Slot	Low	15	17.5	63.5	0.28
Case 96	Radial	Ceiling	15	17.5	63.5	0.28
Case 97	Slot	Ceiling	15	17.5	63.5	0.29
Case 86	Slot	Low	15	17.5	63.5	0.29
Case 94	Slot	Ceiling	15	17.5	63.5	0.31
Case 29	Low Ind	Low	5	11	51.8	0.32
Case 33	Low Ind	Low	15	17.5	63.5	0.32
Case 85	Radial	Low	15	17.5	63.5	0.33
Case 65	Low Ind	Low	15	17.5	63.5	0.33
Case 35	Slot	Ceiling	15	17.5	63.5	0.34
Case 84	Low Ind	2 Door exhausts	15	17.5	63.5	0.34
Case 36	Low Ind	Ceiling	15	17.5	63.5	0.39
Case 34	Radial	Ceiling	15	17.5	63.5	0.41
Case 83	Slot	2 Door exhausts	15	17.5	63.5	0.49
Case 67	Low Ind	Low	10	14.8	58.6	0.57
Case 63	Low Ind	Low	10	14.8	58.6	0.58
Case 66	Low Ind	Low	5	6.6	43.9	0.72
Case 62	Low Ind	Low	5	6.6	43.9	0.77

Table 3.14 Ranking of Cases with respect to Cage NH_3 (Day 4)

Case Name	Supply Diffuser Type	Exhaust Location and Number	Supply ACH	Supply Temperature (°C)	Supply Temperature (°F)	Cage NH_3 (day 4) (ppm)
Case 87	Radial	Low	15	19.2	66.6	3.13
Case 88	Slot	Low	15	19.2	66.6	3.49
Case 03	Radial	Low	15	18.8	65.8	3.53
Case 89	Low Ind	Low	15	19.2	66.6	3.68
Case 79	Radial	2 Door exhausts	15	18.8	65.8	3.70
Case 23	Slot	Low	15	18.8	65.8	3.71
Case 06	Slot	Low	15	18.8	65.8	3.72
Case 30	Low Ind	Low	20	19.8	67.6	3.75
Case 22	Radial	Low	15	18.8	65.8	3.77
Case 80	Slot	2 Door exhausts	15	18.8	65.8	3.84
Case 09	Low Ind	Low	15	18.8	65.8	3.88
Case 81	Low Ind	2 Door exhausts	15	18.8	65.8	3.92
Case 82	Radial	2 Door exhausts	15	18.8	65.8	3.92
Case 32	Slot	Low	15	17.5	63.5	3.93
Case 28	Low Ind	Low	10	16.8	62.2	3.93
Case 69	Radial	High x4 / Low x4	15	18.8	65.8	3.94
Case 29	Low Ind	Low	5	11	51.8	3.97
Case 92	Low Ind	Ceiling	15	18.8	65.8	4.02
Case 02	Radial	High	15	18.8	65.8	4.03
Case 20	Slot	Ceiling	15	18.8	65.8	4.04
Case 41	Slot	Ceiling x4	15	18.8	65.8	4.06
Case 64	Low Ind	Low	20	18.9	66.0	4.07
Case 37	Radial	Ceiling/Low 50/50	15	18.8	65.8	4.13
Case 68	Low Ind	Low	20	18.9	66.0	4.13
Case 84	Low Ind	2 Door exhausts	15	17.5	63.5	4.17
Case 57	Radial	Low	15	18.8	65.8	4.17
Case 04	Slot	Ceiling	15	18.8	65.8	4.18
Case 72	Radial	High x4 / Low x2	15	18.8	65.8	4.22
Case 90	Radial	Ceiling	15	18.8	65.8	4.22
Case 05	Slot	High	15	18.8	65.8	4.23
Case 24	Low Ind	Low	15	18.8	65.8	4.24
Case 42	Low Ind	Ceiling x4	15	18.8	65.8	4.25
Case 38	Slot	Ceiling/Low 50/50	15	18.8	65.8	4.28
Case 91	Slot	Ceiling	15	18.8	65.8	4.33
Case 33	Low Ind	Low	15	17.5	63.5	4.44
Case 31	Radial	Low	15	17.5	63.5	4.45
Case 52	Radial	Ceiling	15	18.8	65.8	4.49
Case 74	Low Ind	High x4 / Low x2	15	18.8	65.8	4.53
Case 97	Slot	Ceiling	15	17.5	63.5	4.54
Case 86	Slot	Low	15	17.5	63.5	4.54
Case 71	Low Ind	High x4 / Low x4	15	18.8	65.8	4.56
Case 58	Slot	High	15	18.8	65.8	4.58
Case 39	Low Ind	Ceiling/Low 50/50	15	18.8	65.8	4.58
Case 70	Slot	High x4 / Low x4	15	18.8	65.8	4.58
Case 19	Radial	Ceiling	15	18.8	65.8	4.61
Case 18	Low Ind	Ceiling	15	18.8	65.8	4.62
Case 94	Slot	Ceiling	15	17.5	63.5	4.66
Case 17	Slot	Ceiling	15	18.8	65.8	4.71
Case 61	Low Ind	Low	15	18.8	65.8	4.73
Case 21	Low Ind	Ceiling	15	18.8	65.8	4.73
Case 50	Radial	Ceiling	15	18.8	65.8	4.73

Case Name	Supply Diffuser Type	Exhaust Location and Number	Supply ACH	Supply Temperature (°C)	Supply Temperature (°F)	Cage NH_3 (day 4) (ppm)
Case 85	Radial	Low	15	17.5	63.5	4.76
Case 95	Low Ind	Ceiling	15	17.5	63.5	4.77
Case 08	Low Ind	High	15	18.8	65.8	4.83
Case 76	Radial	Ceiling	15	18.8	65.8	4.85
Case 73	Slot	High x4 / Low x2	15	18.8	65.8	4.87
Case 65	Low Ind	Low	15	17.5	63.5	4.90
Case 35	Slot	Ceiling	15	17.5	63.5	4.90
Case 77	Slot	Ceiling	15	18.8	65.8	4.94
Case 10	Radial	Ceiling	15	20.7	69.3	4.94
Case 15	Low Ind	Low	15	20.7	69.3	4.94
Case 43	Low Ind (rot 90°)	Ceiling	15	18.8	65.8	4.96
Case 93	Radial	Ceiling	15	17.5	63.5	4.97
Case 75	Radial	Ceiling/Low 50/50	15	18.8	65.8	4.98
Case 56	Radial	High	15	18.8	65.8	5.01
Case 83	Slot	2 Door exhausts	15	17.5	63.5	5.15
Case 78	Low Ind	Ceiling	15	18.8	65.8	5.16
Case 66	Low Ind	Low	5	6.6	43.9	5.21
Case 45	Radial	Ceiling	15	18.8	65.8	5.22
Case 62	Low Ind	Low	5	6.6	43.9	5.23
Case 54	Slot	Ceiling	15	18.8	65.8	5.32
Case 40	Radial	Ceiling x4	15	18.8	65.8	5.33
Case 46	Radial	Ceiling	15	18.8	65.8	5.35
Case 47	Radial	Ceiling	15	18.8	65.8	5.36
Case 11	Radial	Low	15	20.7	69.3	5.42
Case 36	Low Ind	Ceiling	15	17.5	63.5	5.44
Case 98	Low ind	Ceiling	15	17.5	63.5	5.50
Case 96	Radial	Ceiling	15	17.5	63.5	5.51
Case 49	Radial	Ceiling	15	18.8	65.8	5.56
Case 51	Radial	Ceiling	15	18.8	65.8	5.64
Case 63	Low Ind	Low	10	14.8	58.6	5.64
Case 12	Slot	Ceiling	15	20.7	69.3	5.66
Case 34	Radial	Ceiling	15	17.5	63.5	5.66
Case 16	Radial	Ceiling	15	18.8	65.8	5.76
Case 14	Low Ind	Ceiling	15	20.7	69.3	5.82
Case 48	Radial	Ceiling	15	18.8	65.8	5.98
Case 44	Radial (rot 90°)	Ceiling	15	18.8	65.8	6.03
Case 67	Low Ind	Low	10	14.8	58.6	6.03
Case 55	Low Ind	Ceiling	15	18.8	65.8	6.22
Basecase	Radial	Ceiling	15	18.8	65.8	6.33
Case 59	Slot	Low	15	18.8	65.8	6.38
Case 07	Low Ind	Ceiling	15	18.8	65.8	6.71
Case 53	Radial	Ceiling	15	18.8	65.8	7.02
Case 13	Slot	Low	15	20.7	69.3	7.21
Case 60	Low Ind	High	15	18.8	65.8	7.56
Case 25	Radial	Ceiling	15	18.8	65.8	11.05
Case 27	Low Ind	Ceiling	15	18.8	65.8	12.31
Case 26	Slot	Ceiling	15	18.8	65.8	18.42

3.4 Recommendations

There were a total of 101 typical animal room and ventilation configurations analyzed by CFD simulation and subjected to rigorous quantitative post-processing. The analysis focused on CO_2 and NH_3 concentrations in the scientist's breathing zone (4'11''- 5'11'', 1.5m to 1.8m) and in the cages occupied by mice. As stated in section 3.2, the nominal pass/fail limits chosen were 1 ppm NH_3 in the breathing zone and 25 ppm NH_3 in the cage.

The results of the CFD simulations performed in this study show that no particular room layout or ventilation system produces consistently good or bad results. Indeed, often improvements in the room are accompanied by poorer ventilation in the cages. The CO_2 concentration values are representative of any airborne contaminants, whereas the NH_3 concentrations that are related to the CO_2 concentrations also depend on temperature and relative humidity.

The level of CO_2 concentration in the room breathing zone depends on both the flow rate into the room and the number of cages, and mice present in the room. Doubling the number of cages leads to approximately double the amount of CO_2. Rooms with low stocking density could be operated with lower flow rates;

Acceptable day 5 NH_3 concentrations are produced by supply flow rates of 0.85cfm (4.01e-4 m^3/s) per 100g body weight of mice (equivalent to 5 ACH for single density racks, 10 ACH for double density racks);

Acceptable day 6 NH_3 concentrations are produced by supply flow rates of around 1.28cfm (6.04e-4 m^3/s) per 100g body weight of mice (equivalent to 7.5 ACH for single density racks, 15 ACH for double density racks);

Changing bedding every four to five days will produce acceptable rooms (at supply flow rates of around 0.85 cfm (4.01e-4 m^3/s) per 100g body weight of mice) and acceptable cage environments for the mice;

Increasing the cage temperature by 3.0 ^oC (5.4 ^oF) could extend the period for changing to six or seven days, and can provide a better environment for the mice;

Ceiling level exhausts often provide poor ventilation for cages, compared with low level exhausts;

Although increasing the ventilation rate reduces the concentration of contaminants in the occupied zone of the room by increased dilution, the same cannot be said for cage concentrations. In fact, with single cage density, the cage concentrations of NH_3 were seen to rise with ventilation rates increasing from 15 to 20 ACH;

Higher temperatures in the room and cages reduce the relative humidity, and NH_3 generation and concentrations. Although this can be achieved by low level exhausts (which consistently appear to produce higher temperatures) it is better achieved by increasing the supply discharge temperature for high level and ceiling exhausts, resulting in less cooling in the room and, therefore, lower running costs.

The experimental measurement of NH_3 generation shows dependency on relative humidity. As relative humidity is dependent on temperature (if the level of moisture in the air is constant), raising the temperature in the room and cages will reduce the levels of NH_3. Further, as indicated in the study by Gordon, Becker and Ali (1997), increasing the cage temperatures above the normal 22.0 to 23.0 ^oC (72.0 to 74.0 ^oF) is likely to provide a more comfortable environment for the mice. A recommendation of this study is that the supply discharge temperatures should be increased by 3.0 to 4.0 ^oC (5.4 to 7.2 ^oF) to about 23.0 ^oC (73.4 ^oF). This will provide room temperatures around 25 ^oC (77 ^oF) and cages with a temperature of about 26.0 ^oC (78.8 ^oF), though a few individual cages may rise as high as 28.0 ^oC (82.4 ^oF).