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Analysis of Ventilation Data from the U.S. Environmental Protection Agency Building Assessment Survey and Evaluation (BASE) Study

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ABSTRACT
The U.S. Environmental Protection Agency (EPA) Building Assessment Survey and Evaluation (BASE) study included a range of measurements in 100 randomly selected U.S. office buildings for the purpose of characterizing the existing building stock with respect to determinants of indoor air quality and occupant perceptions of indoor environments. One aspect of the evaluation was the characterization of the ventilation systems serving the study spaces and selected measurements of ventilation performance. This report presents an analysis of these data with a focus on supply and outdoor airflows, including comparisons of the measured data with design values and the outdoor air requirements in ASHRAE Standard 62-2001. The results indicate that, as expected based on thermal load considerations, the average value of the design and measured supply airflow are both about 5 L/s•m^2 (1 cfm/ft^2). The measured outdoor air ventilation is higher than might be expected, with a mean value of **49 L/s (105 cfm)** per person based on volumetric airflow measurements at the air handlers and measured occupant densities. These outdoor air ventilation values are high on average relative to the minimum outdoor air requirements in Standard 62 due to the high outdoor air fractions (relative to minimum) and the actual occupancy being on average 80 % of the design occupancy. Nevertheless, about 17 % of the ventilation measurements are still below the 10 L/s (20 cfm) per person requirement in Standard 62. Under conditions of minimum outdoor air intake and accounting for the lower occupancy levels, the mean ventilation rate is roughly 11 L/s (22 cfm) per person and about one-half of the values are below the per person requirement in Standard 62. In addition, this report contains a number of suggested modifications to the protocol used in these assessments for consideration in future studies.

This report is a revision of the original report on these data published in 2004. This revision reflects some additional analyses of the data, which results in some changes to the numerical values reported, but not to the overall conclusions. The additional analyses are discussed in Appendix F of this report, which was published as a NIST Letter Report in October 2008. All values in this revised report that have changed relative to the original report are noted in bold font. Those tables and figures have been updated are also noted in bold font in the lists of tables and figures page vii and viii respectively.

Keywords: carbon dioxide, design, measurement, mechanical ventilation, office buildings, ventilation

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1. INTRODUCTION AND BACKGROUND

Building ventilation is a primary determinant of indoor air quality (IAQ) in buildings as it impacts indoor contaminant concentrations and occupant comfort. However, relatively few measurements of office building ventilation performance have been conducted, and those data that exist generally have not employed consistent measurement methods and have not involved representative collections of buildings. As discussed below, the EPA Building Assessment Survey and Evaluation (BASE) study was conducted to assess IAQ, including ventilation, in a large number of randomly selected office buildings throughout the U.S. using a standardized protocol. Ventilation performance assessment was a key part of the survey, and this report presents an analysis of the ventilation data collected during the study. The building evaluations were conducted by EPA contractors, and the analysis presented in this report is based on the ventilation data collected by the contractors.

1.1 EPA BASE Study

The EPA BASE study was originally conceived to address the IAQ data gap in public and commercial office buildings. As described in the protocol for the study (EPA 2003), the primary goal of the study was to define the status of the existing building stock with respect to determinants of IAQ and occupant perceptions. The study was also intended to provide data that would form the basis for future building studies, as well as provide guidance on building design, construction, operation, and maintenance. EPA assembled a steering committee to support the design, planning, and implementation of the effort in the following areas: study design; building and heating, ventilating, and air conditioning (HVAC) characteristics; human response and questionnaires; environmental measurements; diagnostics and mitigation; and program integration. A protocol was then developed that incorporated the three major study areas: comfort and environmental measurements; building and HVAC characterization; and an occupant questionnaire. While certain aspects of the entire building were characterized, one or more representative sampling spaces (referred to in this report as *study spaces*) in each building were more intensively characterized due to cost and time limitations. Ultimately the data from the study will reside in a publicly accessible database, and it is expected that the data will be used for a number of applications, such as: developing distributions of IAQ, building and HVAC characteristics; developing new hypotheses regarding, for example, the causes of occupant symptoms; establishing standardized protocols for IAQ studies; examining the relationship of symptoms to building characteristics; and, developing guidance on building design, construction, operation, and maintenance.

Buildings included in the sample were not intended to be IAQ complaint buildings, although some complaint buildings may have been included. However, buildings that had been highly publicized by the media for their IAQ problems were excluded. The building sampling strategy randomized the sample to the extent possible, limited by the success in gaining access to buildings. Over the five-year period from 1994 to 1998, 100 buildings were studied as part of the BASE program. Each building was studied for a one-week period, generally in either the summer or winter, during which the various measurements were conducted. On Wednesdays and Thursdays of that week, HVAC system performance measurements were made at the same time that environmental measurements were made in the occupied space. These HVAC performance measurements were generally made at approximately 9:30 a.m. and 2:30 p.m. on each day. The HVAC performance measurements are described briefly in Table 1, which also contains the number of the data form from the BASE protocol.

Parameter	Monitoring approach	Form Number*
Supply and recirculation airflow	Duct traverse for each air handling unit (AHU) serving study space using pitot tube or hot-wire anemometer.	E-1
Percent outdoor air intake	Calculation from carbon dioxide (CO_2) concentration measured in outdoor air and the supply and return air of each AHU serving the study space.	E-1
Outdoor air intake	For each AHU serving the study space, duct traverse in the outdoor air intake duct. If not possible, estimate from difference between supply and recirculation airflow.	E-1
Supply air temperature and relative humidity	Measurement in supply air duct for each AHU serving study space.	E-1
Exhaust fan operation	Observation by technician mornings and afternoons of monitoring days	E-3
Exhaust fan airflow	Measurement of airflow rates of all exhaust fans serving the study space using flow capture hood or duct traverse; measurement of individual exhaust grilles within the study area; one time measurement.	E-4
Local ventilation performance – supply airflow	Measurement of airflow from all supply diffusers serving the study space (preferred) using flow capture hood; measure a minimum of 50 % of the supply diffusers serving the study space.	E-2
Outdoor air ventilation rate – continuous CO_2	Estimation of ventilation from continuous CO_2 concentration at three locations in study space; only method used in naturally ventilated buildings	E-5

* Form number for data collection in BASE protocol.

Table 1 HVAC performance parameters

The study areas in each building were selected based on the following criteria (EPA 2003):

- Number of occupants: 25 occupants who work for 20 or more hours per week and are available to complete the questionnaire, but preferably 50 to 60 such occupants.
- Served by no more than two air-handling units, but preferably just one.
- A maximum of three floors, but preferably just one.
- Preferably floor area not to exceed 1900 m^2 (20 000 ft^2)

There have been previous analyses of the building and HVAC data, as well as some papers describing the BASE study in more general terms (Brightman et al. 1996, Womble et al. 1995 and 1996). Ludwig et al. (2002) present an analysis of the ventilation data, including a comparison with the outdoor air requirements in ASHRAE Standard 62-1999 (ASHRAE 1999). They conclude that ventilation rates based on indoor CO_2 levels have lower uncertainties than the rates based on the other methods considered and that most of the measured values are higher than the requirements in Standard 62. However, the uncertainties considered are based only on instrumentation specifications and do not consider other sources of error. In particular, the uncertainties of the ventilation estimates using indoor CO_2 are based on only the concentration measurements and not on validity of the assumptions inherent in the mass balance methodology used to make these estimates. Also, their analysis did not investigate ventilation system design values and did not address other ventilation performance parameters of interest, such as supply airflows. Apte et al. (2000) and Erdman et al. (2002) examine associations between sick building syndrome symptoms and indoor-outdoor CO_2 concentration differences as surrogates for per person ventilation rates.

1.2 Objectives of Ventilation Analysis

The purpose of the analysis presented in this report is to produce information on ventilation system design and performance for the 100 BASE office buildings. While there have been some studies of ventilation in office buildings (Persily 1989, Persily and Dols 1991, Persily at al. 1992), none have been associated with such thorough characterizations of indoor environmental conditions and occupant symptoms nor have they been applied to a representative set of buildings. Therefore, the BASE data provide a unique opportunity to obtain important information about U.S. office buildings including ventilation system design values, measured ventilation performance, and the relationship of these measurement results to design values and to requirements in standards. While the following sections describe the specific parameters that are considered, the focus of this analysis is primarily on supply airflows and outdoor air ventilation. It is envisioned that the results of this analysis will be used to investigate relationships of ventilation to IAQ performance parameters and to occupant symptoms. In addition to providing design and measured ventilation data, this study was performed to evaluate the BASE protocol with respect to its ability to obtain reliable ventilation performance data and to recommend modifications to the protocol for use in future studies.

2. METHODOLOGY

The data analysis involved calculations of various parameters using the data obtained by the EPA contractor, most of which is described in the results section. The overall analysis approach is summarized in this section, along with a more detailed discussion of some specific parameters such as the outdoor air fraction of an air handler.

The analysis focused primarily on the study spaces and the ventilation systems serving these spaces in terms of both design and measured performance. As noted earlier, the study spaces were portions of buildings, or in some cases whole buildings, that were the subject of the BASE study test protocol. In this study, ventilation design and performance is assessed primarily in terms of supply airflow and outdoor air intake, along with exhaust airflows to a lesser degree. In addition, occupancy levels are examined. All of the analysis performed by NIST employs data that were provided by EPA, much of which had already been processed by their contractors. For example, the data from duct traverses had already been converted into volumetric airflows. NIST did not use the raw data from the field to verify the processing done by the contractor, as the protocol and data processing already had significant quality control checks. The BASE variables used in the NIST analysis, as well as those obtained from the contractor's analysis, are identified in Appendix A.

The analysis results are presented in the form of the following summary statistics for the variables of interest: mean, standard deviation, median, the 10^{th}, 25^{th}, 75^{th} and 90^{th} percentile values, and the minimum and maximum values.

2.1 Buildings, Study Spaces and Air Handling Systems

The data analysis focused first on the buildings involved in the BASE study and the study spaces in the buildings. Basic information was analyzed to characterize the age and size of the buildings as well as the size and occupancy of the study spaces. The air handling systems serving the study spaces were examined in terms of the types of system, means of outdoor air intake control, and system design specifications. The latter includes supply, return and minimum outdoor airflow capacity and design occupant density. The system design airflows were obtained as part of the BASE protocol, when available, from system specifications and other design documentation. The primary outcomes of these analyses are the supply airflow capacity per unit floor area, expressed as L/s•m^2 (cfm/ft^2), and the minimum outdoor air intake in L/s•person (cfm/person). These design parameters are then examined as a function of building age to determine if any trends over time are evident. In addition, the design capacities of the exhaust ventilation systems are examined, including their contribution to the net airflow balance of the building.

2.2 Measured Data

The analysis of the measured data focused on the following ventilation performance parameters: supply airflow, outdoor air fraction, outdoor air ventilation, and exhaust airflow. An uncertainty analysis is performed for all the calculated parameters based on propagation of the uncertainty estimates for each of the measured quantities, i.e., 30 % for the measured outdoor air intake and recirculation airflow, 10 % for the supply airflows, and 90 mg/m^3 (50 ppm(v)) for the CO_2 concentrations. The uncertainties of the airflows are estimates from an analysis by the EPA contractor who performed the tests (EHE 2001a). The actual uncertainties may very well be larger, or perhaps smaller, than these estimates; however, there is insufficient information available to develop better estimates of the measurement uncertainties. The value for the CO_2 monitors is based on the instrumentation specifications in the study protocol.

Occupant Density

As part of the BASE protocol, the number of occupants in each study space was counted twice a day for at least two days during the test week. These data are analyzed to determine the occupant density of each space in units of number per 100 m^2 (1000 ft^2). These values are compared with the design occupancy based on the number of workstations in each study space and with the occupant density values in ASHRAE Standard 62-2001 (ASHRAE 2001a) and in addendum n to that standard (ASHRAE 2003).

Supply Airflow

The measured supply airflows for the individual air handlers are first compared with the design values. The ratios of measured to design are then evaluated as a function of system type and outdoor air temperature. The supply airflows for the air handlers were combined to determine the total supply airflow to each study space. The supply airflow to each study space was based on the percentage of the air handler airflow serving the study space, which is a variable determined in the ventilation system evaluation. The survey protocol did not provide an uncertainty estimate for these percentages. For the purposes of this analysis, the uncertainty is assumed to equal 10 % of the value except in cases where 100 % of the air is delivered to the study space. In those cases the uncertainty is assumed to be zero. The study space supply airflows are normalized by floor area served and examined as a function of outdoor air temperature.

Outdoor Air Fraction

A key ventilation performance parameter assessed in the study is the outdoor air fraction F_o, i.e., the ratio of the outdoor air intake to the supply airflow. It is of interest as a performance parameter itself and as a means of determining the outdoor air intake through multiplication by the supply airflow. The outdoor air fraction was determined in two ways, dividing the measured outdoor airflow by the measured supply airflow and through the measurement of CO_2 concentrations in the outdoor, supply and recirculation airstreams. The former determination is referred to as a *volumetric* value, while the latter is referred to as the *CO_2 ratio* value.

The volumetric outdoor air fraction was determined for each air handler measurement based on whichever of the expressions in Equations (1a), (1b) and (1c) apply. In Equation (1a), F_o-volumetric is determined by the measured outdoor air intake divided by the supply airflow. In cases where the outdoor air intake was not measured directly but the supply and recirculation flows were measured, F_o-volumetric was determined using Equation (1b). Finally, in cases where the supply airflow was not measured, F_o-volumetric was determined using Equation (1c) based on the sum of the outdoor and recirculation airflows. Mathematically, these three means of determining the volumetric intake fraction are expressed as follows:

$$F_o = Q_O/Q_S \quad (1a)$$

$$F_o = (Q_S - Q_R)/Q_S \quad (1b)$$

$$F_o = Q_O/(Q_O + Q_R) \quad (1c)$$

where F_o is the outdoor air fraction and Q_O, Q_S and Q_R are the outdoor, supply and recirculation airflows respectively. The value of F_o with the minimum uncertainty was identified and is referred to as the *best* volumetric value of F_o. For some air handlers, the value of F_o could be determined using more than one of these expressions. For a small number of cases in which only Equation (1b) could be used, the value of Q_S was less than Q_R, resulting in a negative value. In those cases, the outdoor air fraction and Q_O were both set to zero, but the large uncertainty values were carried through the analysis.

Values of F_o were also determined based on measured CO_2 concentrations in the outdoor, supply and recirculation airstreams using Equation (2),

$$F_o = (C_R - C_S) / (C_R - C_O) \quad (2)$$

where C_R, C_S and C_O are the CO_2 concentrations in the supply, recirculation and outdoor airstreams respectively.

Outdoor Air Ventilation

Outdoor air intake is determined for individual air handlers using whichever of the following approaches was possible:

- Direct measurements of the volumetric airflow in the outdoor air intake duct using standard air speed traverse approaches.
- The difference between direct measurements of the supply and recirculation volumetric airflows.
- The outdoor air fraction based on CO_2 (see Equation (2)) multiplied by the supply airflow.

The measured outdoor airflows for the individual air handlers are compared with the design values for minimum outdoor air for the systems where such a design value exists. The ratios of the measured to design values are evaluated as a function of system type and outdoor air temperature. Based on the measurements at the individual air handlers, the outdoor air ventilation in each study space is calculated. These calculations employ the value of the percentage of the air from each handler that is provided to the study space. As noted above, the protocol does not provide an uncertainty estimate for these values, and the uncertainty is assumed to equal 10 % except when the value is 100 %.

The outdoor air ventilation in the study space is also estimated based on the CO_2 concentrations measured with the fixed monitors used in the study. A number of such monitors were deployed in each study space, which recorded the CO_2 concentration (and other variables) every 5 min over several days. The CO_2 concentrations were averaged across the study space and the peak value identified. In some cases both a morning and an afternoon peak were identified, if the concentration pattern indicated two distinct peaks. In other cases, only a single peak was determined for the day. The peak concentration minus the corresponding outdoor concentration is then used to estimate the outdoor airflow per person assuming that the CO_2 concentration is at equilibrium and assuming a CO_2 generation rate per person of 0.0052 L/s (0.011 cfm). This method is based on a single-zone mass balance of CO_2 in the study space and therefore is valid only when the concentration is indeed at steady-state, the concentration is uniform throughout the space, airflows from adjoining spaces can be ignored, and the outdoor concentration, ventilation rate and generation rate are all constant (Persily 1997). Since the validity of these assumptions was not investigated as part of this study (except that the outdoor concentration was monitored), the validity of the results obtained with this method are subject to question.

Supply Diffuser and Exhaust Airflows

The BASE protocol included one measurement of the supply airflow at the accessible supply air diffusers and the exhaust airflow at exhaust grilles located in the study space. In the case of the supply diffusers, the total supply airflow to the study space is compared with the value based on the measurements at the air handler(s). The measured exhaust airflows are compared with the corresponding design values.

2.3 Timing of Building Evaluations

As noted earlier, the goal in the BASE study was to conduct the measurements during the winter and summer when the systems were more likely to be operating at minimum outdoor air conditions and to increase the likelihood that the system operation would not vary over the test week. Figure 1 is a plot of the measurement dates by month of the year. Note the large number of measurements made during the month of March. However, the month does not necessarily indicate the percentage of outdoor air intake; the outdoor air temperature is a better predictor. Figure 2 shows the distribution of the measurements based on the outdoor air temperature at which the ventilation measurements were made. If one assumes that minimum outdoor air intake occurs for air temperatures below 5 °C (41 °F) and above 20 °C (68 °F), then 339 of the 548 measurement events (or 62 %), with the outdoor temperature recorded, would correspond to minimum outdoor air intake. Of course, the percent of outdoor air intake as a function of outdoor temperature depends on the individual system, and some systems were 100 % outdoor air systems. But based on temperature alone, about one-third of the tests might be expected to be at other than minimum outdoor air intake. The issue of percent outdoor air intake, including the temperature dependence, is discussed again when the outdoor air fraction and outdoor air ventilation measurements are presented.

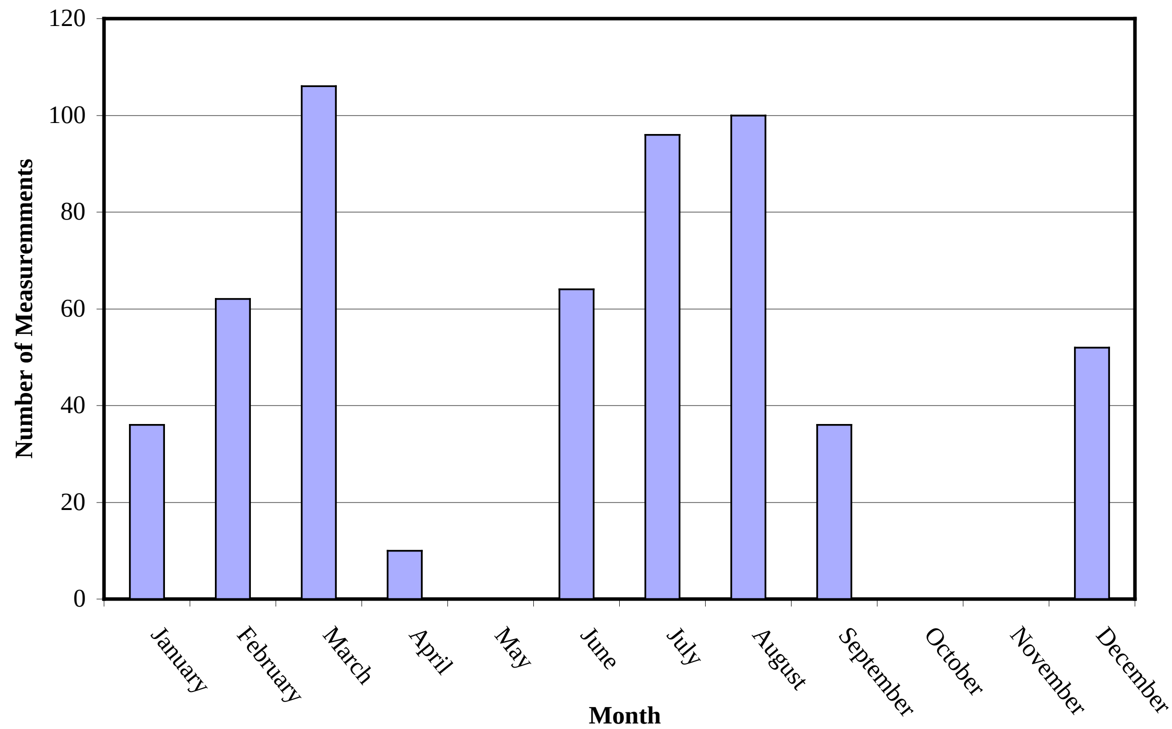

Figure 1 Frequency distribution of measurements based on month

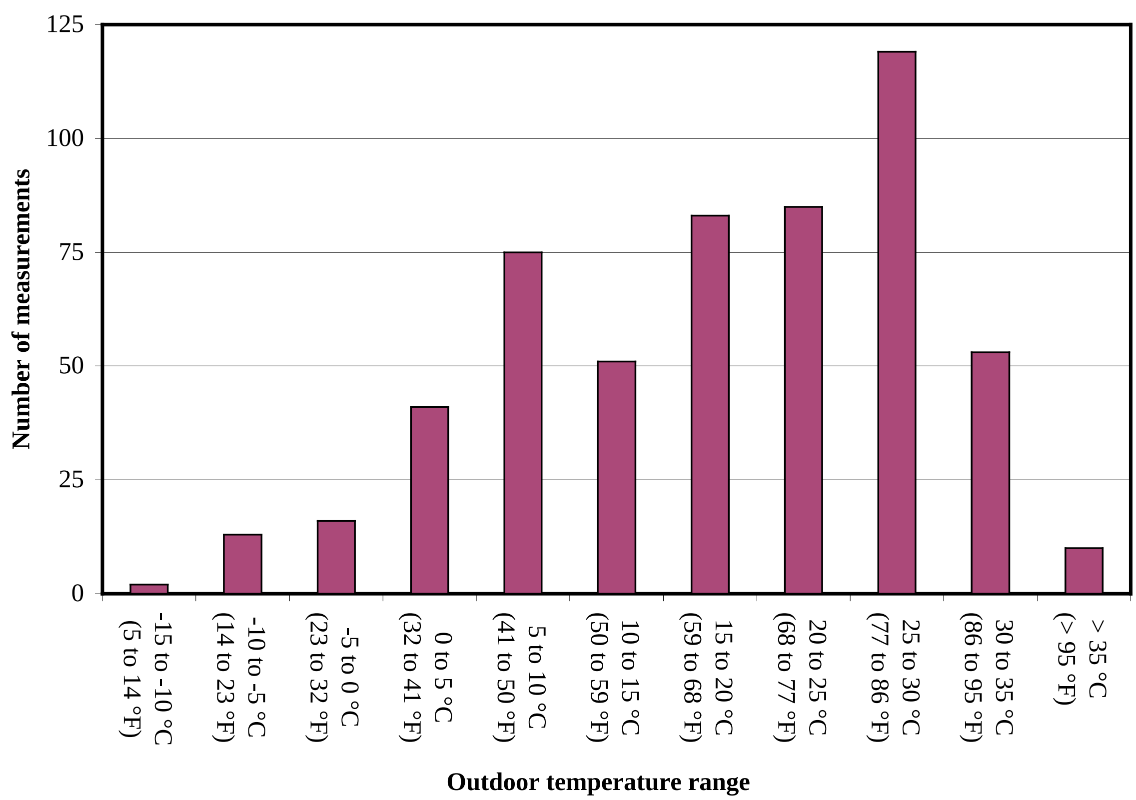

Figure 2 Frequency distribution of measurements based on outdoor temperature

3. RESULTS

This section presents the results of the ventilation analysis performed on the BASE building data. These results include information on the buildings and study spaces, system design parameters, and measured values of occupant density, supply airflow, outdoor air fraction, outdoor air ventilation and exhaust airflow.

3.1 Building and Study Space Information

As noted earlier, 100 buildings were involved in the BASE study. These buildings were randomly selected as described in Womble et al. (1995), and were located throughout the United States. Table 1 presents a summary of the characteristics of the buildings. The years of construction range from 1850 to 1996, with a mean of 1961, though most of them have been renovated at some point. The total number of stories, below and above grade, range from 1 to 61, with a mean of 10 stories. The gross floor area of the buildings range from about 1700 m^2 (18 000 ft^2) to 134 200 m^2 (1 445 000 ft^2), with a mean of 24 800 m^2 (266 000 ft^2). The occupied floor areas, which exclude atria, vacant office space, hallways, stair and elevator shafts, mechanical rooms and core areas, range from 600 m^2 (6000 ft^2) to 98 500 m^2 (1 060 000 ft^2), with a mean of 16 400 m^2 (177 000 ft^2). Of the 100 buildings, 97 have mechanical ventilation systems while three employ predominantly natural ventilation, i.e., buildings NYBS06, ORIS02 and WAIA01. (These building codes are used in the BASE study to identify each building, with the first two letters indicating the state in which they are located.) Ninety-nine of the buildings are air-conditioned (building WAIA01 being the exception), and all are heated.

	Year of construction	**Number of stories**	**Gross floor area** m^2 (ft^2)	**Occupied floor area** m^2 (ft^2)
Mean	1961	10	24 800 (266 000)	16 400 (177 000)
Std. Dev.	31	11	27 900 (300 000)	18 500 (199 000)
Minimum	1850	1	1700 (18 000)	600 (6000)
10^{th} percentile	1906	3	3700 (40 000)	2300 (25 000)
25^{th} percentile	1953	4	7400 (80 000)	5100 (55 000)
Median	1972	6	14 000 (151 000)	8500 (91 000)
75^{th} percentile	1983	12	27 900 (300 000)	21 300 (229 000)
90^{th} percentile	1988	22	65 100 (701 000)	35 900 (386 000)
Maximum	1996	61	134 200 (1 445 000)	98 500 (1 060 000)

Table 2 Building information

It is interesting to compare the BASE buildings to those included in the 1995 U.S. Department of Energy Commercial Building Energy Consumption Survey or CBECS (DOE 1998). CBECS is a national survey of commercial buildings that is conducted quadrennially with a target population of all commercial buildings in the United States with more than 100 m^2 (1000 ft^2) of floor area. The median age of the CBECS buildings corresponds to a year of construction of 1972, which is identical to the BASE value. The mean floor area of the 1995 CBECS office buildings is 1400 m^2 (14 900 ft^2), which is much less than the BASE buildings. However, as noted earlier, the BASE buildings were selected such that the study space had at least 25 occupants and preferably 50 or 60 occupants. The mean number of workers in the CBECS office buildings is 38.4 and 74 % of the office buildings have less than 20 occupants. Therefore the difference in the floor areas between CBECS and BASE is not surprising. Of the 705 000 CBECS office buildings, all but 1000 are heated and 98 % are cooled, consistent with the BASE buildings. A previous analysis of the BASE buildings relative to the CBECS data notes that the BASE buildings are most representative of office buildings with more than 50 occupants, which constitute roughly 11 % of the office building stock but about 73 % of the U.S. office building occupants (EHE 2001b).

The 100 study spaces within the buildings were selected based on the criteria described above, and some of their characteristics are summarized in Table 3. The occupied floor areas range from 430 m^2 (4600 ft^2) to 6440 m^2 (69 300 ft^2), with a mean of 1540 m^2 (16 600 ft^2). The mean number of workstations is 72, which corresponds to 5.3 workstations per 100 m^2 of floor area (4.9 per 1000 ft^2). The number of workstations in this table is the sum of the number of private, partitioned and open-space workstations that were counted as part of the study space characterization. The study space characterization also yielded a value for the design floor area per workstation (variable name B1DESWS). Computing the number of workstations per floor area based on B1DESWS yields similar values to those obtained based on the number of workstations as presented in the table, but not identical. The number of workstation density in the table is below the default value of 7 per 100 m^2 (1000 ft^2) in ASHRAE Standard 62-2001, but close to the default value of 5 per 100 m^2 (1000 ft^2) for office space in addendum n to the standard (ASHRAE 2003). For the 97 study spaces with mechanical ventilation, the mean number of supply air diffusers is 106 and the mean floor area per diffuser of 18.4 m^2 (198 ft^2).

	Occupied floor area, m^2 (ft^2)	**Number of workstations**	**Workstations per 100 m^2 (1000 ft^2)**	**Number of supply air diffusers**	**Floor area per diffuser m^2 (ft^2)**
# of values	100	100	100	97	97
Mean	1540 (16 600)	72	5.3 (4.9)	106	18.4 (198)
Std. Dev.	740 (8 000)	19	2.0 (1.9)	53	16.1(174)
Minimum	430 (4600)	39	1.0 (0.9)	6	5.3 (57)
10th percentile	880 (9 500)	50	3.0 (2.8)	47	8.4 (91)
25th percentile	1130 (12 100)	58	4.0 (3.7)	73	10.9 (118)
Median	1430 (15 400)	68	4.8 (4.5)	98	15.1 (163)
75th percentile	1780 (19 200)	88	6.3 (5.8)	132	19.8 (213)
90th percentile	2250 (24 200)	100	7.6 (7.1)	168	26.9 (290)
Maximum	6440 (69 300)	118	12.5 (11.6)	281	140.0 (1507)

Table 3 Study space information

3.2 Ventilation System Design Parameters

The study spaces in the 97 mechanically ventilated buildings are served by a total of 141 mechanical ventilation systems. Of these systems, 50 are constant air volume (CV) and 91 are variable air volume (VAV). CV systems provide a constant amount of supply air, while varying the supply air temperature to meet the heating and cooling loads of the space. VAV systems maintain a constant supply air temperature and vary the supply airflow to meet the loads. The system types are summarized in Table 4 based on the system classification and letter codes in the BASE protocol.

In addition to the system types in Table 4, other design features related to outdoor air intake control were collected for the ventilation systems. Table 5 presents this information for the mechanically ventilated buildings, including the number with systems that employ temperature (dry-bulb) or enthalpy economizer cycles. Twenty-one buildings have dedicated outdoor air fans, with 11 of those also conditioning the air. Five buildings have 100 % outdoor air systems, and 88 have fixed minimum outdoor air intake dampers. A small number have the outdoor air intake controlled using airflow monitoring, supply/return fan tracking or building pressure.

Constant volume (CV)	Number of systems	Variable air volume (VAV)	Number of systems
A Single duct, single zone	13	D Single duct	37
B Single duct, multiple zone reheat	8	E Single duct, reheat	17
J Dual duct	2	F Single duct, induction	7
K Dual duct, reheat	7	G Single duct, fan powered, constant fan	8
N Multizone	17	H Single duct, fan powered, intermittent fan	18
O Blow-through bypass	3	L Dual duct, single fan	3
		M Dual duct, dual fan	1
TOTAL CV	50	TOTAL VAV	91

Table 4 Ventilation System Types

Outdoor air intake control	Number of buildings
Economizer cycle (temperature control)	50
Economizer cycle (enthalpy control)	21
Dedicated outdoor air fan, conditioned	11
Dedicated outdoor air fan, unconditioned	10
100 % outdoor air	5
Fixed minimum outdoor air damper	88
Outdoor air intake controlled via monitoring	2
Outdoor air intake controlled via supply/return fan tracking	5
Outdoor air intake controlled by building pressure	4

Table 5 Outdoor air intake control

The availability of design information varies among the systems, however the information that does exist was analyzed and the results are summarized in Table 6. (Detailed design information for all the systems is provided in Appendix B.) Table 6 presents the floor area served by the systems, the design supply airflow capacity normalized by floor area served (for all systems as well as for CV and VAV systems separately), the ratio of design supply to return airflows, the design minimum outdoor air intake per person and per unit floor area, the ratio of the design minimum outdoor air intake to the design supply air capacity, and the occupant density. The occupant density is based on the number of occupants served by the air handler, which was obtained during the surveys from a building walkthrough or from the building management. (During the study space surveys, the actual number of occupants was counted and those results are presented later in this report.) When calculating the supply airflow capacities, the minimum outdoor air intake, and the occupant densities, some values were not in the expected range. These values include supply airflows greater than 15 L/s•m^2 (3 cfm/ft^2), minimum outdoor air intake greater than 33 L/s (70 cfm) per person or 5 L/s•m^2 (1 cfm/ft^2), and occupant densities greater than 12 per 100 m^2 (1000 ft^2). Values outside these ranges are included in the statistics in Table 6, and the outliers themselves are identified in Table 7.

As seen in Table 6, for the 134 air handling systems with design data, the mean value of the design supply airflow normalized by floor area served is **5.86 L/s•m^2 (1.15 cfm/ft^2)**, which is close to the expected value of 5 L/s•m^2 (1 cfm/ ft^2) based on typical cooling loads and supply air temperatures in office buildings. The median value is even closer to the expected supply airflow rate, and the mean is slightly higher for CV systems and lower for VAV systems. The ratio of the design supply airflow to the design return airflow could be determined for 41 of the systems, and the mean value is 1.14. This value is consistent with the common design intent to provide more supply than return air to a space to achieve positive pressurization and to ensure that toilet and other exhaust systems are able to function properly.

	Floor area served m^2 (ft^2)	**Design supply airflow capacity** L/s•m^2 (cfm/ft^2)			**Supply/ Return**
		All systems	CV	VAV	
# of values	141	134	47	87	41
Mean	**3100 (33 300)**	**5.86 (1.15)**	7.01 (1.38)	**5.25 (1.03)**	1.14
Std. Dev.	**4230 (45 600)**	**3.57 (0.70)**	5.33 (1.05)	**1.85 (0.36)**	0.22
Minimum	**110 (1200)**	1.13 (0.22)	1.13 (0.22)	1.67 (0.33)	0.20
10th percentile	540 (5800)	2.90 (0.57)	2.74 (0.54)	**3.26 (0.64)**	1.00
25th percentile	990 (10 700)	4.15 (0.82)	4.19 (0.83)	4.15 (0.82)	1.07
Median	**1640 (17 600)**	**5.21** (1.03)	5.63 (1.11)	**4.99 (0.98)**	1.11
75th percentile	**3440 (37 000)**	**6.78 (1.33)**	7.83 (1.54)	**6.17 (1.22)**	1.25
90th percentile	**7620 (82 100)**	**8.45 (1.66)**	11.21 (2.21)	**7.56 (1.49)**	1.28
Maximum	33 780 (363 600)	30.18 (5.94)	30.18 (5.94)	**12.47 (2.45)**	1.85

	Design minimum outdoor air intake		**Minimum OA/ Supply**	**Occupant density** #/100 m^2 (1000 ft^2)
	L/s (cfm) per person	L/s•m^2 (cfm/ft^2)		
# of values	74	76	76	137
Mean	18.4 (39.0)	0.94 (0.18)	0.19	**5.3 (4.9)**
Std. Dev.	13.7 (29.0)	1.06 (0.21)	0.22	**6.5 (6.1)**
Minimum	1.3 (2.9)	0.17 (0.03)	0.06	0.9 (0.8)
10th percentile	7.5 (16.0)	0.31 (0.06)	0.08	2.2 (2.0)
25th percentile	10.6 (22.4)	0.42 (0.08)	0.10	2.9 (2.7)
Median	15.2 (32.1)	0.60 (0.12)	0.12	**3.9** (3.7)
75th percentile	23.6 (50.0)	0.92 (0.18)	0.15	5.9 (**5.4**)
90th percentile	29.7 (63.0)	**1.82** (0.36)	0.31	**8.0 (7.4)**
Maximum	98.3 (208.2)	6.67 (1.31)	1.00	65.1 (60.5)

Table 6 System design values

The mean value of the design minimum outdoor air intake per person is 18.4 L/s (39.0 cfm), and the median is 15.2 L/s (32.1 cfm). These values are above the minimum outdoor air requirement for office space in ASHRAE Standard 62-2001 (ASHRAE 2001) of 10 L/s (20 cfm) per person. The design outdoor air intake in Table 6 is based on the number of workstations, since the number of occupants used in the design is not available. However, dividing the design minimum outdoor airflow by the number of occupants based on the occupant density in ASHRAE Standard 62-2001 (7 people per 100 m^2 (1000 ft^2)) instead of the actual number of workstations yields a mean per person outdoor air intake of 13.1 L/s (25.8 cfm) and a median of 8.5 L/s (16.7 cfm), which are closer to the ASHRAE requirement. Note that design the minimum outdoor air intake is available for only 76 of the 141 systems. Also, these systems were designed at various times, and therefore it is not clear what standard or code requirements the systems were used in the design. The table also provides the design minimum outdoor air intake on a floor area basis.

Finally, the mean ratio of the minimum outdoor air intake to supply airflow capacity is 0.18 and the median value is 0.12, consistent with expected values of 10 % to 20 %.

The mean value of the design occupant density in Table 6 is **5.3 people per 100 m^2 (4.9 per 1000 ft^2)**, while the median value is 3.9 per 100 m^2 (3.7 per 1000 ft^2). As noted earlier when discussing the study spaces, these values for the individual air handlers are below the default value of 7 per 100 m^2 (1000 ft^2) in ASHRAE Standard 62-2001, but close to the default value of 5 per 100 m^2 (1000 ft^2) for office space in addendum n to the standard (ASHRAE 2003).

System *	**Issue**	**Comments**
AZHW10 (2 of 2)	High supply capacity, 24 L/s•m^2 (4.7 cfm/ft^2)	System (1) at 8 L/s•m^2 (1.5 cfm/ft^2)
LAGW05 (1 of 2)	High supply capacity, 18 L/s•m^2 (3.6 cfm/ft^2)	System (2) at 4 L/s•m^2 (0.7 cfm/ft^2); occupant density 5 times that of system (2); floor area could be low
~~MOCS01 (1 of 1)~~	~~High supply capacity, 27 L/s•m^2 (5.3 cfm/ft^2)~~	
PABS04 (2 of 2)	High supply capacity, 25 L/s•m^2 (5.9 cfm/ft^2)	System (1) at 4 L/s•m^2 (0.8 cfm/ft^2)
CAEW09 (1 of 1)	High minimum outdoor air 53 L/s (113 cfm) per person,	Minimum outdoor air based on supply and return capacities
CAJS21 (2 of 2)	High minimum outdoor air, 98 L/s (208 cfm) per person	100 % outdoor air system; System (1) at 29 L/s (61 cfm) per person
MDDS01 (1 of 1)	High minimum outdoor air, 51 L/s (109 cfm) per person	
NCDW03 (2 of 5)	High minimum outdoor air, 38 L/s (80 cfm) per person	Other 4 systems from 9 L/s (20 cfm) per person to 16 L/s (33 cfm) per person; system (2) occupant density about 25 % of other 4 systems.
NECW02 (1 of 1)	High minimum outdoor air, 38 L/s (80 cfm) per person	High occupant density, 16 occupants per 100 m^2 (1000 ft^2)
TNFS10 (1 of 1)	High minimum outdoor air, 34 L/s (72 cfm) per person	Low occupant density, 1.1 occupants per 100 m^2 (1000 ft^2)
CAJW25 (1 of 1)	High occupant density, 61 occupants per 100 m^2 (1000 ft^2)	Supply airflow 24 L/s•m^2 (2.5 cfm/ft^2); floor area could be low
~~MOCS01 (1 of 1)~~	~~High occupant density, 24 occupants per 100 m^2 (1000 ft^2)~~	
NECW02 (1 of 1)	High occupant density, 16 occupants per 100 m^2 (1000 ft^2)	
SDBW02 (1 of 1)	High occupant density, 38 occupants per 100 m^2 (1000 ft^2)	Low minimum outdoor air 1 L/s (3 cfm) per person, consistent with high occupant density value
TNDS05 (1 of 2)	High occupant density, just over 12 occupants per 100 m^2 (1000 ft^2)	System (2) lists no occupants

* Values in parentheses refers to air handler number relative to total number of air handlers, e.g. (2 of 2) means second of two air handlers serving the study space.

Table 7 System design outliers[+]

[+] The text in the table noted with a strikethrough corresponds to two occurrences that are no longer outliers given the modifications to the data described earlier.

The ventilation requirements in ASHRAE Standard 62-2001 were recently revised by addendum n to the standard (ASHRAE 2003). In the new procedure, the number of occupants is multiplied by an outdoor air requirement in units of L/s (cfm) per person and the product is added to the floor area multiplied by a separate requirement in units of L/s•m^2 (cfm/ft^2). For office space these values are 2.5 L/s (5 cfm) per person and 0.3 L/s•m^2 (0.06 cfm/ft^2). This method was used to determine the per person ventilation requirements of the study spaces based on the number of workstations and the floor area. Table 8 presents the results. Note that the mean outdoor air requirement is slightly lower than the 10 L/s (20 cfm) per person requirement in Standard 62-2001, but the variation about the mean highlights the intended impact of occupant density.

	Study space outdoor air requirement L/s (cfm) per person
Mean	**9.0 (19.1)**
Std. Dev.	**3.3 (6.9)**
Minimum	4.8 (10.2)
10^{th} percentile	**6.5 (13.7)**
25^{th} percentile	7.2 (15.3)
Median	8.7 (18.3)
75^{th} percentile	10.0 (21.1)
90^{th} percentile	**12.1 (25.7)**
Maximum	33.5 (71.0)

Table 8 Study space outdoor air requirements based on Standard 62 addendum n

The system design values were examined to determine if there was a dependence on the year that the building was built. Figures 3 through 5 show the design supply airflow capacity, the design minimum outdoor air intake, and the occupant density, respectively, as a function of the year built. No clear trends are evident for any of these parameters, though there is a suggestion of lower supply airflows and occupant densities in newer buildings. Figures 3 and 4 show that more of the recent buildings employ VAV than CV systems, and that these VAV systems tend to have lower supply capacities as seen in Table 6. The supply air capacity was also examined as a function of the climate in which the building is located, as expressed by the number of heating and cooling degree days, but no relationship was evident.

The BASE protocol also obtained information on the frequency of a number of system maintenance activities. Table 9 summarizes the frequency of some inspection and maintenance activities that might impact ventilation airflows. Note that these frequencies are listed as the number of buildings, not the number of air handlers. Some of the less common frequencies, such as bi-weekly, are not included in the table. Also, not all of the buildings reported the inspection and maintenance items listed in the table. The air handler inspections appear to occur fairly often, but there is no information on the extent of these inspections. The other four activities are reported to occur much less often, particularly ductwork inspections and system testing, adjusting and balancing. The ratios of the measured airflows to design values were evaluated with respect to these frequencies, but no trends were evident.

Frequency	Air handler inspection	Ductwork inspection	Controls inspection	Controls recalibration	Testing, adjusting & balancing
	Number of buildings				
Daily	14	0	14	0	0
Weekly	5	0	2	0	0
Monthly	23	1	4	4	0
Quarterly	29	2	12	3	0
Semi-annually	6	1	11	7	0
Annually	3	4	14	10	3
As needed	4	32	28	58	52
None	0	59	12	15	43

Table 9 Reported frequencies of selected system maintenance activities

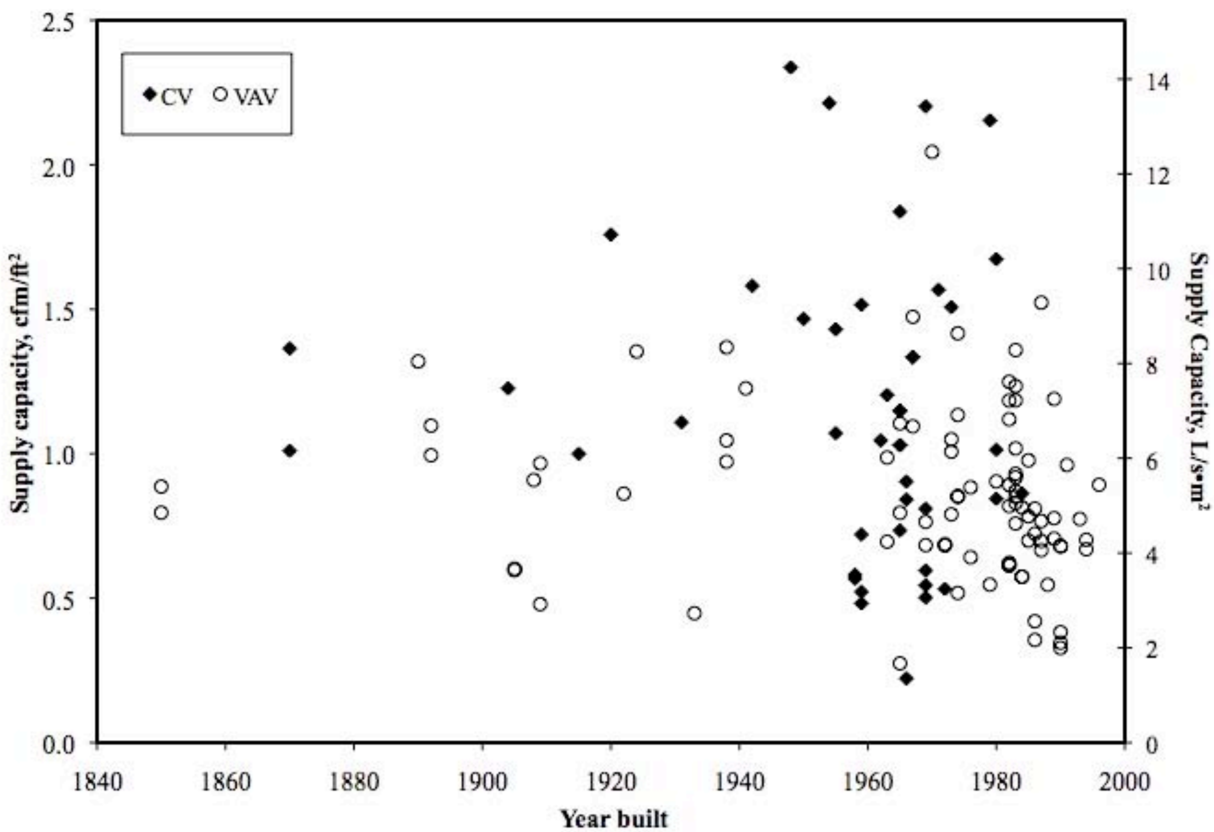

Figure 3 Design supply airflow capacity versus year built

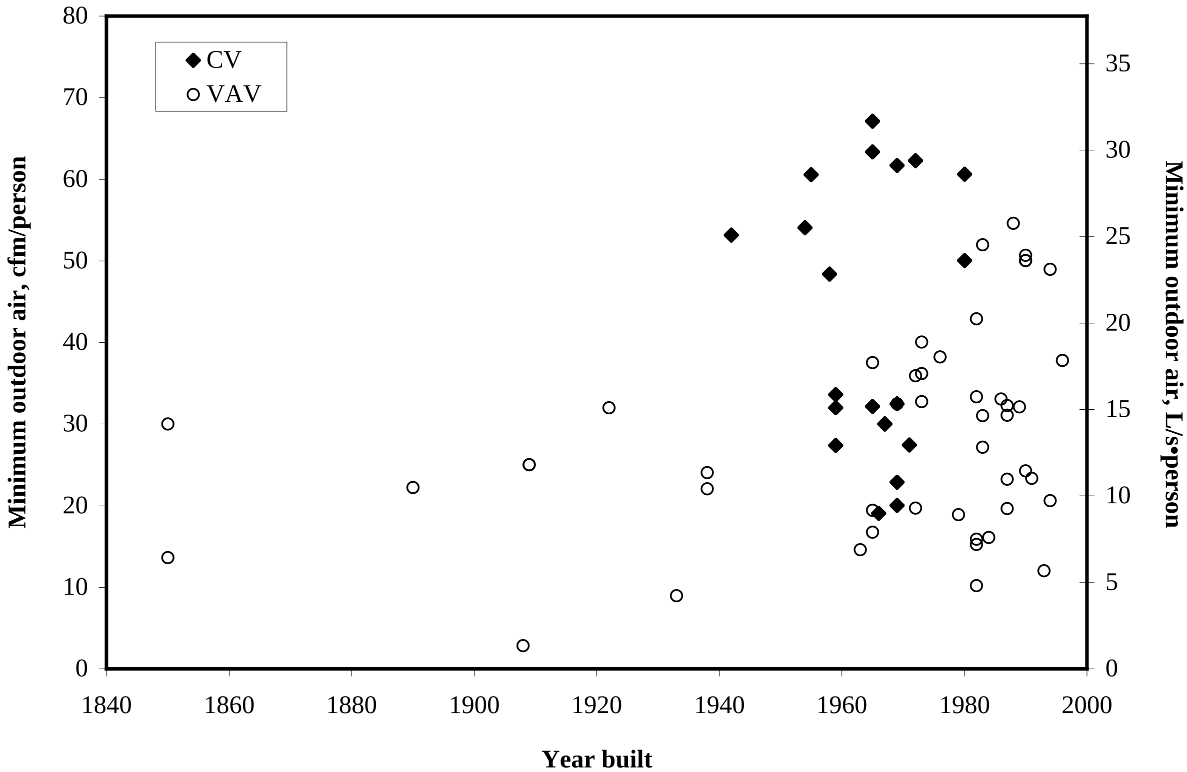

Figure 4 Design minimum outdoor air intake versus year built

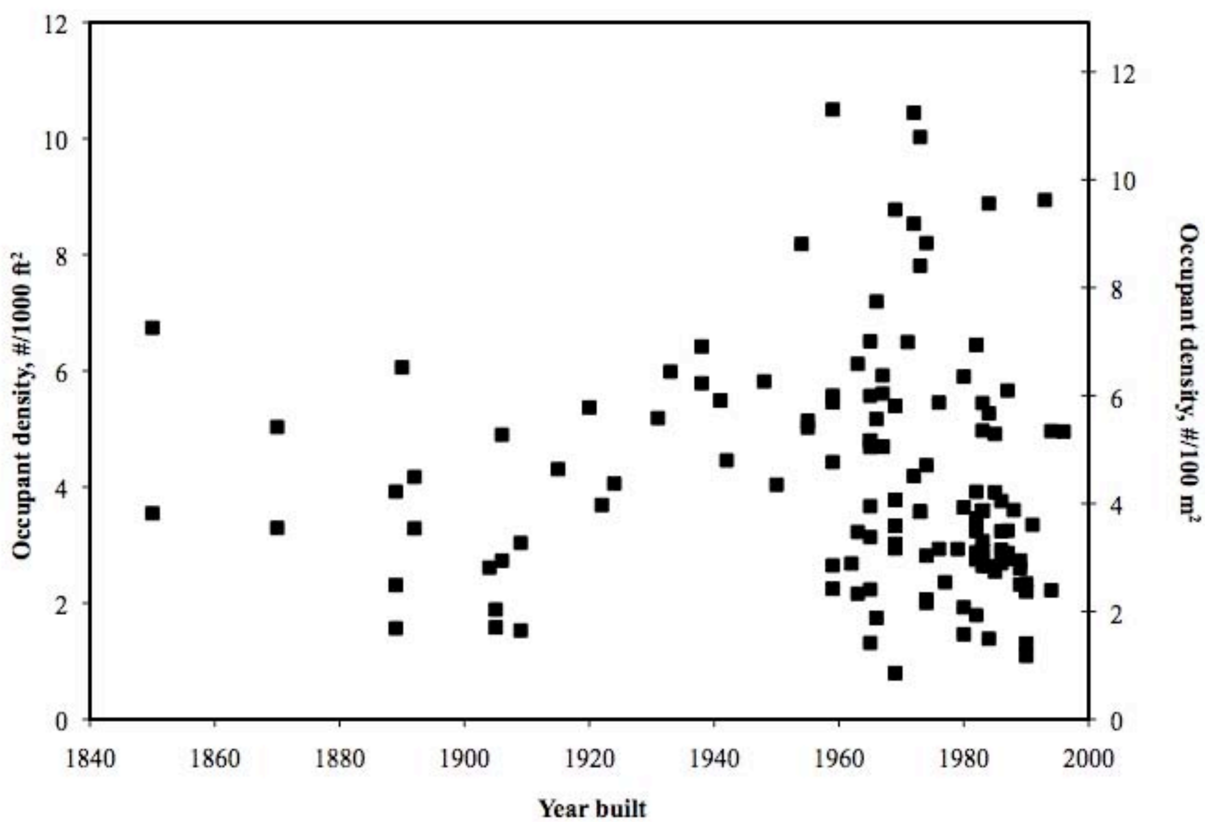

Figure 5 Design occupant density versus year built

3.3 Exhaust System Design and Building Airflow Balance

In addition to the air handlers discussed in the last section, the 159 exhaust ventilation systems serving the study spaces were also considered in an attempt to examine the net design airflow into or out of the buildings. Table 10 presents a summary of the design information for the exhaust systems, which are predominantly toilet exhausts but also include kitchen exhaust, building relief and other fans. Design airflows are available for only 129 of the exhaust fans. Note that the individual airflows cover a wide range, with the maximum design airflow 500 times the minimum. The third column presents the design airflow normalized by floor area for the 126 systems for which the floor area served is available. (For toilet exhausts, the floor area is that of the toilet room.) While the variation in this normalized value is still large, it is less than for the airflows. The last column presents the normalized design airflows for only the toilet exhausts, which exhibit a smaller standard deviation than for all the exhaust fans.

	All exhaust systems		**Toilet exhausts only**
	L/s (cfm)	L/s•m^2 (cfm/ft^2)	L/s•m^2 (cfm/ft^2)
# of values	129	126	88
Mean	2310 (4880)	14.9 (2.94)	14.3 (2.81)
Standard deviation	3290 (6960)	21.8 (4.28)	13.2 (2.59)
Minimum	40 (90)	0.6 (0.13)	0.7 (0.14)
10th percentile	180 (390)	4.2 (0.83)	6.2 (1.23)
25th percentile	400 (850)	6.8 (1.34)	7.5 (1.47)
Median	950 (2020)	9.6 (1.89)	10.1 (1.99)
75th percentile	2610 (5530)	15.0 (2.96)	16.0 (3.15)
90th percentile	4990 (10 570)	23.0 (4.52)	22.9 (4.51)
Maximum	21 250 (45 030)	189.0 (37.19)	91.3 (17.98)

Table 10 Summary of exhaust system design values

In addition to the exhaust fan design values, the net design airflow into, or out of, the buildings was also considered. The issue of interest is whether and to what extent these buildings are designed for positive pressurization, which is the typical design intent motivated by infiltration control, moisture transport through building envelopes and proper functioning of building exhaust fans. While the mean ratio of the supply to return design airflows for the study space air handlers in Table 6 is greater than one, this ratio does not include exhaust airflows and therefore does not describe the design airflow balance. In the BASE protocol, design values were obtained for air handler supply, return and outdoor airflows and for the exhaust fans serving the study spaces. These design values do not allow the determination of the net airflow for the building when there are other air handlers and exhaust fans. Therefore, a design airflow analysis for the whole building could only be performed for the six study spaces that correspond to an entire building. Table 11 presents the relevant design values for these buildings and the results of the net airflow analysis.

With only six buildings, and a lack of design data in some cases, the net building airflow can be calculated for only a small number of cases. The sixth column of Table 11 contains the design supply airflow minus the design return and exhaust airflows for the three buildings for which it could be calculated. This quantity describes the net airflow into the conditioned space of the building. For buildings CAEW09 and CAJS22, the values are positive and equal to 0.05 L/s•m^2 (0.23 cfm/ft^2) and 0.17 L/s•m^2 (0.85 cfm/ft^2) respectively. In building SDBW01 the value is negative but very small, -0.01 L/s•m^2 (-0.05 cfm/ft^2), which is very close to a balance between the airstreams. The last column presents the balance between the air entering and leaving the building, i.e., the design minimum outdoor air intake minus the exhaust. Only four values can be determined, with three positive and one slightly negative. The three positive values, for buildings CAES09, CAJS22 and SDBW01 respectively, are 0.05 L/s•m^2 (0.23 cfm/ft^2), 0.01 L/s•m^2 (0.03 cfm/ft^2) and 0.01 L/s•m^2 (0.05 cfm/ft^2). The negative value is so close to zero that it indicates a balance between the minimum intake and exhaust airflows.

	Design airflows, L/s (cfm)				**Net design airflow,** L/s (cfm)	
Building	**Supply**	**Return**	**Minimum outdoor air**	**Exhaust**	**Sup. – ret. – exh.**	**MinOA – Exh.**
AZHS04	11 150 (23 610)	No value	No value	8330 (17 640)	--	--
CAEW09	38 730 (82 050)	30700 (65040)	8030 (17 010)	600 (1280)	7430 (15 730)	7430 (15 730)
CAJS22	8970 (19 010)	No value	1040 (2200)	780 (1650)	8190 (17 360)	260 (550)
SDBW01	9920 (21 010)	9590 (20310)	1500 (3170)	920 (1950)	-590 (-1250)	580 (1220)
TNFS08	8640 (183 10)	No value	590 (1250)	600 (1260)	--	-10 (-10)
TXFS02	17 000 (36 020)	No value	No value	No value	--	--

Table 11 Net design airflow analysis

3.4 Measured Occupant Density

The actual number of occupants was counted at least four times in each study space. Table 12 summarizes these observations. These data show that on average the actual occupancy is about 80 % of the design occupancy as defined by the number of work stations, corresponding to a mean occupant density of 4.0 people per 100 m^2 (3.7 per 1000 ft^2). The occupant density data were also analyzed for only those times when the ventilation parameters were measured, typically on Wednesday and Thursday of the test week. There were 388 such values, but the summary statistics are essentially identical to those seen in Table 11.

	Measured occupant density, #/100 m^2 (#/1000 ft^2)	**Measured density/Number of work stations**
# of values	824	824
Mean	4.0 (3.7)	0.78
Standard deviation	1.7 (1.6)	0.24
Minimum	0.9 (0.9)	0.24
10th percentile	2.3 (2.2)	0.57
25th percentile	2.8 (2.6)	0.65
Median	3.6 (3.3)	0.76
75th percentile	5.0 (4.6)	0.87
90th percentile	6.3 (5.9)	0.98
Maximum	11.1 (10.3)	3.13

Table 12 Summary of measured occupant density

3.5 Ventilation System Performance Measurements

This section presents the ventilation system performance measurement results for the air handlers serving the study spaces and for the study spaces themselves. There were 562 ventilation measurement events, that is, the total number of times that some or all of the ventilation measurements were made on the study space air handlers. These measurements cover 97 of the 100 BASE buildings, excluding the three naturally ventilated buildings. Appendix C lists a number of cases where measurement issues associated with the volumetric airflow measurements were identified, along with any adjustments that were made to account for these issues. The measurements are presented in Appendix D for the air handlers and Appendix E for the study spaces. Each measured value in these appendices is presented with an uncertainty estimate associated with the value. The naturally ventilated buildings are discussed in conjunction with the outdoor air ventilation estimated using peak CO_2 concentrations in section 3.5.4.

3.5.1 Supply Airflow

Of the 562 measurement events, 495 included measurements of the system supply airflow. In some cases, the supply airflow is estimated by adding the outdoor air intake and the recirculation airflow, resulting in a total of 536 measured supply airflow values. As noted earlier, the uncertainty associated with the supply airflow measurements was estimated to equal 10 %. When the supply airflow is based on the sum of the outdoor and recirculation airflows, the uncertainty in the supply airflow is about 25 %, based on a 30 % uncertainty in the outdoor airflow and 10 % in the recirculation flow.

The measured supply airflows are compared with the design supply capacities in the 512 cases where a design value exists. The mean value of the ratio of the measured supply airflow to the design value is 0.83. The mean is 0.72 for the VAV systems and 1.07 for the CV systems. The VAV systems are expected to have a lower ratio of measured to design, since these systems modulate the supply airflow in response to internal loads. Figure 6 is a plot of the measured to design ratio against outdoor temperature. Note that for the VAV systems, the ratio decreases for outdoor temperatures below about 15 °C (59 °F), presumably due to the lower cooling loads at these temperatures. The CV data points exhibit little dependence on outdoor temperature. Four CV points have a ratio of about 4.5, which all correspond to the single air handler serving study space CAJS03. This air handler has the lowest design value of supply airflow capacity per unit floor area, and it is possible that the design value is in error or out of date. The mean ratio of measured to design for CV systems is reduced from 1.07 to 0.98 without these four values.

The supply airflows for the air handlers were combined to determine the supply airflow to each study space. These supply airflows were then divided by the study space floor area (B1AREA), and the results are summarized in Table 13 and plotted versus outdoor air temperature in Figure 7. Both the table and the figure distinguish between VAV and CV systems. The values of the study space supply airflow per unit floor area range from **0.88 L/s•m^2** (0.17 cfm/ft^2) to 21.11 L/s•m^2 (4.15 cfm/ft^2). The mean value for all the systems is **5.12 L/s•m^2 (1.01 cfm/ft^2)**; the mean uncertainty is 16 % of the measured value, and the maximum is 31 %. As expected, the VAV systems have lower supply airflows than the CV systems, and the dependence on outdoor temperature is similar to that seen in Figure 6. Note that the high points in Figure 7 do not correspond to the high points in Figure 6. The eight points in Figure 7 greater than 15 L/s•m^2 (3 cfm/ft^2) correspond to cases with high design supply airflows (CAES17 and LAGW05).

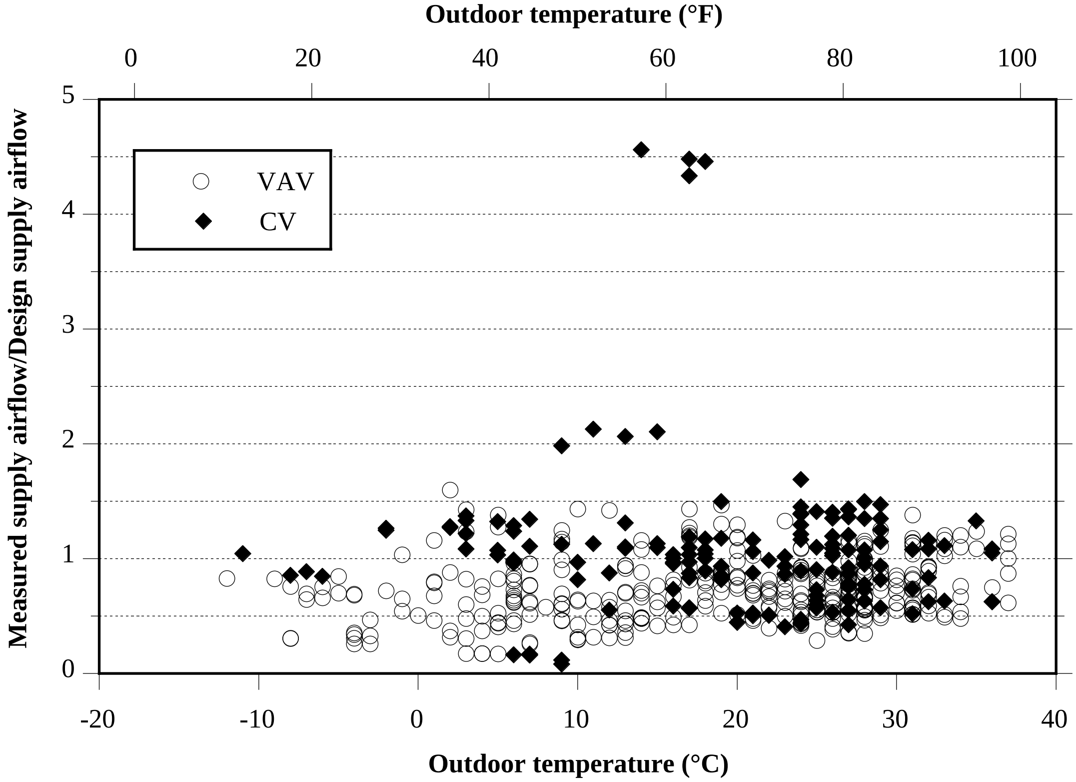

Figure 6 Ratio of measured to design supply airflow versus outdoor temperature

	Supply airflow/Floor area L/s•m^2 (cfm/ft^2)		
	All systems	VAV	CV
# of values	384	289	95
Mean	**5.12 (1.01)**	**4.55 (0.90)**	6.86 (1.35)
Std. Dev.	**3.02 (0.59)**	**2.62 (0.52)**	3.46 (0.68)
Minimum	0.88 (0.17)	0.88 (0.17)	1.80 (0.35)
10th percentile	**2.16 (0.43)**	**2.12 (0.42)**	2.25 (0.44)
25th percentile	**2.99 (0.59)**	**2.89 (0.57)**	4.82 (0.95)
Median	**4.69 (0.92)**	**4.30 (0.85)**	5.72 (1.13)
75th percentile	**6.25 (1.23)**	**5.69 (1.12)**	9.04 (1.78)
90th percentile	**8.47 (1.67)**	**7.19 (1.41)**	11.34 (2.23)
Maximum	21.11 (4.15)	21.11 (4.15)	16.24 (3.20)

Table 13 Summary of measured supply airflows

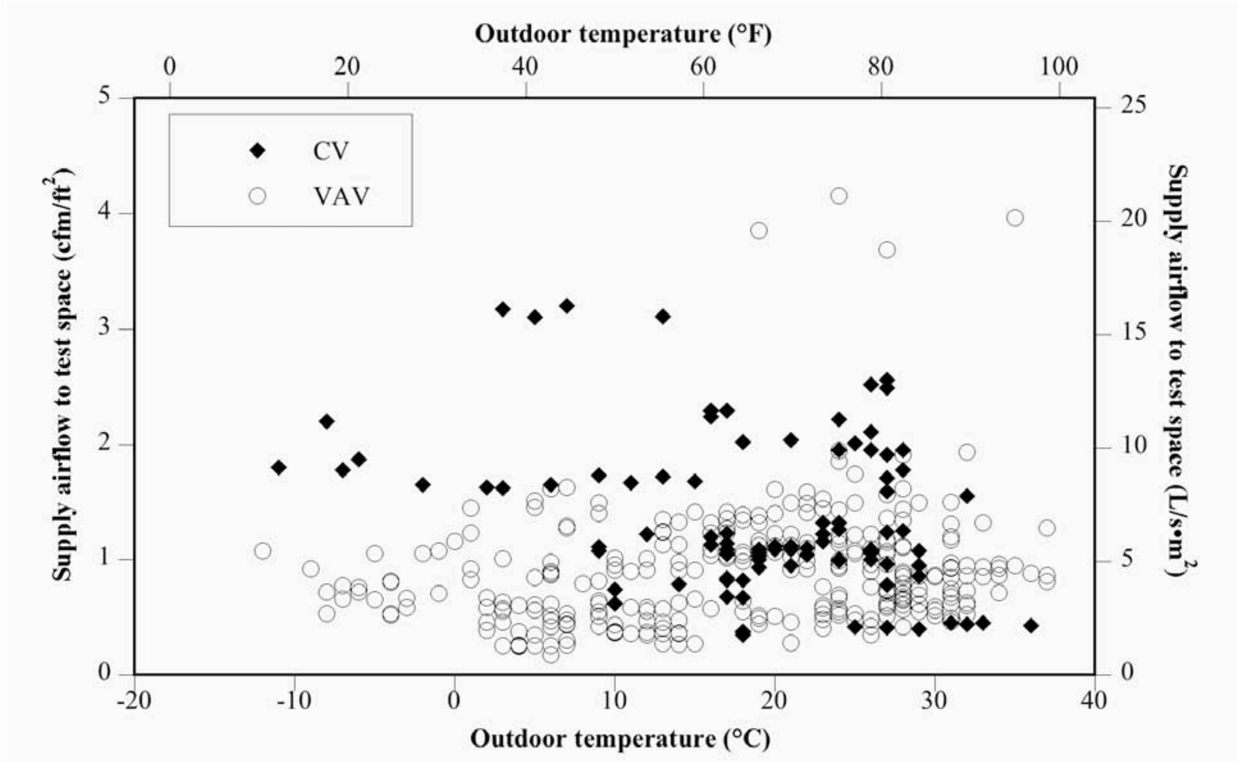

Figure 7 Measured study space supply airflow versus outdoor temperature

3.5.2 Outdoor Air Fraction

The outdoor air fraction (i.e., the outdoor air intake divided by the supply airflow) was determined in two ways, dividing the measured outdoor airflow by the measured supply airflow and second through the measurement of CO_2 concentrations in the outdoor, supply and recirculation airstreams. The former determination is referred to as the volumetric value, while the latter is referred to as the CO_2 ratio value. The volumetric outdoor air fraction was determined for each air handler test based on whichever of the expressions in Equations (1a), (1b) and (1c), described in section 2.2, apply. For some air handlers, the value of F_o could be determined using more than one of the expressions. Of the 562 air handler test events, there were 350 values of F_o based on Q_O divided by Q_S (Equation 1a), 125 based on (Q_S minus Q_R) divided by Q_S (Equation 1b) and 57 based on Q_O divided by (Q_O plus Q_R) (Equation 1c). As noted earlier, in some cases when Equation (1b) was applied, the value of Q_R was greater than Q_S, but the difference was never significantly different from zero. In those cases, the outdoor airflow and outdoor air fraction are both set equal to zero. For each determination of the outdoor air fraction, the uncertainty is calculated based on the uncertainties in Q_O, Q_S and Q_R. When F_o can be determined using more than one of these expressions, the value of F_o with the lowest uncertainty is identified and referred to as the *best* volumetric value of F_o. The outdoor air fraction was also determined using CO_2 concentrations measured in the outdoor, supply and recirculation airstreams using Equation (2).

Table 14 summarizes the measured outdoor air fractions for both the volumetric and CO_2 methods. Some of the volumetric values are greater than 100 %, which does not make physical sense. However, in all of these cases but one, the uncertainty around the value includes 100 % outdoor air. That single value is not included in Table 14 or the subsequent analysis, but it is included in Appendix D. The mean volumetric outdoor air fraction is **0.38**, and the mean CO_2

value is 0.31. The mean uncertainty in the volumetric outdoor air fraction is 0.16, while the maximum uncertainty is 0.44. The uncertainties in the CO_2-based values tend to be larger, with a mean uncertainty of 0.60 (roughly twice the mean outdoor air fraction) and several values as high as 2 to 4 in units of outdoor air fraction.

	Best volumetric	**Carbon dioxide**
# of values	**509**	520
Mean	**0.38**	0.31
Standard deviation	0.35	0.27
Minimum	0.00	0.00
10^{th} percentile	0.04	0.03
25^{th} percentile	0.10	0.11
Median	0.22	0.23
75^{th} percentile	0.59	0.44
90^{th} percentile	1.00	0.75
Maximum	**1.52**	1.20

Table 14 Summary of measured outdoor air fraction

Figure 8 is a plot of the outdoor air fraction against outdoor air temperature, with systems having economizer cycles distinguished from those that do not. Note that most of the low outdoor air intake values, i.e., outdoor air fractions below about 0.25, correspond to temperatures greater than 20 °C (68 °F). As expected, systems with economizer cycles tend to have higher outdoor air fractions at milder temperatures than systems without economizers; the non-economizer systems also tend to operate more consistently at lower outdoor air fractions. However, there are some exceptions to this general dependence, which could be due to a variety of causes such as the temperature and humidity sensors used to control the economizers being out of calibration. The dependence of outdoor air fraction on outdoor temperature leads one to expect that minimum outdoor air intake conditions are more likely to exist at these warmer temperatures than under colder conditions, which has implications for planning field evaluations of ventilation system performance.

Figure 9 is a plot of the outdoor air fraction against outdoor temperature for an idealized economizer cycle. It shows that such a system operates at minimum outdoor air at cold and hot temperatures, less than 0 °C (32 °F) and greater than 20 °C (68 °F), though these particular values are only examples. In between these two temperatures, the system uses outdoor air to cool the building, with a lower outdoor air fraction as the temperature gets colder. Figure 10 is a plot of whole building air change rates measured with the tracer gas decay method plotted against outdoor air temperature from a previous study (Persily et al. 1992). These data clearly exhibit the pattern seen in Figure 9. While the data in Figure 8 suggest the same pattern and are consistent with expected variations due to economizer operation, note that the actual data include typically four points for each building generally over a narrow temperature range and not all the buildings have economizer cycles.

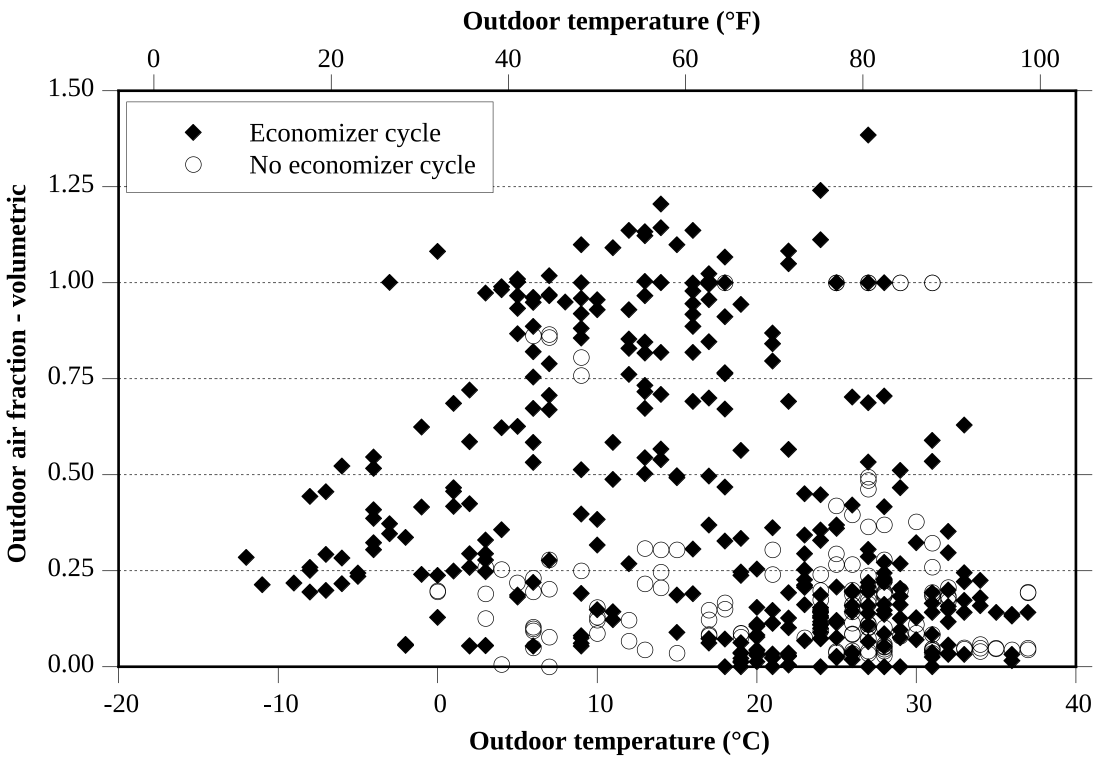

Figure 8 Volumetric outdoor air fraction versus outdoor temperature

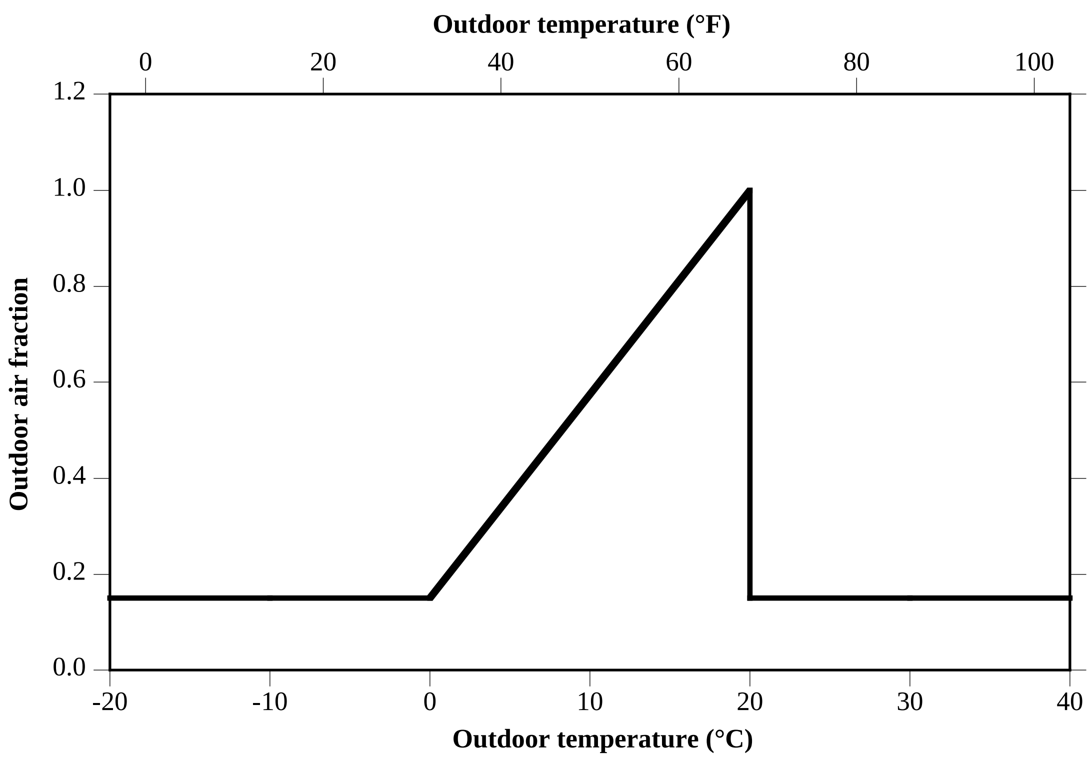

Figure 9 Outdoor air fraction for an idealized economizer cycle

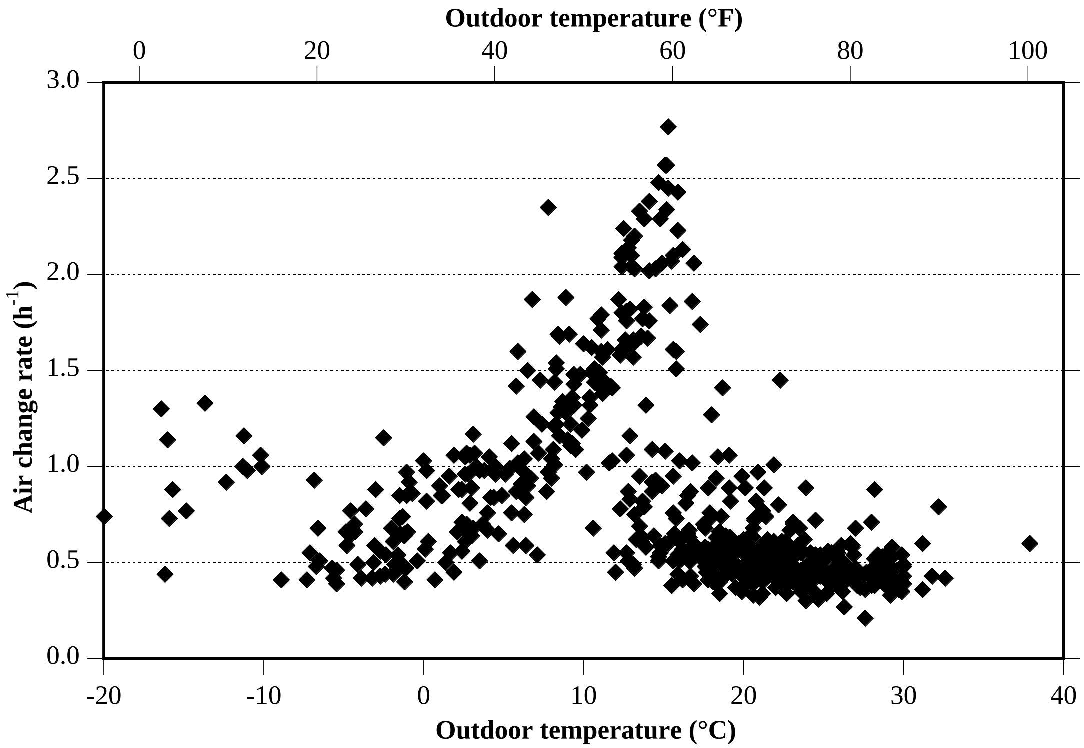

Figure 10 Measured air change rates versus outdoor air temperature (Persily et al. 1992)

As noted earlier, the uncertainties in the CO_2-based outdoor air fractions tend to be larger than the uncertainties in the volumetric values. The CO_2 uncertainties are based on the concentration measurement uncertainty of 90 mg/m^3 (50 ppm(v)). The larger uncertainties in the CO_2 values occur due to the magnitude of the concentration measurement uncertainty relative to the concentration differences in Equation 2. The difference between C_R and C_O, relative to the concentration measurement uncertainty, is the primary determinant of the uncertainty in F_o. Figure 11 is a plot of the CO_2 concentration difference between the recirculation and outdoor airstream versus time of day at which the concentration measurements began. The average concentration difference is 391 mg/m^3 (217 ppm(v)), with a mean difference for measurements before noon of 418 mg/m^3 (232 ppm(v)) and an afternoon mean of 369 mg/m^3 (205 ppm(v)). Given that the concentration measurement uncertainty of 90 mg/m^3 (50 ppm(v)) is equal to 25 % of the mean concentration difference, it is not surprising that the values of F_o based on CO_2 are so imprecise.

In making these measurements, the same CO_2 monitor was used to measure the concentration in the three airstreams over a relatively short period of time. Therefore, it is reasonable to expect that the uncertainty is lower for the differential CO_2 concentrations in Equation 2 than for the absolute concentrations. The uncertainties in the CO_2 outdoor air fractions were recalculated using an uncertainty of 90 mg/m^3 (50 ppm(v)) for the differential concentrations. The mean uncertainty was reduced from 0.60 to 0.42, and the median value of the uncertainty decreased from 0.43 to 0.31. It is not possible to estimate the actual uncertainty in the differential concentrations after the fact, though it is likely to be less than for the absolute concentrations. Nonetheless, the form of the equation used to determine F_o from CO_2 concentrations makes it advantageous to perform the uncertainty calculations based on the uncertainty in the differential concentration and also implies that one can tolerate some zero drift in the CO_2 monitor without a large degradation in accuracy.

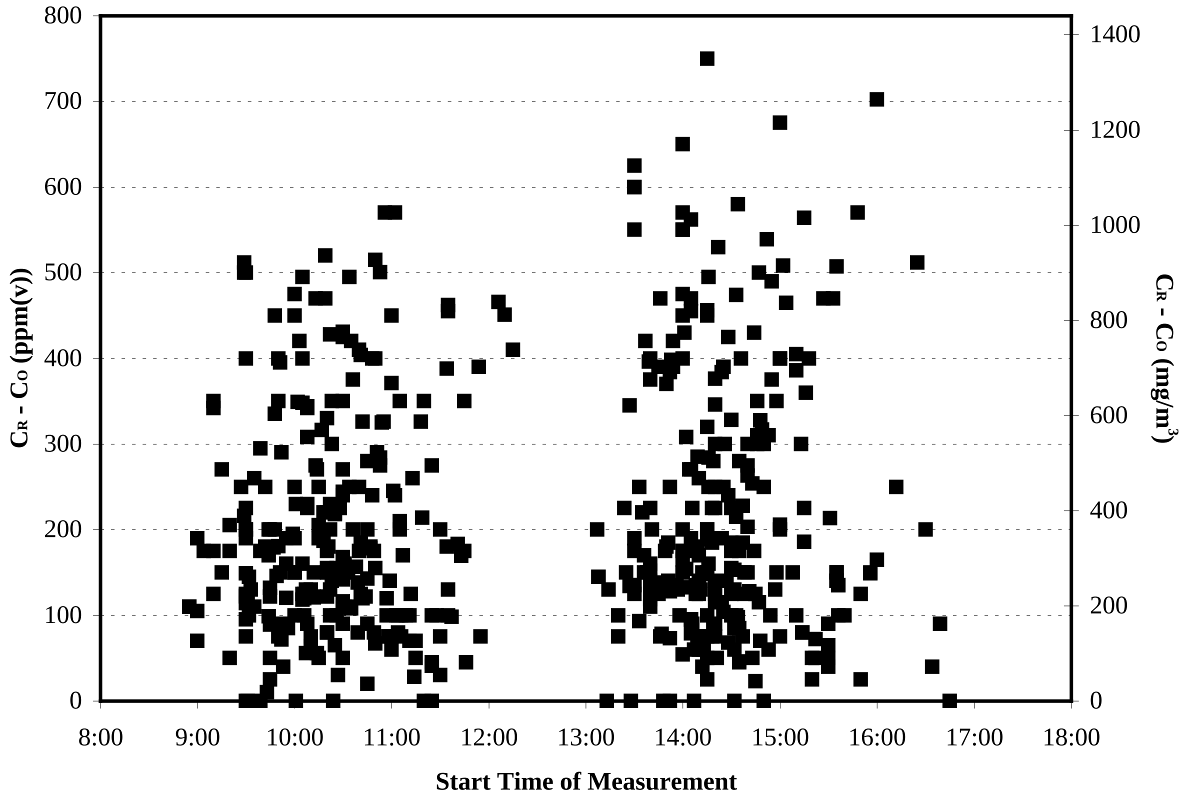

Figure 11 Return minus outdoor air CO_2 concentration versus time of day

Figure 12 is a plot of F_o based on CO_2 versus the volumetric value. This comparison shows that despite the high level of uncertainty in the CO_2 values, they are generally consistent with those based on volumetric airflows. The line in the plot corresponds to perfect agreement between the two parameters and is not a curve fit to the data. A linear regression of the CO_2 to the volumetric values yields a slope of 0.61 and an r-squared of 0.58.

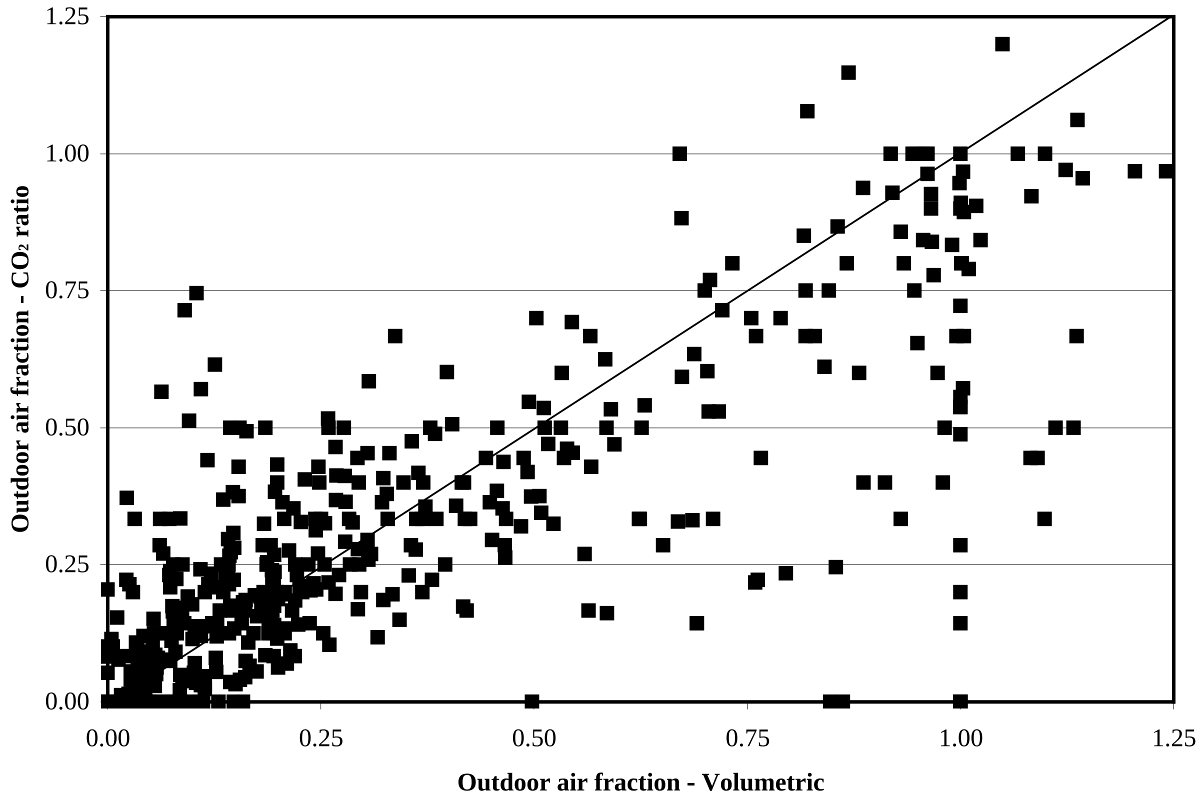

Figure 12 Outdoor air fraction based on CO_2 versus volumetric

3.5.3 Outdoor Air Ventilation

Of the 562 measurement events, 510 included traverse measurements, or estimates based on the difference between the supply and recirculation airflow, of the system outdoor air intake. The measured outdoor airflows are compared with the design minimum outdoor air intakes for the 274 cases where such a design value exists. Figure 13 is a plot of the ratio of the measured outdoor air intake to the design intake versus outdoor air temperature, with a distinction between systems with economizer cycles and those without. The mean ratio of the measured to design outdoor airflow is 1.93, including one case where the measured value is about 30 times larger than the design minimum. The mean is 2.28 for the economizer systems and 1.37 for non-economizer systems. Economizer systems are expected to have a higher ratio of measured to design, since they increase the outdoor air intake for free cooling and the design value is a minimum. Note the existence of many points with a ratio of measured to design below 1.0, which would not exist if the systems were operating as intended.

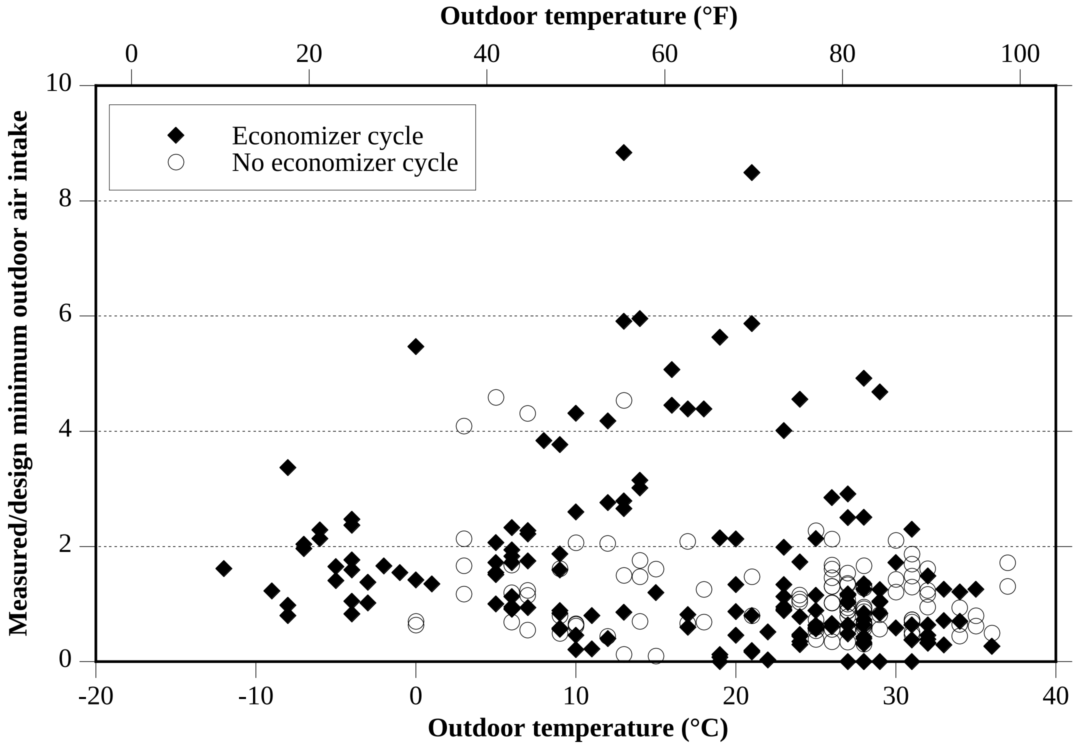

Figure 13 Ratio of measured to design outdoor airflow versus outdoor temperature

As described in section 2.2, outdoor air ventilation rates in the study spaces were calculated based on the measurements for the individual air handlers and the percentage of air from each handler provided to the study space. Table 15 summarizes the measured outdoor air ventilation to the study spaces. The second column presents these values on a per person basis using the actual number of occupants during each measurement. The mean value is **49 L/s (105 cfm)** per person, which is high relative to the 10 L/s (20 cfm) per person value specified in many current building codes (based on ASHRAE Standard 62-2001). The mean uncertainty in the per person rates is about 40 % of the mean value. Of these per person values, 17 % are below 10 L/s (20 cfm) per person and 9 % are below 5 L/s (10 cfm). Per person rates below 10 L/s (20 cfm) were seen in 22 of the 97 mechanically ventilated buildings, while rates below 5 L/s (10 cfm) were seen in 13 of the buildings. The table also presents the outdoor air ventilation in L/s•m^2 (cfm/ft^2)

of floor area and air changes per hour. There are two less cases of ventilation per person because of two events without measured values of occupancy.

	Per person L/s (cfm) per person	**Per unit floor area** L/s•m^2 (cfm/ft^2)	**Air changes per hour,** h^{-1}
# of values	367	369	369
Mean	**49 (105)**	**1.87 (0.37)**	**1.83**
Std. Dev.	**54 (114)**	**2.08 (0.41)**	**2.07**
Minimum	0 (0)	0 (0)	0.00
10th percentile	6 (13)	0.24 (0.05)	0.22
25th percentile	13 (27)	0.50 (0.10)	0.47
Median	30 (63)	1.03 (0.20)	0.98
75th percentile	**66 (140)**	**2.30 (0.45)**	**2.46**
90th percentile	**116 (245)**	**4.64 (0.91)**	**4.46**
Maximum	**310 (657)**	**12.31 (2.42)**	**13.23**

Table 15 Summary of Measured Outdoor Air Ventilation – Volumetric

Given the noted prevalence of minimum outdoor air intake conditions at higher outdoor air temperatures, the per person ventilation values were separated into those with outdoor temperatures below and above 20 °C (68 °F). The mean value below 20 °C (68 °F) is **60 L/s (126 cfm)** per person, and the mean for temperatures greater than or equal to that value is 38 L/s (81 cfm) per person.

The per person outdoor air rates were also analyzed to identify those for which the outdoor air fraction was below 20 %, presuming that those values correspond to operation under minimum outdoor air intake. Of the 367 values of outdoor air per person, 148 correspond to less than 20 % outdoor air. (These minimum conditions are seen in 42 of the 97 mechanically ventilated buildings.) The mean of these values is 13.7 L/s (28.9 cfm) per person based on the measured number of occupants, and the median is 11.7 L/s (24.7 cfm). Normalizing these minimum outdoor airflows by the number of workstations, rather than the measured number of occupants, yields a mean of 10.5 L/s (22.2 cfm) per person and a median of 9.4 L/s (20.0 cfm). Of these 148 values corresponding to minimum outdoor air, 41 % are below the per person requirement in Standard 62-2001 based on the measured number of occupants and 50 % are below that requirement based on the number of workstations. In other words, under minimum outdoor air intake, about one-half of the measured outdoor air intake rates are below the requirements in ASHRAE Standard 62-2001 based on the expected occupancy levels in the space. Similarly, about 20 % of these minimum values are below 5 L/s (10 cfm) per measured occupant and about 25 % are below 5 L/s (10 cfm) per workstation.

Outdoor air ventilation was also determined from the CO_2-based outdoor air fraction multiplied by the measured supply airflow. The values for the air handlers are then combined to determine the outdoor airflow per person for the study spaces, and the results are summarized in Table 16. Due to the large uncertainties in the CO_2 outdoor air fraction, the mean uncertainty in the study space outdoor airflow is also quite large, **85 L/s (179 cfm) per person**. Nevertheless, the mean values of the volumetric and CO_2-ratio outdoor ventilation airflow per person are remarkably similar, **49 L/s (105 cfm) and 44 L/s (94 cfm)** respectively. Figure 14 is a plot of the CO_2-ratio ventilation to the volumetric values. While there is significant scatter about the line of perfect agreement, and a tendency for the CO_2-ratio values to be lower at the highest per person ventilation, the two determinations are consistent on average. A linear regression of CO_2-ratio to the volumetric ventilation yields a slope of **0.80** and an r-squared of **0.64**.

	Outdoor air per person, L/s (cfm)
# of values	356
Mean	**44 (94)**
Std. Dev.	**47 (101)**
Minimum	0 (0)
10^{th} percentile	5 (11)
25^{th} percentile	12 (26)
Median	31 (65)
75^{th} percentile	**59 (125)**
90^{th} percentile	**96 (203)**
Maximum	**339 (717)**

Table 16 Summary of Measured Outdoor Air Ventilation – CO_2 Ratio

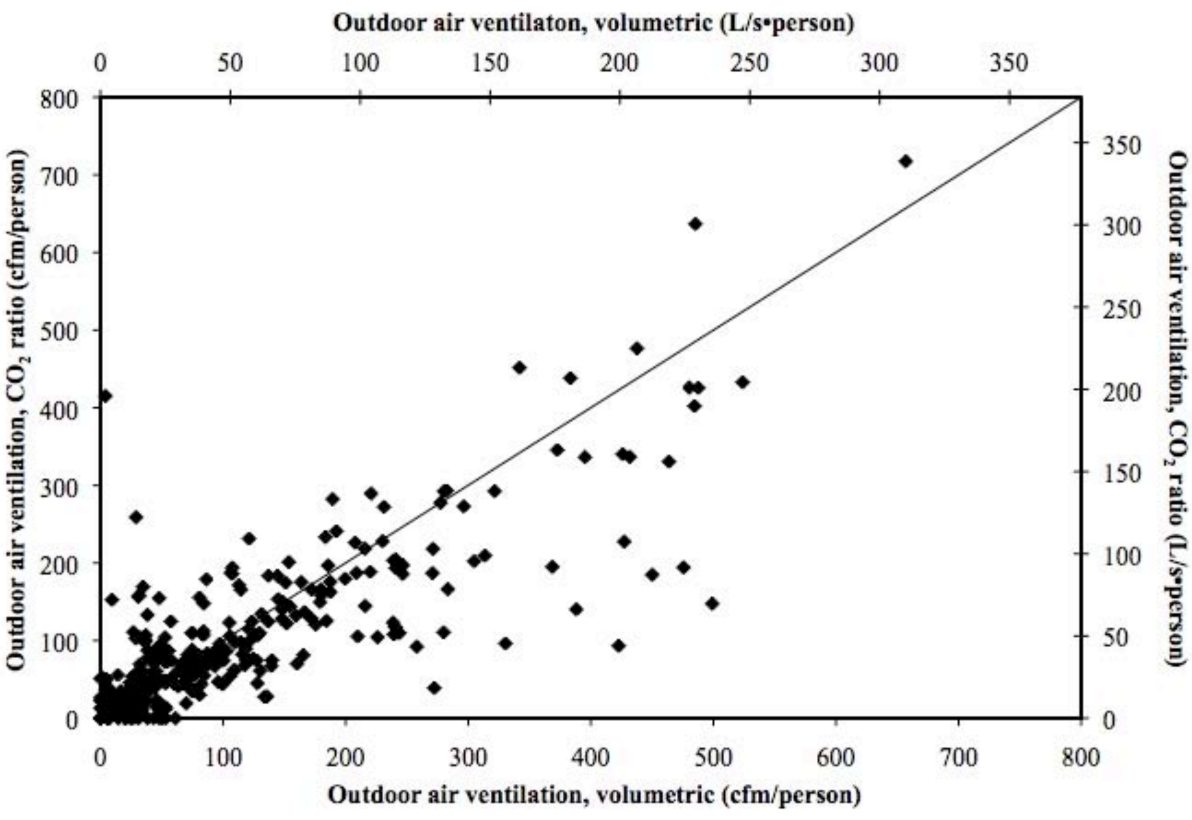

Figure 14 Outdoor air ventilation, CO_2-ratio versus volumetric

As noted, the measured per person outdoor air ventilation values are high relative to the outdoor air requirement in ASHRAE Standard 62-2001. These values are higher than might be expected for two primary reasons; the occupant density is below design and the outdoor air fraction is frequently not at minimum, generally due to economizer operation. As noted earlier, the mean measured occupant density is about 3.5 persons per 100 m^2 (3.2 per 1000 ft^2), corresponding to about 80 % of the number of workstations and about half of the default occupant density in Standard 62-2001. In addition, the mean outdoor air fraction is about 0.40. If each outdoor air measurement is adjusted to the design occupant density (number of workstations) and to minimum outdoor air intake, then the per person ventilation values are more consistent with expectations. Table 17 presents these adjustments, with the measured outdoor air ventilation per person from Table 15 in the second column. The next column presents the outdoor air ventilation normalized by the number of workstations in the space rather than the measured occupancy, which reduces the mean ventilation rate to **36 L/s (76 cfm)** per person. In the last two columns, the values are adjusted to an outdoor air fraction of 0.15. This adjustment involves dividing the outdoor air ventilation rate by the actual outdoor air fraction and then multiplying the result by 0.15, unless the actual fraction is already 0.15 or less. In the latter cases, the ventilation rate is not adjusted. The 15 % value is used as a typical value of the minimum outdoor air fraction. (Note from Table 6 that the mean value of the design minimum outdoor air fraction was **19 %**, and the median was 12 %.) The values in the fourth column are based on the number of workstations in the study space, while the values in the last column use the default occupant density for office space in Standard 62-2001, i.e., 7 people per 100 m^2 (1000 ft^2). As discussed earlier, the design value for occupant density is not available for the study spaces. However, if one uses the default value in Standard 62-2001 for office space, as in the last column of Table 17, the mean per person ventilation rate are very close to the requirement in the standard.

	Measured (Table 15)	Adjusted to # of workstations	Adjusted to 15 % outdoor air	
			# of workstations	Standard 62 default occupant density
	L/s (cfm) per person			
Mean	**49 (105)**	**36 (76)**	**12 (26)**	**8 (18)**
Std. Dev.	**54 (114)**	**37 (79)**	**8 (17)**	**6 (13)**
Minimum	0 (0)	0 (0)	0 (0)	0 (0)
10th percentile	6 (13)	5 (10)	4 (9)	3 (5)
25th percentile	13 (27)	10 (22)	**7 (14)**	5 (10)
Median	30 (63)	21 (45)	**11 (23)**	7 (15)
75th percentile	**66 (140)**	**52 (110)**	**16 (34)**	11 **(23)**
90th percentile	**116 (245)**	**87 (184)**	**21 (44)**	16 **(34)**
Maximum	**310 (657)**	**210 (444)**	**47 (100)**	42 (89)

Table 17 Outdoor air ventilation adjusted for occupancy and outdoor air fraction

3.5.4 Outdoor Airflows from Peak Carbon Dioxide

Indoor carbon dioxide concentrations were also used to estimate outdoor air ventilation, using a steady-state, single-zone mass balance analysis to relate the indoor CO_2 concentration to the per person outdoor air ventilation as discussed in Section 2.2. As noted, a critical assumption behind the approach is that the indoor CO_2 concentration is indeed at steady state. It is also assumes constant outdoor concentration, ventilation and occupancy, as well as a uniform indoor CO_2 concentration. Note that this approach provides the only means to estimate the outdoor air ventilation in the three naturally ventilated buildings.

As described earlier, peak CO_2 concentrations were used to estimate outdoor ventilation per person for all 100 study spaces. These estimates are based on averaging the CO_2 concentrations among the fixed monitors in each space on a 10 min basis, and then identifying the maximum value of this average for the morning and afternoon of each day. The per person ventilation rates based on these estimates are summarized in Table 18. The second column contains all the values of the per person outdoor airflow determined from the peak CO_2 data. The third column contains only those values obtained on the "test days," i.e., those days (typically Wednesday and Thursday of the study week) during which the other ventilation measurements were made. The last column reproduces the summary statistics for the volumetric measurements from Table 15. The mean uncertainty in the peak CO_2 ventilation rates is **10 L/s (22 cfm) per person**, which is about one-half the mean uncertainty for the volumetric rates. Also, note that the peak CO_2 values are significantly lower than those obtained from the volumetric measurements. This trend is contrary to what one might expect, as the outdoor airflows determined using the peak CO_2 method include both ventilation system outdoor air intake and outdoor air infiltration due to envelope leakage, while the volumetric results include only the former. Figure 15 is a plot of the per person outdoor air ventilation determined from the peak CO_2 concentrations versus the corresponding volumetric values. The solid line corresponds to perfect agreement. Note that above roughly 25 L/s (50 cfm) per person, almost all of the CO_2-based values are lower than the volumetric airflows.

	Outdoor air ventilation, L/s (cfm) per person		
	All peak CO_2 data	**Peak CO_2 data on "test days"**	**Volumetric results from Table 15**
# of values	**548**	**353**	367
Mean	**20 (43)**	**21 (45)**	**49 (105)**
Std. Dev.	**14 (31)**	**17 (35)**	**54 (114)**
Minimum	6 (13)	6 (13)	0 (0)
10th percentile	10 (20)	10 (21)	6 (13)
25th percentile	12 (26)	13 (27)	13 (27)
Median	18 **(37)**	18 (**38**)	30 (63)
75th percentile	24 (**50**)	25 (**53**)	**66 (140)**
90th percentile	**32 (68)**	**33 (71)**	**116 (245)**
Maximum	213 (452)	213 (452)	**310 (657)**

Table 18 Summary of Measured Outdoor Air Ventilation – Peak CO_2

The reason that the peak CO_2 values tend to be lower than expected has been investigated, but no explanation has yet been verified. Considering the methodology behind the peak CO_2 analysis, one might suspect the lack of steady-state CO_2 concentrations could be impacting the agreement between the two values. However, steady state is more likely to occur at the higher ventilation rates due to the shorter system time constants, resulting in better agreement at higher rates, which is contrary to what is seen in Figure 15. Another potential explanation is the existence of significant CO_2 concentration gradients within the study spaces, as well as between them and adjoining spaces, given that the single-zone analysis method assumes a uniform concentration within the zone and neglects interzone transfer of CO_2. While it is certainly possible that the CO_2 concentrations were different in adjoining zones, one would expect the impact to be positive in some cases and negative in others. However, the differences in the data tend to all be in one direction. The level of agreement was examined in those study spaces that corresponded to an entire building, for which concentration differences in adjoining spaces are not an issue, and the peak CO_2 and volumetric ventilation rates were not observed to agree any better. Note that the fixed CO_2 monitors in the study spaces were placed at a height of 1.1 m (43 in.) above the floor and at locations representative of workstation layout and work activities, i.e., locations in hallways and passageways were intentionally avoided (EPA 2003). Given these guidelines on location, it is possible that the measured CO_2 concentrations are higher than the study-space average. If the measured CO_2 concentration is indeed higher than the true space average, then the calculated ventilation rates would be low relative to their actual value. Also, it is reasonable to expect that the lack of uniformity would be more pronounced at higher outdoor air ventilation with less recirculation of return air, leading to the observed increase in errors. However, it is not possible to verify the magnitude of the concentration nonuniformity in these spaces based on the available data, and therefore it cannot be confirmed whether this is necessarily a valid explanation for the observed differences. The peak CO_2 concentrations were examined with the issue of nonuniformity in mind, and it was determined that the actual average concentration in the study space would have to be 360 mg/m^3 to 720 mg/m^3 (200 ppm(v) to 400 ppm(v)) lower than that measured by the fixed monitors to explain the observed differences.

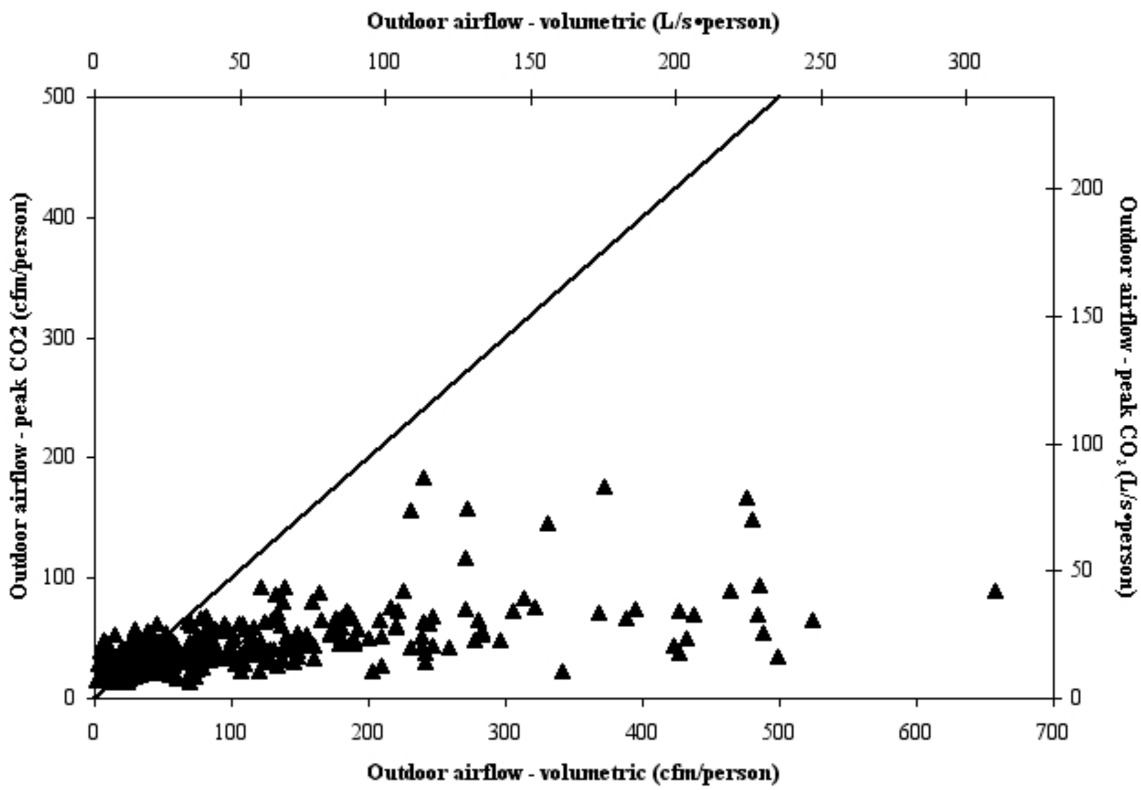

Figure 15 Outdoor air ventilation, CO_2 peak versus volumetric

The peak CO_2 analysis provides the only means for estimating ventilation rates in the three naturally ventilated buildings. Table 19 presents the estimated outdoor air ventilation rates for each of the three study spaces for each time period it was estimated, generally once in the morning and once in the afternoon. These values are presented first as per person values, based only on the difference between the peak CO_2 concentration and the outdoor concentration, along with an estimate of the uncertainty in each value. The last column presents these values in air changes per hour, based on the study space volume and the measured occupancy. The first study space, NYBS06, has high per person ventilation rates, especially in units of air changes per hour, but also high uncertainties. Since high ventilation values correspond to low differences between the peak CO_2 concentration and the outdoor concentration, higher uncertainties always exist at higher ventilation rates. It is not clear why the ventilation rates in this building are so high, but it does have operable windows, 50 % of which were reported to be open during the measurements. In addition, the building has toilet exhausts with design flow rates per floor area on the high end of the buildings. However, the measured exhaust flows during the test week were zero. The afternoon reading on the third day for NYBS06 has a much lower ventilation rate than the other times. There were no outdoor concentration readings available for building ORIS02, and a value of 670 mg/m^3 (373 ppm(v)) was assumed. While peak CO_2 analysis allows the estimation of ventilation in the naturally ventilated buildings, the comparison with the volumetric values in the mechanically ventilated buildings does raise questions regarding their validity.

Study space	**Date**	**Time of day**	**Outdoor air ventilation per person**	**Uncertainty in outdoor air per person**	**Outdoor air ventilation**	**Uncertainty in outdoor air ventilation**
		AM or PM	L/s (cfm)		h^{-1}	
NYBS06	6/16/98	AM	40.3 (85.4)	17.8 (38.0)	33.4	16.3
	6/16/98	PM	27.8 (58.9)	8.8 (18.6)	28.5	12.4
	6/17/98	AM	42.6 (90.2)	20.0 (42.3)	40.2	20.9
	6/17/98	PM	33.3 (70.6)	12.4 (26.3)	40.3	18.1
	6/18/98	AM	44.2 (93.6)	21.5 (45.5)	46.1	22.9
	6/18/98	PM	19.6 (41.5)	4.6 (9.7)	7.8	4.5
ORIS02	8/30/94	AM	26.1 (55.4)	8.0 (17.0)	0.5	0.2
	8/30/94	PM	25.9 (54.9)	7.9 (16.7)	0.4	0.2
	8/31/94	AM	29.5 (62.5)	10.1 (21.4)	0.5	0.2
	8/31/94	PM	28.0 (59.3)	9.2 (19.4)	0.6	0.3
	9/1/94	AM	45.2 (95.7)	23.1 (49.0)	1.0	0.5
	9/1/94	PM	28.3 (60.0)	9.4 (19.8)	0.5	0.2
WAIW01	2/25/97	AM	8.4 (17.9)	1.2 (2.5)	0.5	0.1
	2/25/97	PM	7.4 (15.7)	1.0 (2.0)	0.4	0.1
	2/26/97	AM	12.6 (26.8)	2.2 (4.6)	0.4	0.1
	2/26/97	PM	7.4 (15.6)	1.0 (2.0)	0.4	0.1
	2/27/97	AM	8.8 (18.7)	1.2 (2.6)	0.5	0.1

Table 19 Outdoor air ventilation for naturally ventilated spaces

3.5.5 Supply Diffuser Airflows

The BASE protocol calls for airflow to be measured at the individual supply diffusers serving the study space one time during the test week. Diffuser measurements were made in 88 of the 97 mechanically ventilated buildings, and Table 20 presents the results of those measurements. The second column contains the number of diffusers in these 88 study spaces, while the third column summarizes the fraction of those diffusers for which the supply airflow was measured. The total supply airflow, normalized by study space floor area, is presented in the fourth column. This value is adjusted to account for less than 100 % of the diffusers being measured by assuming the supply airflow per diffuser at the unmeasured diffusers is the same as at the mean of the measured value. The last column is the total (adjusted) supply airflow in the fourth column divided by the supply airflow determined at the air handlers, as discussed in section 3.3.1. On average, the total supply airflow at the diffusers is only 73 % of the value measured at the air handlers. This lack of agreement is a function of the large measurement uncertainties in both values, plus the possibility of supply duct leakage. However, the existence and magnitude of such leakage was not assessed as part of this study, and these data do not serve as a reliable measure of duct leakage.

	# of diffusers	**Fraction of diffusers measured**	**Total diffuser flow, adjusted** L/s•m^2 (cfm/ft^2)	**Total diffuser flow/ Study space supply airflow at air handlers**
Mean	93	0.94	3.40 (0.67)	0.73
Std. Dev.	42	0.09	1.66 (0.33)	0.36
Minimum	13	0.57	0.30 (0.06)	0.16
10^{th} percentile	39	0.86	1.31 (0.26)	0.36
25^{th} percentile	71	0.91	2.28 (0.45)	0.48
Median	93	0.97	3.27 (0.64)	0.67
75^{th} percentile	107	1.00	4.23 (0.83)	0.83
90^{th} percentile	146	1.00	5.25 (1.03)	1.22
Maximum	258	1.00	9.66 (1.90)	1.96

Table 20 Summary of measured supply airflows at diffusers

3.5.6 Exhaust Airflows

Airflows for the exhaust fans serving each study space were measured one time during the test week. Measured airflows were obtained for 56 of the 159 exhaust fans serving the study spaces. Of these values, design airflows are only available for 41 of the fans. Neglecting the seven cases where the measured exhaust airflow is zero, the average ratio of the measured exhaust airflow to the design value is 0.57. The median value is 0.47 and the standard deviation is 0.34; the 10 and 90 percentile values are 0.21 and 0.99 respectively.

4. DISCUSSION

4.1 Summary of Results

The ventilation-related information collected as part of the BASE study provides a unique characterization of ventilation system design and performance in U.S. office buildings. No such database of randomly selected office buildings existed prior to this effort, making the results of the survey that much more significant. While the office buildings studied tend to be larger and with higher occupancy than the average U.S. office building, the results obtained are quite revealing. In terms of design, the data show the relative prevalence of different system types and different approaches to outdoor air control, as described in Tables 4 and 5. Of the 141 ventilation systems considered, 50 are constant volume and the rest are VAV. In almost 75 % of the study spaces the systems employ economizer control to provide "free cooling" when the outdoor weather is appropriate. Twenty-one of the spaces have dedicated outdoor air fans, and five have 100 % outdoor air systems.

As expected based on thermal load considerations, but never previously verified, the average value of the supply air capacity is about 5 L/s•m^2 (1 cfm/ft^2). Other system design parameters of interest have the following mean values: ratio of supply airflow capacity to return airflow capacity, 1.14; design minimum outdoor air per person (workstation), 18 L/s (39 cfm); and, ratio of design minimum outdoor air intake to supply air capacity, **19 %**. The per person design minimum outdoor air intake, based on the number of workstations, is significantly higher than the requirement in ASHRAE Standard 62-2001 of 10 L/s (20 cfm) per person. However, if the per person design value is instead calculated using the default occupant density in the ASHRAE standard, the mean value of the minimum outdoor air intake per person is 13 L/s (26 cfm) and the median is roughly 9 L/s (17 cfm). However, as noted, the design occupancy used to determine the design minimum outdoor air intake is not available for the systems studied.

The BASE study also provides valuable information on occupant density in office buildings. The mean number of workstations per 100 m^2 (1000 ft^2) is about 5, as compared with the default value in Standard 62-2001 of 7. However, the recent revision of that standard via addendum n (ASHRAE 2003) reduces the default value to 5, which appears to be a reasonable change given the results of this study. The measured occupant density in the spaces is lower still, with a mean value of 4.0 people/100 m^2 (3.7 people /1000 ft^2), corresponding to about 80 % of the workstations being occupied.

The ventilation measurements indicate how the systems operate relative to their design and also provide performance parameters that can be used to analyze other data collected in the BASE study, for example contaminant concentrations and prevalence of occupant symptoms. The mean measured supply airflow for the 97 mechanically ventilated study spaces is very close to the mean design value, i.e., 5 L/s•m^2 (1 cfm/ft^2). As might be expected, these supply values are relatively independent of outdoor air temperature for the constant volume systems but tend to increase for warmer temperatures in the VAV systems. The measured outdoor air fraction, i.e., the ratio of the outdoor air intake to the supply airflow, has a mean value of about 0.40. For buildings with economizer controls, the outdoor air fraction tends to be lowest for warmer temperatures and increases at milder temperatures. However, with only 4 measurements per system, generally under similar weather conditions, the noted dependence mixes the results for many buildings, and the temperature dependence cannot be examined in detail for any single building. Outdoor air ventilation rates tend to be higher than might be expected, with a mean value of **49 L/s (105 cfm)** per person based on the number of occupants and **36 L/s (76 cfm)** per person based on the number of workstations in the space. Still, seventeen percent of these measured values (per occupant) are below the 10 L/s (20 cfm) per person requirement in ASHRAE Standard 62-2001, and these lower rates occur in 22 of the 97 mechanically ventilated buildings. While these values are high on average relative to the minimum outdoor air requirements in Standard 62, the high outdoor air fractions and the low occupancy relative to the actual number of workstations (and to the default occupancy value in the standard) explains most of the higher values. Adjusting the measured outdoor air ventilation rates to minimum outdoor air conditions and to the occupant density in Standard 62 reduces the mean to 9 L/s (19 cfm) per person. Considering only those values that correspond to minimum outdoor air intake, the mean ventilation rate is 14 L/s (29 cfm) per person. Adjusting these minimum values for the number of workstations rather than the measured occupancy levels yields a mean of 11 L/s (22 cfm) per person, with one-half of these minimum values being below the requirement in ASHRAE Standard 62-2001. In other words, under minimum outdoor air intake, about one-half of the measured outdoor air intake rates are below the requirements in ASHRAE Standard 62-2001 based on the expected occupant levels in the space, and about one-quarter of the rates are below 5 L/s (10 cfm) per person, i.e., one-half of the ASHRAE requirement.

The outdoor air ventilation rates calculated from the CO_2-based outdoor air fraction (determined from airstream CO_2 concentrations) multiplied by the volumetric supply airflow rate are generally consistent with the outdoor air rates from volumetric airflow measurements in the air handlers. However, the CO_2 ratio ventilation rates have much larger uncertainties due to the larger uncertainties in the CO_2-based outdoor air fractions. Outdoor air ventilation rates determined from steady-state analysis of peak CO_2 concentrations in the space are consistently lower than the volumetric outdoor air rates. A number of explanations have been explored, but the reason for this discrepancy has not been identified. Therefore, questions exist as to the reliability of the peak- CO_2 ventilation rates.

4.2 Comparison with European Audit Project

During the time of the BASE study, a similar research effort was conducted in Europe. The European Audit Project involved measurements of building characteristics, environmental conditions and ventilation performance, as well as the administration of occupant questionnaires, in 56 buildings in eleven European countries (Bluyssen et al. 1995 and 1996). Ventilation performance was measured in nine of the countries using a range of different techniques, e.g., tracer gas decay in a single room, constant concentration tracer gas, and subtraction of exhaust from supply airflows determined using velocity traverses. The final report (Bluyssen et al., 1995) contains one value of supply airflow, infiltration and outdoor airflow per unit floor area for each building in which they were measured. The results are also presented in the form of cumulative frequency distributions for outdoor and supply airflow in units of L/s-m^2 and air changes per hour. The median value of the supply airflow is roughly 2.2 L/s- m^2 (0.43 cfm/ft^2), which is about one-half of the median for the BASE buildings. The median outdoor airflow in the European Audit buildings is about 1.7 L/s- m^2 (0.33 cfm/ft^2), which is somewhat higher than the median for the BASE buildings of 1.1 L/s- m^2 (0.22 cfm/ft^2). In units of air changes per hour, the medians are roughly 2.1 h^{-1} and 1.0 h^{-1} for the European and BASE buildings respectively. Given the uniqueness of these two datasets, a more detailed comparison of the ventilation results would be worth pursuing.

4.3 Recommendations for Ventilation Assessment

In addition to analyzing the ventilation-related data collected as part of the BASE study, another objective of this effort was to examine the procedures used to collect these data and recommend changes to the protocol for potential consideration in future studies. In terms of the design information, it would have been helpful to collect sufficient design data to perform an airflow balance on each building and each study space. The existing protocol includes the collection of design specifications for only the supply, return and exhaust fans that serve the study space. These data only allow the calculation of the net design airflow into and out of the building when the study space is a whole building. It would have been desirable to collect design data for all fans serving the building, including supply and return fan capacities, minimum outdoor air values, and exhaust fan capacities. Given the interest in net airflow balances for whole buildings, particularly in the context of infiltration and moisture control, such data would be of great interest.

The determination of the outdoor air fraction from CO_2 concentrations in the supply, return and outdoor airstreams was associated with large measurement uncertainties due to the uncertainty in the concentration measurement itself and the low concentration differentials that exist under some conditions. These large uncertainties limited the usefulness of multiplying these outdoor air fractions by system supply airflows as a means of determining outdoor air intake. Nevertheless, this approach still has value based on the relative simplicity of measuring CO_2 concentrations and on the fact that some outdoor air intakes are configured such that a velocity traverse is impractical. The CO_2 approach to determining outdoor air fraction could be improved by using a more accurate concentration monitor, employing the uncertainty in the differential concentration rather than absolute concentration (when a single monitor is used), and making the concentration measurements after the indoor concentration has increased to the maximum degree expected based on the occupancy schedule. Despite these large uncertainties, the outdoor air fractions determined from CO_2 concentrations agree on average with the volumetric outdoor air fractions.

Outdoor air ventilation measurements are performed for a number of reasons, but often to determine the minimum outdoor airflow for a system. Based on the measurements in this study, it is evident that one is more likely to encounter conditions of minimum intake at warmer outdoor air temperatures, perhaps 25 °C (77 °F) and above. Minimum intake is less likely to be encountered at colder temperatures based on the data presented here. Since the dependence of outdoor air fraction on temperature is building specific, it is important to obtain a sense of this dependency when studying a building if one aims to determine outdoor airflow under conditions of minimum intake.

Outdoor air ventilation was also estimated based on peak CO_2 concentrations, using a single-zone steady-state mass balance analysis of each study space. The values determined tended to be lower than those based on volumetric airflow measurements at the air handlers, and the reason for this difference is not evident. In fact, one would expect these values to be higher since they include envelope infiltration in addition to outdoor air intake. One potential explanation is that the concentrations measured in the space were elevated due to the influence of high CO_2 levels from occupant exhalations. The CO_2 data collected in the BASE study should be examined further to understand this discrepancy and potentially determine ways to improve this approach to estimate building ventilation. In addition, the reliability of the estimates of the generation rates of CO_2 from occupants and of the occupant activity or met levels used in making these estimates merits evaluation if this approach is going to be more widely used. Current guidance on estimating ventilation rates based on peak CO_2 levels (ASTM 1998) may then need to be updated based on the results of this evaluation.

In addition to these potential modifications of the BASE protocol, there are other ventilation performance parameters of interest that could be added to such evaluations. One such addition is the determination of envelope airtightness using fan pressurization testing. The importance of building leakage on energy consumption and indoor air quality has been discussed elsewhere and the available airtightness data is quite limited (Persily 1998). In addition, building survey protocols could also be extended to include tracer gas measurements of infiltration rates, both with the ventilation systems on and off. These rates are again of interest due to their influence on energy and indoor air quality, and the number of office buildings in which they have been measured is indeed small.

The challenges in making reliable measurements of outdoor air intake rates is evident from this study. Some of the problems include limited access to system components, ductwork configurations that do not provide appropriate traverse planes, and accuracy limitations inherent in duct traverses. Alternative approaches to determining outdoor air intake at air handlers are being investigated and ideally will be more reliable and convenient for field application. One challenge in this respect is the lack of a primary standard for use in evaluating the accuracy of these various approaches.

Finally, the BASE ventilation assessment has provided a unique dataset for U.S. office buildings, but the study was focused intentionally on larger buildings. As noted in the discussion of the CBECS data, most U.S. office buildings are much smaller than those included in the BASE study. Based on both indoor air quality and energy considerations, there is a need to conduct a similar study in smaller office buildings. In addition to the obvious difference of size, smaller buildings tend to different system types that larger buildings and different approaches to design and operation.

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Appendix A: BASE Variables Used in Analysis

This appendix lists the variables used in the analysis presented in this report. The variable names referenced in the BASE protocol are as listed in the BASE Study Database Description and Variable List (EHE 2000) and from the initial processing of the field data by the EPA contractor.

Building Variables
EVENT: Building identifier
A1YEAR: Year built
A1YEAR2: Year of last building addition
A1AREA: Building occupied floor area
A1AREA2: Building gross floor area
A1BELOW: Building stories below grade
A1ABOVE: Building stories above grade
A1VENTIL: Building has mechanical or natural ventilation?
A1COOLIN: Building has air conditioning system, yes or no?
A1HEATIN: Building has air heating system, yes or no?

System Variables
SYSTEM: System number
C1TYPE: Central air handling and distribution system type code, A through P as described in Appendix B
C1RETFAN: Return fan, yes or no?
C1TS#PCT: Percent of system capacity serving the study space, by air handler #.
C5CONPOS: Dedicated outdoor air intake fan, outdoor air conditioned
C5UNPOS: Dedicated outdoor air intake fan, outdoor air unconditioned
C5UNSUC1: Outdoor air drawn into system by supply fan suction through distinct intake duct
C5UNSUC2: Outdoor air drawn directly into air handler by supply fan suction with no duct
C5CONST1: 100% outdoor air system
C5CONST2: System has temperature-based economizer
C5CONST3: System has fixed minimum outdoor air intake
C5CONST4: System has enthalpy-based economizer
C5CONST5: System controls outdoor air intake based on building pressure
C5MINOU1: Minimum outdoor air intake controlled by fixed damper
C5MINOU2: Minimum outdoor air intake controlled by airflow monitoring
C5MINOU3: Minimum outdoor air intake controlled by fan tracking
C7ARAT1: Design supply air capacity of system
C7ARAT2: Design minimum outdoor air intake for system
C7AAREA: Floor area served by system
C7AOCCU: Number of occupants served by air handler
C7ARETFA: System has a return fan?
C7ARET1: Design return air capacity
C7ARET2: Floor area served by return

Study Space Variables
EVENT: Building identifier
TSDESC: Floors and spaces constituting study space
B1AREA: Study space occupied floor area
B1AREA2: Study space gross floor area

B1AH#PCT: Percentage of study space air supply by air handler number #
B1CEILIN: Study space ceiling height
B1PLENUM: Study space plenum height
B1PRIV: Number of private workstations in study space
B1PART: Number of workstations in study space located in partitioned areas
B1OPEN: Number of workstations in study space located in open office areas
B1DESWS: Floor area per workstation
B1SUPPLY: Number of supply vents in the study space
B1OCC_#A and B1OCC_#B: Measured test space occupancy, with # indicating measurement event (Monday is 1, Tuesday is 2, …); A indicates morning measurement and B indicates afternoon

Supply diffuser measurements
D3ADATE: Date of measurement
D3ARAT#: Measured supply diffuser airflow, # indicated which diffuser

Exhaust measurements
C7BAREA: Floor area served by exhaust fan
C7BRATE: Design exhaust airflow rate
C7BLOCAT; Location of exhaust fan
D2DATE: Date of measurement
D2FLOW: Measured airflow rate of exhaust fan

Weather
DATE: Date of measurement
TIME: Time of measurement
TEMP: Outdoor air temperature

Continuous carbon dioxide measurements using fixed monitors
CO2: Measured carbon dioxide concentration.
DATE: Date of measurement
EVENT: Building identifier
SITEID: Sample site identifier
TIME: Time of measurement

Variables provided with data analysis by EPA contractor
These apply to ventilation system airflow and carbon dioxide concentration measurements. Several are directly from the BASE variable list, but others (primarily volumetric airflow rates) are derived from BASE variables.

Building/study space number
Date of measurement
Period of measurement, AM or PM
Supply airflow rate, for each date and period
Outdoor airflow rate, for each date and period
Recirculation airflow rate, for each date and period
Supply air carbon dioxide concentration, for each date and period
Outdoor air carbon dioxide concentration, for each date and period
Recirculation air carbon dioxide concentration, for each date and period

Appendix B: System Design Information

This appendix presents the following design information for the air handlers serving the study spaces:

System ID
System type from list below:
- A Single Duct, Constant Volume, Single Zone
- B Single Duct, Constant Volume, Multiple Zone Reheat
- C Single Duct, Constant Volume, Multiple Zone Bypass
- D Single Duct, Variable Air Volume
- E Single Duct, Variable Air Volume, Reheat
- F Single Duct, Variable Air Volume, Induction
- G Single Duct, Variable Air Volume, Fan Powered, Constant Fan
- H Single Duct, Variable Air Volume, Fan Powered, Intermittent Fan
- I Single Duct, Variable Air Volume, Dual Conduit
- J Dual Duct, Constant Volume
- K Dual Duct, Constant Volume, Reheat
- L Dual Duct, Variable Air Volume, Single Fan
- M Dual Duct, Variable Air Volume, Dual Fan
- N Multizone, Constant Volume
- O Constant Volume, Blow- Through Bypass
- P Texas Multizone, or Three-Deck Multizone

Design supply airflow capacity
Floor area served by system
Design supply airflow capacity per unit floor area
Design minimum outdoor air intake
Design minimum outdoor air intake per unit floor area
Number of occupants served by air handler
Design minimum outdoor air intake per person
Ratio of design minimum outdoor air intake to design supply airflow capacity
Occupant density per unit floor area
Design return airflow capacity
Ratio of design supply airflow capacity to design return airflow

Changes in the table relative to the original 2004 report are highlighted in yellow.

System ID	System type	Design supply airflow capacity		Floor area served by system		Design supply capacity per unit floor area		Design minimum outdoor air intake	
		L/s	cfm	m^2	ft^2	L/s-m^2	cfm/ft^2	L/s	cfm
ARFW01(01)	N	5195	11006	890	9584	5.83	1.15		
ARFW01(02)	N	5195	11006	890	9584	5.83	1.15		
ARFW02(01)	E	10638	22538	3642	39201	2.92	0.57	708	1501
ARFW02(02)	E	9011	19091	1529	16457	5.89	1.16	590	1251
ARFW03(01)	H	4865	10306	729	7846	6.67	1.31		
ARFW03(02)	H	4510	9555	502	5404	8.98	1.77		
AZHS02(01)	E	7835	16600	1085	11680	7.22	1.42		
AZHS02(02)	E	7084	15009	855	9206	8.28	1.63		
AZHS04(01)	E	9540	20212	1731	18630	5.51	1.08		
AZHS04(02)	A	1606	3402	189	2033	8.50	1.67		
AZHW10(01)	N	9446	20012	1227	13203	7.70	1.52		
AZHW10(02)	N	7557	16010	317	3408	23.86	4.70		
AZHW11(01)	N	19364	41024	2599	27972	7.45	1.47		
AZHW12(01)	G	7455	15795	3732	40169	2.00	0.39	1077	2281
AZHW12(02)	G	7462	15809	3202	34462	2.33	0.46	1077	2281
CAES17(01)	K	11713	24814	1458	15696	8.03	1.58	1757	3722
CAEW07(01)	K	17475	37022	3289	35398	5.31	1.05		
CAEW001)	E	38727	82048	6438	69295	6.01	1.18	8029	17010
CAJS01(01)	A			2090	22499				
CAJS01(02)	A			711	7650				
CAJS01(03)	A			711	7650				
CAJS02(01)	J	14169	30018	1260	13561	11.24	2.21	2834	6004
CAJS03(01)	B	9295	19692	8242	88721	1.13	0.22	1394	2954
CAJS21(01)	K	6718	14233	924	9950	7.27	1.43	1429	3027
CAJS21(02)	K	4520	9576	831	8944	5.44	1.07	4520	9576
CAJS222(01)	E	8973	19011	1901	20466	4.72	0.93	1039	2201
CAJS23(01)	J	8312	17610	1044	11237	7.96	1.57	945	2001
CAJW18(01)	D	8218	17410	1646	17719	4.99	0.98		
CAJW18(02)	L			572	6154				
CAJW19(01)	K	16199	34320	2650	28521	6.11	1.20		
CAJW20(01)	F	75566	160094	13889	149499	5.44	1.07	13224	28016
CAJW24(01)	E	28337	60035	3790	40800	7.47	1.47		
CAJW25(01)	F	14742	31233	1183	12730	12.46	2.45		
CAJW26(01)	F	38539	81648	7153	77000	5.39	1.06		
COAS02(01)	D	19248	40779	3439	37018	5.60	1.10		
COAS04(01)	D	47229	100059	5086	54750	9.28	1.83	4723	10006
COAS06(01)	F	9134	19352	1427	15363	6.40	1.26	850	1801
FLDW07(02)	N	7745	16410	2076	22350	3.73	0.73	1495	3167
FLDW08(01)	H	11160	23643	1636	17608	6.82	1.34	1086	2301
FLDW10(01)	H	5904	12507	1556	16750	3.79	0.75	520	1101
FLGS01(01)	E	10211	21633	1878	20220	5.43	1.07	1417	3002
FLGS04(01)	N	6707	14208	989	10650	6.78	1.33	708	1501
FLGS04(02)	N	6707	14208	989	10650	6.78	1.33	708	1501
FLGS11(01)	H	5564	11787	1486	16000	3.74	0.74	331	700
FLGS11(02)	H	5564	11787	1486	16000	3.74	0.74	331	700
FLGS12(01)	N	11557	24484	1033	11119	11.19	2.20	1747	3702
GADS01(01)	E	10296	21813	2392	25748	4.30	0.85	1015	2151
GADS02(01)	E	6990	14809	1686	18145	4.15	0.82	945	2001
GADS02(02)	E	6990	14809	1686	18145	4.15	0.82	945	2001
GADS03(01)	A	9583	20303	2187	23538	4.38	0.86		

System ID	System type	Design supply airflow capacity		Floor area served by system		Design supply capacity per unit floor area		Design minimum outdoor air intake	
		L/s	cfm	m^2	ft^2	L/s-m^2	cfm/ft^2	L/s	cfm
ILBS01(01)	H			1190	12805				
ILBS01(02)	H			967	10407				
ILBS02(01)	L	8501	18011	1030	11086	8.25	1.62		
ILBS03(01)	N	13954	29562	2240	24111	6.23	1.23		
LAGW04(01)	O	9918	21012	1926	20736	5.15	1.01	945	2001
LAGW04(02)	O	8973	19011	2093	22527	4.29	0.84	945	2001
LAGW05(01)	N	6848	14508	372	4000	18.43	3.63	666	1411
LAGW05(02)	N	4534	9606	1239	13337	3.66	0.72	453	960
LAGW06(01)	D	6973	14773	2091	22511	3.33	0.66	589	1248
LAGW06(02)	B	1417	3002	130	1394	10.94	2.15	119	253
MABW05(01)	D	8995	19056	4151	44681	2.17	0.43		
MABW05(02)	D	9779	20717	3819	41112	2.56	0.50		
MABW06(01)	E	6612	14008	1259	13548	5.25	1.03	756	1601
MABW08(01)	G	15637	33129	3736	40215	4.18	0.82	3903	8269
MABW08(02)	B	12001	25425	4441	47807	2.70	0.53	11992	25406
MDDS01(01)	B	24309	51500	4317	46464	5.63	1.11	12360	26185
MDDS03(01)	A	2125	4502	868	9342	2.45	0.48	659	1396
MDDS03(02)	A	1835	3887	692	7449	2.65	0.52		
MDDS04(01)	D	2942	6234	606	6526	4.85	0.96	283	600
MDDS04(02)	D	3396	7194	629	6765	5.40	1.06	340	720
MIBW01(01)	D	3627	7684	851	9159	4.26	0.84		
MIBW01(02)	D	3859	8175	808	8696	4.78	0.94		
MIBW03(01)	D	19364	41024	3902	42000	4.96	0.98	2834	6004
MIBW04(01)	D	16530	35020	3409	36691	4.85	0.95	1577	3342
MIBW04(02)	D	16530	35020	2454	26419	6.73	1.33	1360	2882
MNBW01(01)	D	7080	15000	1514	16301	4.67	0.92	661	1400
MNBW02(01)	D	6667	14125	1818	19572	3.67	0.72		
MNBW02(02)	D	6620	14025	1818	19572	3.64	0.72		
MNBW04(01)	D			3423	36843				
MOCS01(01)	D	30699	65038	9722	104650	3.16	0.62		
MOCS05(01)	D	70843	150088	14957	160999	4.74	0.93		
NCDW02(01)	D	26448	56033	5092	54812	5.19	1.02		
NCDW02(02)	D	26448	56033	5092	54812	5.19	1.02		
NCDW03(01)	A	595	1261	215	2315	2.77	0.54	76	160
NCDW03(02)	A	595	1261	233	2511	2.55	0.50	76	160
NCDW03(03)	A	595	1261	197	2117	3.02	0.60	76	160
NCDW03(04)	A	520	1101	126	1360	4.11	0.81	61	130
NCDW03(05)	D	520	1101	112	1200	4.66	0.92	61	130
NCDW06(01)	G	14780	31313	2038	21933	7.25	1.43		
NECW01(01)	M	87373	185108	10116	108893	8.64	1.70		
NECW02(01)	L	70843	150088	8492	91410	8.34	1.64	56674	120070
NECW03(01)	F	40617	86051	9748	104930	4.17	0.82		
NMES01(01)	H	2810	5953	803	8640	3.50	0.69		
NMES01(02)	H	5054	10706	1444	15540	3.50	0.69		
NMES02(01)	B	14594	30918	1229	13231	11.87	2.34		
NMES03(01)	D	7887	16710	1036	11150	7.61	1.50		
NMES03(02)	D	9304	19712	1289	13875	7.22	1.42		
NVAW01(01)	D	52702	111655	7623	82056	6.91	1.36		
NVAW02(01)	D	42817	90713	9711	104534	4.41	0.87	6140	13008
NVAW03(01)	N	4605	9756	664	7152	6.93	1.36		
NVAW03(02)	N	1736	3677	338	3640	5.13	1.01		

System ID	System type	Design supply airflow capacity		Floor area served by system		Design supply capacity per unit floor area		Design minimum outdoor air intake	
		L/s	cfm	m^2	ft^2	L/s-m^2	cfm/ft^2	L/s	cfm
NYBS01(01)	E	35421	75044	7353	79150	4.82	0.95	11689	24765
NYBS01(02)	E	18891	40023	3077	33119	6.14	1.21	5667	12007
NYBS02(01)	N	2208	4678	517	5560	4.27	0.84		
NYBS02(02)	N	2310	4893	503	5416	4.59	0.90		
NYBS04(01)	D	9446	20012	1412	15199	6.69	1.32		
NYBS04(02)	D	9446	20012	1558	16766	6.06	1.19		
NYBS05(01)	F	6777	14358	2483	26726	2.73	0.54	678	1436
NYBS07(01)	B	5667	12007	1084	11670	5.23	1.03		
ORIS03(01)	K	22670	48028	4329	46602	5.24	1.03	2598	5503
ORIS03(03)	K	22670	48028	2428	26138	9.33	1.84	2598	5503
ORIS04(01)	O	7337	15544	1445	15552	5.08	1.00		
PABS03(01)	D	22528	47728	5313	57185	4.24	0.83	2409	5103
PABS04(01)	D	17985	38102	4323	46530	4.16	0.82	3306	7004
PABS04(02)	A	7486	15859	248	2670	30.18	5.94		
SCDW01(01)	E	11099	23514	1380	14851	8.04	1.58	945	2001
SCDW02(01)	F	18891	40023	11297	121600	1.67	0.33	2834	6004
SDBW01(01)	E	9918	21012	2145	23088	4.62	0.91	1497	3172
SDBW02(01)	G	9446	20012	1705	18350	5.54	1.09	945	2001
SDBW04(01)	B	11335	24014	1480	15934	7.66	1.51		
TNDS05(01)	B	13130	27816	4451	47907	2.95	0.58	13130	27816
TNDS05(02)	A	7745	16410	2684	28891	2.89	0.57	7745	16410
TNDS06(01)	D	132127	279924	33783	363649	3.91	0.77	19246	40774
TNDS07(01)	N	8501	18011	952	10242	8.93	1.76		
TNFS08(01)	G	5904	12507	785	8447	7.52	1.48	590	1251
TNFS08(02)	D	2739	5804	542	5832	5.06	1.00	425	900
TNFS09(01)	G	8921	18901	1505	16200	5.93	1.17	1181	2501
TNFS09(02)	G	6962	14749	1092	11750	6.38	1.26	708	1501
TNFS10(01)	H	15420	32669	7312	78706	2.11	0.42	2928	6204
TXFS01(01)	D	56561	119830	9652	103897	5.86	1.15	3840	8135
TXFS02(01)	D	7793	16510	1373	14783	5.67	1.12		
TXFS02(02)	D	9210	19511	1483	15968	6.21	1.22		
TXFS07(01)	H	51262	108604	10380	111734	4.94	0.97		
TXFS08(01)	H	7179	15209	1688	18165	4.25	0.84	548	1161
TXFS08(02)	H	6976	14779	1718	18495	4.06	0.80	581	1231
TXFS09(01)	D	4581	9706	1123	12086	4.08	0.80	583	1236
TXFS09(02)	D	5904	12507	1379	14844	4.28	0.84	763	1616
TXFW05(01)	H	111932	237139	18792	202282	5.96	1.17		
TXFW06(01)	H	86797	183888	16357	176069	5.31	1.04		
WAIW03(01)	H	6612	14008	1985	21366	3.33	0.66	1984	4202
WAIW04(01)	H	8973	19011	1730	18623	5.19	1.02		
# of values		134	134	141	141	134	134	76	76
Mean		16097	34103	3098	33349	5.86	1.15	3269	6926
StdDev		21224	44964	4234	45579	3.57	0.70	7236	15331
Minimum		520	1101	112	1200	1.13	0.22	61	130
10th percentile		2850	6037	542	5832	2.90	0.57	331	700
25th percentile		6612	14008	989	10650	4.15	0.82	642	1360
Median		8973	19011	1636	17608	5.21	1.03	1027	2176
75th percentile		16059	34022	3439	37018	6.78	1.33	2834	6004
90th percentile		38671	81928	7623	82056	8.45	1.66	7887	16710
Maximum		132127	279924	33783	363649	30.18	5.94	56674	120070

System ID	Design minimum outdoor air intake per unit floor area		Number of occupants	Design minimum OA per person		Ratio of design minimum OA to supply	Occupant density		Design return fan capacity		Ratio of design supply to return
	L/s-m^2	cfm/ft^2		cfm	L/s		/1000 ft^2	/100 m^2	L/s	cfm	
ARFW01(01)			46				4.8	5.2			
ARFW01(02)			46				4.8	5.2			
ARFW02(01)	0.19	0.04	60	25.0	11.8	0.07	1.5	1.6			
ARFW02(02)	0.39	0.08	50	25.0	11.8	0.07	3.0	3.3			
ARFW03(01)			44				5.6	6.0			
ARFW03(02)			32				5.9	6.4			
AZHS02(01)			42				3.6	3.9			
AZHS02(02)			33				3.6	3.9	6707	14208	1.06
AZHS04(01)			68				3.7	3.9			
AZHS04(02)			12				5.9	6.4			
AZHW10(01)			35				2.7	2.9			
AZHW10(02)			19				5.6	6.0			
AZHW11(01)			113				4.0	4.3			
AZHW12(01)	0.29	0.06	94	24.3	11.5	0.14	2.3	2.5			
AZHW12(02)	0.34	0.07	45	50.7	23.9	0.14	1.3	1.4			
CAES17(01)	1.20	0.24	70	53.2	25.1	0.15	4.5	4.8			
CAEW07(01)			95				2.7	2.9	12752	27016	1.37
CAEW001)	1.25	0.25	150	113.4	53.5	0.21	2.2	2.3	30699	65038	1.26
CAJS01(01)			52				2.3	2.5			
CAJS01(02)			30				3.9	4.2			
CAJS01(03)			12				1.6	1.7			
CAJS02(01)	2.25	0.44	111	54.1	25.5	0.20	8.2	8.8			
CAJS03(01)	0.17	0.03	155	19.1	9.0	0.15	1.7	1.9	47229	100059	0.20
CAJS21(01)	1.55	0.30	50	60.5	28.6	0.21	5.0	5.4	5290	11207	1.27
CAJS21(02)		1.07	46	208.2	98.2	1.00	5.1	5.5			
CAJS222(01)	0.55	0.11	183	12.0	5.7	0.12	8.9	9.6			
CAJS23(01)	0.90	0.18	73	27.4	12.9	0.11	6.5	7.0			
CAJW18(01)			59				3.3	3.6			
CAJW18(02)											
CAJW19(01)			92				3.2	3.5	15349	32519	1.06
CAJW20(01)	0.95	0.19	741	37.8	17.8	0.17	5.0	5.3	68009	144084	1.11
CAJW24(01)			224				5.5	5.9	25504	54032	1.11
CAJW25(01)			770				60.5		12586	26666	1.17
CAJW26(01)			420				5.5	5.9	30472	64558	1.26
COAS02(01)			133				3.6	3.9			
COAS04(01)	0.93	0.18	310	32.3	15.2	0.10	5.7	6.1	42506	90053	1.11
COAS06(01)	0.60	0.12	55	32.7	15.5	0.09	3.6	3.9			
FLDW07(02)	0.72	0.14	50	63.3	29.9	0.19	2.2	2.4			
FLDW08(01)	0.66	0.13	69	33.4	15.7	0.10	3.9	4.2			
FLDW10(01)	0.33	0.07	108	10.2	4.8	0.09	6.4	6.9			
FLGS01(01)	0.75	0.15	70	42.9	20.2	0.14	3.5	3.7			
FLGS04(01)	0.72	0.14	50	30.0	14.2	0.11	4.7	5.1			
FLGS04(02)	0.72	0.14	50	30.0	14.2	0.11	4.7	5.1			
FLGS11(01)	0.22	0.04	44	15.9	7.5	0.06	2.8	3.0			
FLGS11(02)	0.22	0.04	46	15.2	7.2	0.06	2.9	3.1			
FLGS12(01)	1.69	0.33	60	61.7	29.1	0.15	5.4	5.8			
GADS01(01)	0.42	0.08	67	32.1	15.2	0.10	2.6	2.8			
GADS02(01)	0.56	0.11	40	50.0	23.6	0.14	2.2	2.4			
GADS02(02)	0.56	0.11	40	50.0	23.6	0.14	2.2	2.4			
GADS03(01)			124				5.3	5.7			

System ID	Design minimum outdoor air intake per unit floor area		Number of occupants	Design minimum OA per person		Ratio of design minimum OA to supply	Occupant density		Design return fan capacity		Ratio of design supply to return
	L/s-m²	cfm/ft²		cfm	L/s		/1000 ft²	/100 m²	L/s	cfm	
ILBS01(01)			35				2.7	2.9			
ILBS01(02)			51				4.9	5.3			
ILBS02(01)			45				4.1	4.4	7793	16510	1.09
ILBS03(01)			63				2.6	2.8			
LAGW04(01)	0.49	0.10	40	50.0	23.6	0.10	1.9	2.1			
LAGW04(02)	0.45	0.09	33	60.6	28.6	0.11	1.5	1.6			
LAGW05(01)	1.79	0.35	42	33.6	15.9	0.10	10.5	11.3			
LAGW05(02)	0.37	0.07	30	32.0	15.1	0.10	2.2	2.4			
LAGW06(01)	0.28	0.06	66	18.9	8.9	0.08	2.9	3.2			
LAGW06(02)	0.92	0.18				0.08					
MABW05(01)			120				2.7	2.9	8180	17330	1.10
MABW05(02)			120				2.9	3.1	8426	17851	1.16
MABW06(01)	0.60	0.12	50	32.0	15.1	0.11	3.7	4.0	4362	9240	1.52
MABW08(01)	1.04	0.21	420	19.7	9.3	0.25	10.4	11.2	16105	34120	0.97
MABW08(02)	2.70	0.53	408	62.3	29.4	1.00	8.5	9.2			
MDDS01(01)	2.86	0.56	241	108.7	51.3	0.51	5.2	5.6			
MDDS03(01)	0.76	0.15	51	27.4	12.9	0.31	5.5	5.9			
MDDS03(02)			33				4.4	4.8			
MDDS04(01)	0.47	0.09	44	13.6	6.4	0.10	6.7	7.3			
MDDS04(02)	0.54	0.11	24	30.0	14.2	0.10	3.5	3.8			
MIBW01(01)			45				4.9	5.3	3254	6894	1.11
MIBW01(02)			34				3.9	4.2	3171	6719	1.22
MIBW03(01)	0.73	0.14	373	16.1	7.6	0.15	8.9	9.6	17427	36922	1.11
MIBW04(01)	0.46	0.09	172	19.4	9.2	0.10	4.7	5.0	14953	31678	1.11
MIBW04(02)	0.55	0.11	172	16.8	7.9	0.08	6.5	7.0	15170	32139	1.09
MNBW01(01)	0.44	0.09	45	31.1	14.7	0.09	2.8	3.0			
MNBW02(01)			37				1.9	2.0			
MNBW02(02)			31				1.6	1.7			
MNBW04(01)			87				2.4	2.5			
MOCS01(01)			295				2.8	3.0	25976	55032	1.18
MOCS05(01)			374				2.3	2.5			
NCDW02(01)			110				2.0	2.2			
NCDW02(02)			113				2.1	2.2			
NCDW03(01)	0.35	0.07	7	22.9	10.8	0.13	3.0	3.3			
NCDW03(02)	0.32	0.06	2	80.0	37.8	0.13	0.8	0.9			
NCDW03(03)	0.38	0.08	8	20.0	9.4	0.13	3.8	4.1			
NCDW03(04)	0.49	0.10	4	32.5	15.3	0.12	2.9	3.2			
NCDW03(05)	0.55	0.11	4	32.5	15.3	0.12	3.3	3.6			
NCDW06(01)			60				2.7	2.9			
NECW01(01)			893				8.2	8.8	47229	100059	1.85
NECW02(01)	6.67	1.31	1500	80.0	37.8	0.80	16.4	17.7	56674	120070	1.25
NECW03(01)			921				8.8	9.4	36366	77045	1.12
NMES01(01)			12				1.4	1.5	2782	5893	1.01
NMES01(02)			41				2.6	2.8	5001	10596	1.01
NMES02(01)			77				5.8	6.3			
NMES03(01)			20				1.8	1.9			
NMES03(02)			45				3.2	3.5			
NVAW01(01)			359				4.4	4.7			
NVAW02(01)	0.63	0.12	393	33.1	15.6	0.14	3.8	4.0	39700	84109	1.08
NVAW03(01)			36				5.0	5.4	3674	7784	1.25
NVAW03(02)			12				3.3	3.5	1193	2527	1.46

System ID	Design minimum outdoor air intake per unit floor area		Number of occupants	Design minimum OA per person		Ratio of design minimum OA to supply	Occupant density		Design return fan capacity		Ratio of design supply to return
	L/s-m²	cfm/ft²		cfm	L/s		/1000 ft²	/100 m²	L/s	cfm	
NYBS01(01)	1.59	0.31	618	40.1	18.9	0.33	7.8	8.4			
NYBS01(02)	1.84	0.36	332	36.2	17.1	0.30	10.0	10.8			
NYBS02(01)			40				7.2	7.7			
NYBS02(02)			28				5.2	5.6			
NYBS04(01)			50				3.3	3.5	8501	18011	1.11
NYBS04(02)			70				4.2	4.5	8501	18011	1.11
NYBS05(01)	0.27	0.05	160	9.0	4.2	0.10	6.0	6.4	5313	11257	1.28
NYBS07(01)			65				5.6	6.0			
ORIS03(01)	0.60	0.12	171	32.2	15.2	0.11	3.7	3.9			
ORIS03(03)	1.07	0.21	82	67.1	31.7	0.11	3.1	3.4			
ORIS04(01)			67				4.3	4.6			
PABS03(01)	0.45	0.09	350	14.6	6.9	0.11	6.1	6.6			
PABS04(01)	0.76	0.15	195	35.9	17.0	0.18	4.2	4.5	14169	30018	1.27
PABS04(02)									6966	14759	1.07
SCDW01(01)	0.68	0.13	90	22.2	10.5	0.09	6.1	6.5	10154	21513	1.09
SCDW02(01)	0.25	0.05	160	37.5	17.7	0.15	1.3	1.4	16530	35020	1.14
SDBW01(01)	0.70	0.14	61	52.0	24.5	0.15	2.6	2.8	9587	20312	1.03
SDBW02(01)	0.55	0.11	700	2.9	1.3	0.10	38.1	41.1			
SDBW04(01)			57				3.6	3.9	11335	24014	1.00
TNDS05(01)	2.95	0.58	575	48.4	22.8	1.00	12.0	12.9			
TNDS05(02)	2.89	0.57				1.00					
TNDS06(01)	0.57	0.11	1067	38.2	18.0	0.15	2.9	3.2			
TNDS07(01)			55				5.4	5.8			
TNFS08(01)	0.75	0.15	46	27.2	12.8	0.10	5.4	5.9			
TNFS08(02)	0.78	0.15	29	31.0	14.7	0.16	5.0	5.4			
TNFS09(01)	0.78	0.15	104	24.1	11.4	0.13	6.4	6.9			
TNFS09(02)	0.65	0.13	68	22.1	10.4	0.10	5.8	6.2			
TNFS10(01)	0.40	0.08	86	72.1	34.0	0.19	1.1	1.2			
TXFS01(01)	0.40	0.08	348	23.4	11.0	0.07	3.3	3.6			
TXFS02(01)			42				2.8	3.1			
TXFS02(02)			49				3.1	3.3			
TXFS07(01)			362				3.2	3.5			
TXFS08(01)	0.32	0.06	59	19.7	9.3	0.08	3.2	3.5			
TXFS08(02)	0.34	0.07	53	23.2	11.0	0.08	2.9	3.1			
TXFS09(01)	0.52	0.10	60	20.6	9.7	0.13	5.0	5.3			
TXFS09(02)	0.55	0.11	33	49.0	23.1	0.13	2.2	2.4			
TXFW05(01)			515				2.5	2.7	111460	236138	1.00
TXFW06(01)			495				2.8	3.0	86797	183888	1.00
WAIW03(01)	1.00	0.20	77	54.6	25.8	0.30	3.6	3.9			
WAIW04(01)			54				2.9	3.1			
# of values	76	76	137	74	74	76	137	137	41	41	41
Mean	0.94	0.18	154	39.0	18.4	0.19	4.9	5.3	22045	46705	1.14
StdDev	1.06	0.21	229	29.0	13.7	0.22	6.1	6.5	24074	51003	0.22
Minimum	0.17	0.03	2	2.9	1.3	0.06	0.8	0.9	1193	2527	0.20
10th percentile	0.31	0.06	30	16.0	7.5	0.08	2.0	2.2	3674	7784	1.00
25th percentile	0.42	0.08	42	22.4	10.6	0.10	2.7	2.9	6966	14759	1.07
Median	0.60	0.12	60	32.1	15.2	0.12	3.7	3.9	12752	27016	1.11
75th percentile	0.92	0.18	150	50.0	23.6	0.15	5.4	5.9	30472	64558	1.25
90th percentile	1.82	0.36	339	63.0	29.7	0.31	7.4	8.0	47229	100059	1.28
Maximum	6.67	1.31	1500	208.2	98.3	1.00	60.5	65.1	111460	236138	1.85

Appendix C: Volumetric Airflow Data Issues

This appendix describes measurement issues identified with the volumetric airflow data and any adjustments that were made to account for these issues.

Building	Measurement Issue	Data adjustment
ARFW02	Wednesday a.m. volumetric outdoor air value for system #2 significantly below other measured values for that system, while outdoor air fraction for this time period based on CO_2 consistent with other values.	Delete suspect value, no study space volumetric outdoor airflow for Wednesday a.m.
AZHS04	System #1 measured recirculation airflow greater than supply airflow for 3 of 4 readings, leading to negative values for outdoor airflow; not significantly different from zero based on uncertainty in recirculation and supply airflows.	Set system #1 outdoor airflow equal to zero in those 3 cases.
AZHW10	No outdoor airflow measurement on System #2, but System #1 outdoor airflow values very close to sum of supply airflows for System #1 and #2; survey notes indicate common outdoor air intake for both systems.	Calculate study space outdoor airflow based on System #1 values alone.
CAJS01	No outdoor airflow measurement on System #1 of three systems; all systems are 100% outdoor air; note that System #1 supply airflow is only about 10 % of supply airflow of other two systems.	Assume System #1 outdoor airflow equals supply airflow.
CAJW18	Two systems listed under system design information, but no design or measured data on System #2; survey notes indicate that System #2 is heating only and wasn't operating during test week.	Results based on System #1 measurements alone.
CAJW26	Volumetric outdoor air fraction greater than 100 % for 3 of 4 readings, but not significantly different from 100 % based on uncertainty.	Use the 3 calculated values greater than 100 %.
COAS04	Measured recirculation airflow greater than supply airflow for one reading, leading to negative value for outdoor airflow; not significantly different from zero based on uncertainty in recirculation and supply airflows.	Set value of outdoor airflow equal to zero in that case.
ILBS01	Volumetric measurements of supply airflow only for both systems; survey notes indicate outdoor air intake damper closed during test week; outdoor airflows can only be determined by product of supply airflow and outdoor air fraction from CO_2.	No adjustments made to data.
LAGW05	Volumetric supply airflow values measured for both systems, outdoor airflow values for System #2 are duplicates of System #1 values; survey notes indicate common outdoor air intake serves both systems.	Use System #1 values alone to determine outdoor air fraction and study space outdoor airflow.
LAGW06	No volumetric supply airflow values and only one outdoor airflow value for System #2; survey notes indicate that System #2 does not always operate and that common outdoor air intake serves both systems; System #2 design supply capacity and minimum outdoor air only 20 % of System #1.	Add single System #2 outdoor airflow to corresponding System #1 value when calculating study space outdoor airflow.
MABW05	One System #2 measured recirculation airflow value greater than supply airflow, leading to negative value	Set value of outdoor airflow equal to zero.

	for outdoor airflow; not significantly different from zero based on uncertainty in recirculation and supply airflows.	
MDDS01	Measured recirculation airflow greater than supply airflow for two readings, leading to negative values for outdoor airflow; not significantly different from zero based on assumed uncertainty in recirculation and supply airflows.	Set value of outdoor airflow equal to zero for these two events.
NCDW03	Five systems; survey notes indicate outdoor air not operated during study week; 5 of 20 potential outdoor airflow values listed, could be leakage into system.	No volumetric airflow rates calculated for the study space.
NMES02	All 4 volumetric outdoor airflows greater than volumetric supply airflows; outdoor air fraction significantly greater than 100 % based on measurement uncertainty for only 1 of the 4 values.	Use all values as calculated.
NVAW03	System #1 measured outdoor airflows greater than supply airflow for all 4 readings, leading to volumetric outdoor air fraction greater than 100 %, but not significantly greater.	No adjustments made to data.
NYBS04	Thursday a.m. volumetric outdoor airflow for system #1 much higher than other values for both systems #1 and #2.	No adjustments made to data.
ORIS03	No volumetric outdoor airflows for System #3; survey notes indicate outdoor air intake serves both systems #1 and #3.	Supply airflow for system #1 based on sum of system #1 and #3 values; outdoor airflow based on System #1 values.
ORIS04	No volumetric outdoor or recirculation airflow values; survey notes indicate outdoor air damper location prevented reliable traverse..	Outdoor airflow from CO_2 ratio only.
PABS03	Measured recirculation airflow greater than supply airflow for all four readings, leading to negative values for outdoor airflow; not significantly different from zero based on assumed uncertainty in recirculation and supply airflows.	Set all 4 values of outdoor airflow equal to zero.

Appendix D: Measured Data for Air Handlers

This appendix presents the following information for the measurements in the air handlers serving the study spaces:

System ID
Day and time of measurement
Supply, outdoor and recirculation airflows, and associated uncertainties (values in italics were not measured directly but were derived from other airflow rates, i.e., supply = outdoor air + recirculation; outdoor air = supply – recirculation)
Outdoor air fraction, based on volumetric and carbon dioxide ratio methods, and associated uncertainties

		Supply airflow		Uncertainty in supply airflow		Outdoor airflow		Uncertainty in outdoor airflow	
System ID	**Day Period**	L/s	cfm	L/s	cfm	L/s	cfm	L/s	cfm
ARFW01(01)	Wed AM	6919	14658	692	1466	385	815	115	245
	Wed PM	6703	14200	670	1420	363	768	109	231
	Thurs AM	6583	13946	658	1395	370	784	111	235
	Thurs PM	6655	14099	665	1410	363	768	109	231
ARFW01(02)	Wed AM	6328	13407	633	1341	348	737	104	221
	Wed PM	6439	13641	644	1364	348	737	104	221
	Thurs AM	6477	13722	648	1372	378	800	113	240
	Thurs PM	6602	13987	660	1399	355	753	107	226
ARFW02(01)	Wed AM	5155	10922	516	1092	4220	8941	1266	2682
	Wed PM	4946	10478	495	1048	4159	8810	1248	2643
	Thurs AM								
	Thurs PM	4946	10478	495	1048	4183	8862	1255	2659
ARFW02(02)	Wed AM	6544	13865	654	1386				
	Wed PM	6300	13347	630	1335	5013	10620	1504	3186
	Thurs AM								
	Thurs PM	6394	13546	639	1355	5221	11062	1566	3319
ARFW03(01)	Wed AM	3753	7951	375	795	158	334	47	100
	Wed PM	4073	8629	407	863	100	211	30	63
	Thurs AM	3961	8392	396	839	108	229	32	69
	Thurs PM	3945	8358	395	836	108	229	32	69
ARFW03(02)	Wed AM	2317	4908	232	491	254	539	76	162
	Wed PM	2515	5328	251	533	287	608	86	182
	Thurs AM	2575	5455	257	545	328	695	98	209
	Thurs PM	2503	5302	250	530	303	643	91	193
AZHS02(01)	Wed AM	4579	9700	458	970	*1670*	*3538*	985	2088
	Wed PM	5361	11359	536	1136	*2600*	*5508*	987	2091
	Thurs AM	4233	8967	423	897	*1243*	*2633*	992	2101
	Thurs PM	4397	9315	440	931	*1628*	*3449*	940	1991
AZHS02(02)	Wed AM	2541	5383	254	538	*1177*	*2494*	482	1020
	Wed PM	2511	5319	251	532	*1240*	*2628*	456	967
	Thurs AM	2041	4323	204	432	*545*	*1155*	493	1044
	Thurs PM	2481	5256	248	526	*692*	*1466*	591	1252
AZHS04(01)	Wed AM	10463	22166	1046	2217	*0*	*0*	3309	7010
	Wed PM	10385	22001	1038	2200	*0*	*0*	3424	7254
	Thurs AM	10229	21671	1023	2167	*1069*	*2265*	2932	6212
	Thurs PM	9831	20827	983	2083	*0*	*0*	3339	7073
AZHS04(02)	Wed AM	*698*	*1478*	182	386	99	209	30	63
	Wed PM	*707*	*1498*	182	386	109	231	33	69
	Thurs AM	*716*	*1516*	193	408	78	166	23	50
	Thurs PM	*810*	*1716*	210	446	119	252	36	76
AZHW10(01)	Wed AM	8276	17533	828	1753	10637	22536	3191	6761
	Wed PM	7891	16717	789	1672	12242	25936	3673	7781
	Thurs AM	9031	19132	903	1913	13458	28512	4037	8554
	Thurs PM	9179	19446	918	1945	13545	28696	4063	8609
AZHW10(02)	Wed AM	4178	8852	418	885				
	Wed PM	4297	9104	430	910				
	Thurs AM	4440	9406	444	941				
	Thurs PM	4321	9154	432	915				
AZHW11(01)	Wed AM	14204	30093	1420	3009	*2705*	*5732*	3731	7904
	Wed PM	16743	35472	1674	3547	*4916*	*10415*	3923	8312
	Thurs AM	16537	35036	1654	3504	*5531*	*11719*	3693	7824
	Thurs PM	18116	38380	1812	3838	*6206*	*13148*	4006	8487
AZHW12(01)	Wed AM	3647	7727	365	773	752	1594	226	478
	Wed PM	3575	7574	357	757	863	1828	259	548
	Thurs AM	3250	6885	325	689	145	307	43	92
	Thurs PM	3105	6579	311	658	110	234	33	70

		Supply airflow		**Uncertainty in supply airflow**		**Outdoor airflow**		**Uncertainty in outdoor airflow**	
System ID	**Day Period**	L/s	cfm	L/s	cfm	L/s	cfm	L/s	cfm
AZHW12(02)	Wed AM	5236	11093	524	1109	1595	3380	479	1014
	Wed PM	5236	11093	524	1109	1595	3380	479	1014
	Thurs AM	5236	11093	524	1109	1617	3427	485	1028
	Thurs PM	5705	12087	571	1209	1738	3683	522	1105
CAES17(01)	Wed AM	16286	34503	1629	3450	*3040*	*6441*	4294	9098
	Wed PM	15564	32974	1556	3297	*2210*	*4682*	4298	9106
	Thurs AM	17549	37179	1755	3718	*9895*	*20963*	2890	6123
	Thurs PM	16737	35459	1674	3546	*5120*	*10847*	3866	8191
CAEW07(01)	Wed AM	17522	37122	1752	3712	5371	11380	1611	3414
	Wed PM	18569	39341	1857	3934	16134	34182	4840	10255
	Thurs AM	17522	37122	1752	3712	13365	28315	4009	8494
	Thurs PM	17236	36516	1724	3652	18092	38329	5427	11499
CAEW09(01)	Wed AM	11693	24773	1169	2477	3704	7847	1111	2354
	Wed PM	12026	25478	1203	2548	3221	6824	966	2047
	Thurs AM	12317	26095	1232	2609	1772	3753	531	1126
	Thurs PM	11360	24067	1136	2407	1691	3583	507	1075
CAJS01(01)	Wed AM	200	423	20	42	*200*	*423*	60	127
	Wed PM	200	423	20	42	*200*	*423*	60	127
	Thurs AM	155	329	16	33	*155*	*329*	47	99
	Thurs PM	200	423	20	42	*200*	*423*	60	127
CAJS01(02)	Wed AM	1336	2830	134	283	1336	2830	401	849
	Wed PM	1315	2786	131	279	1315	2786	394	836
	Thurs AM	1416	3000	142	300	1416	3000	425	900
	Thurs PM	1323	2804	132	280	1323	2804	397	841
CAJS01(03)	Wed AM	1538	3258	154	326	1538	3258	461	977
	Wed PM	1739	3685	174	368	1739	3685	522	1105
	Thurs AM	1613	3418	161	342	1613	3418	484	1025
	Thurs PM	1647	3489	165	349	1647	3489	494	1047
CAJS02(01)	Wed AM	14671	31081	1467	3108	12430	26333	3729	7900
	Wed PM	13720	29067	1372	2907	12601	26696	3780	8009
	Thurs AM	14671	31081	1467	3108	14368	30440	4310	9132
	Thurs PM	14331	30362	1433	3036	15508	32856	4653	9857
CAJS03(01)	Wed AM	40277	85330	4028	8533	40277	85330	12083	25599
	Wed PM	41447	87811	4145	8781	41447	87811	12434	26343
	Thurs AM	42384	89795	4238	8979	42384	89795	12715	26938
	Thurs PM	41631	88200	4163	8820	41447	87811	12434	26343
CAJS21(01)	Wed AM	6088	12897	609	1290	1265	2679	379	804
	Wed PM	4911	10405	491	1040	1196	2534	359	760
	Thurs AM	4558	9657	456	966	1647	3489	494	1047
	Thurs PM	5117	10841	512	1084	1470	3115	441	935
CAJS21(02)	Wed AM	2582	5470	258	547	2582	5470	775	1641
	Wed PM	2849	6035	285	604	2849	6035	855	1811
	Thurs AM	2865	6069	286	607	2865	6069	859	1821
	Thurs PM	2902	6149	290	615	2902	6149	871	1845
CAJS222(01)	Wed AM	4651	9854	465	985	*391*	*829*	1360	2881
	Wed PM	5604	11873	560	1187	*806*	*1708*	1545	3272
	Thurs AM	4494	9521	449	952	*929*	*1968*	1160	2458
	Thurs PM	5567	11793	557	1179	*1172*	*2483*	1431	3032
CAJS23(01)	Wed AM	11349	24044	1135	2404	837	1773	251	532
	Wed PM	10010	21206	1001	2121	1016	2153	305	646
	Thurs AM	11238	23808	1124	2381	967	2048	290	614
	Thurs PM	11535	24439	1154	2444	1098	2326	329	698
CAJW18(01)	Wed AM	10464	22170	1046	2217	845	1791	254	537
	Wed PM	10922	23140	1092	2314	832	1763	250	529
	Thurs AM	10709	22687	1071	2269	938	1986	281	596
	Thurs PM	12081	25596	1208	2560	938	1986	281	596

		Supply airflow		Uncertainty in supply airflow		Outdoor airflow		Uncertainty in outdoor airflow	
System ID	**Day Period**	L/s	cfm	L/s	cfm	L/s	cfm	L/s	cfm
CAJW19(01)	Wed AM	17769	37645	1777	3764	*8828*	*18703*	3217	6816
	Wed PM	17430	36926	1743	3693	*7045*	*14925*	3570	7563
	Thurs AM	17769	37645	1777	3764	*8753*	*18543*	3236	6856
	Thurs PM	16887	35777	1689	3578	*5530*	*11715*	3803	8056
CAJW20(01)	Wed AM	33151	70234	3315	7023	39935	84606	11980	25382
	Wed PM	36439	77200	3644	7720	41671	88284	12501	26485
	Thurs AM	32055	67913	3206	6791	36462	77249	10939	23175
	Thurs PM	32877	69654	3288	6965	36936	78252	11081	23476
CAJW24(01)	Tues AM	19105	40475	1910	4048	13205	27975	3961	8393
	Tues PM	20500	43432	2050	4343	741	1570	222	471
	Wed AM	19105	40475	1910	4048	13205	27975	3961	8393
	Wed PM	21788	46160	2179	4616	729	1545	219	463
	Thurs AM	23076	48889	2308	4889	16164	34245	4849	10274
	Thurs PM	23183	49116	2318	4912	20547	43530	6164	13059
CAJW25(01)	Wed AM	17130	36292	1713	3629	9230	19555	2769	5867
	Wed PM	18047	38233	1805	3823	17256	36560	5177	10968
	Thurs AM	15964	33822	1596	3382	11337	24019	3401	7206
	Thurs PM	17738	37580	1774	3758	18159	38473	5448	11542
CAJW26(01)	Wed AM	29773	63078	2977	6308	33826	71665	10148	21499
	Wed PM	33495	70962	3349	7096	37230	78875	11169	23662
	Thurs AM	31205	66110	3120	6611	33311	70572	9993	21172
	Thurs PM	32779	69446	3278	6945	30939	65547	9282	19664
COAS02(01)	Wed AM	11323	23988	3163	6701	810	1717	243	515
	Wed PM	10049	21290	2710	5742	1080	2289	324	687
	Thurs AM	11012	23330	3021	6401	990	2098	297	629
	Thurs PM	12065	25562	3188	6754	1553	3290	466	987
COAS04(01)	Wed AM	34210	72477	3421	7248	*780*	*1652*	10596	22450
	Wed PM	34890	73918	3489	7392	*2278*	*4827*	10387	22006
	Thurs AM	33529	71036	3353	7104	*153*	*324*	10559	22371
	Thurs PM	34330	72731	3433	7273	*0*	*0*	11020	23348
COAS06(01)	Wed AM	3837	8130	384	813	927	1963	278	589
	Wed PM	4818	10206	482	1021	999	2116	300	635
	Thurs AM	6446	13657	645	1366	1074	2275	322	683
	Thurs PM	5066	10733	507	1073	887	1878	266	564
FLDW07(02)	Wed AM	7499	15888	1979	4192	977	2069	293	621
	Wed PM	6766	14334	1755	3719	1002	2122	300	637
	Thurs AM	6340	13431	1634	3461	983	2083	295	625
	Thurs PM	6911	14643	1789	3791	1039	2201	312	660
FLDW08(01)	Wed AM	6982	14793	698	1479	1307	2769	392	831
	Wed PM	7647	16200	765	1620	871	1846	261	554
	Thurs AM	7090	15020	709	1502	871	1846	261	554
	Thurs PM	7116	15075	712	1508	4773	10112	1432	3034
FLDW10(01)	Wed AM	3702	7844	370	784	285	603	85	181
	Wed PM	3721	7883	372	788	324	686	97	206
	Thurs AM	3783	8015	378	801	356	755	107	226
	Thurs PM	3417	7240	342	724	228	482	68	145
FLGS01(01)	Thurs AM	4769	10103	477	1010	931	1973	279	592
	Thurs PM	5276	11178	528	1118	978	2072	293	622
	Fri AM	4615	9778	462	978	905	1917	272	575
	Fri PM	5005	10603	500	1060	991	2099	297	630
FLGS04(01)	Wed AM	7019	14870	702	1487	246	522	74	157
	Wed PM	7372	15618	737	1562	273	579	82	174
	Thurs AM	7215	15285	721	1529	242	513	73	154
	Thurs PM	7215	15285	721	1529	220	466	66	140
FLGS04(02)	Wed AM	9411	19937	941	1994	395	837	118	251
	Wed PM	9469	20062	947	2006	381	807	114	242
	Thurs AM	9607	20353	961	2035	398	843	119	253
	Thurs PM	10058	21308	1006	2131	413	875	124	263

		Supply airflow		Uncertainty in supply airflow		Outdoor airflow		Uncertainty in outdoor airflow	
System ID	**Day Period**	L/s	cfm	L/s	cfm	L/s	cfm	L/s	cfm
FLGS11(01)	Wed AM	2684	5686	268	569	433	917	130	275
	Wed PM	4318	9149	432	915	449	950	135	285
	Thurs AM	2288	4848	229	485	433	917	130	275
	Thurs PM	4542	9623	454	962	399	846	120	254
FLGS11(02)	Wed AM	3699	7837	370	784	532	1127	160	338
	Wed PM	4594	9732	459	973	508	1077	153	323
	Thurs AM	2976	6306	298	631	482	1022	145	307
	Thurs PM	4250	9003	425	900	472	1000	142	300
FLGS12(01)	Wed AM	*10029*	*21246*	2564	5431	1643	3480	493	1044
	Wed PM	*9658*	*20462*	2452	5194	1655	3507	497	1052
	Thurs AM	*8985*	*19036*	2252	4772	1664	3525	499	1057
	Thurs PM	*8774*	*18589*	2219	4702	1538	3258	461	977
GADS01(01)	Wed AM	*5469*	*11587*	1185	2511	2165	4588	650	1376
	Wed PM	*5890*	*12480*	1327	2811	1895	4014	568	1204
	Thurs AM	*5522*	*11700*	1187	2514	2313	4900	694	1470
	Thurs PM	*5669*	*12010*	1238	2622	2145	4544	643	1363
GADS02(01)	Wed AM	5291	11210	529	1121	855	1811	256	543
	Wed PM	6143	13014	614	1301	978	2072	293	622
	Thurs AM	5017	10630	502	1063	1101	2333	330	700
	Thurs PM	6105	12933	610	1293	989	2096	297	629
GADS02(02)	Wed AM	5017	10630	502	1063	1269	2688	381	806
	Wed PM	5717	12112	572	1211	1118	2368	335	711
	Thurs AM	5253	11129	525	1113	1090	2310	327	693
	Thurs PM	6409	13577	641	1358	1180	2499	354	750
GADS03(01)	Wed AM	11988	25399	1199	2540	956	2026	287	608
	Wed PM	11462	24283	1146	2428	973	2061	292	618
	Thurs AM	11415	24183	1141	2418	973	2061	292	618
	Thurs PM	11274	23885	1127	2388	978	2072	293	622
ILBS01(01)	Wed AM	4889	10359	489	1036				
	Wed PM	4428	9381	443	938				
	Thurs AM	4161	8816	416	882				
	Thurs PM	4792	10152	479	1015				
ILBS01(02)	Wed AM	4460	9450	446	945				
	Wed PM	4889	10359	489	1036				
	Thurs AM	4688	9932	469	993				
	Thurs PM	4720	10001	472	1000				
ILBS02(01)	Wed AM	7212	15280	721	1528	598	1267	179	380
	Wed PM	7488	15864	749	1586	549	1163	165	349
	Thurs AM	7015	14862	702	1486	476	1008	143	302
	Thurs PM	7173	15196	717	1520	543	1151	163	345
ILBS03(01)	Thurs AM	16385	34712	1638	3471	7661	16231	3088	6541
	Thurs PM	15682	33225	1568	3322	6606	13995	3142	6657
	Wed AM	16229	34382	1623	3438	5875	12446	3505	7425
	Wed PM	16931	35870	1693	3587	6027	12768	3683	7804
LAGW04(01)	Wed AM	9213	19518	921	1952	570	1207	171	362
	Wed PM	9735	20624	973	2062	439	929	132	279
	Thurs AM	8967	18997	897	1900	549	1163	165	349
	Thurs PM	9827	20819	983	2082	533	1129	160	339
LAGW04(02)	Wed AM	10687	22641	1069	2264	776	1644	233	493
	Wed PM	10594	22446	1059	2245	821	1739	246	522
	Thurs AM	10287	21795	1029	2179	837	1773	251	532
	Thurs PM	10533	22315	1053	2232	792	1678	238	504
LAGW05(01)	Wed AM	9409	19934	941	1993	2726	5775	818	1732
	Wed PM	9075	19226	907	1923	3054	6471	916	1941
	Thurs AM	9203	19498	920	1950	2868	6077	860	1823
	Thurs PM	8972	19008	897	1901	3023	6405	907	1922
LAGW05(02)	Wed AM	4926	10437	493	1044				
	Wed PM	4876	10331	488	1033				
	Thurs AM	5026	10649	503	1065				
	Thurs PM	4939	10464	494	1046				

		Supply airflow		Uncertainty in supply airflow		Outdoor airflow		Uncertainty in outdoor airflow	
System ID	**Day Period**	L/s	cfm	L/s	cfm	L/s	cfm	L/s	cfm
LAGW06(01)	Wed AM	9962	21106	996	2111	1259	2668	378	800
	Wed PM	10012	21211	1001	2121	1220	2584	366	775
	Thurs AM	9933	21043	993	2104	1216	2575	365	773
	Thurs PM	9992	21169	999	2117	1232	2609	369	783
LAGW06(02)	Wed AM					141	298	42	90
	Wed PM								
	Thurs AM								
	Thurs PM								
MABW05(01)	Wed AM	4182	8860	418	886	*415*	*880*	1205	2553
	Wed PM	6951	14727	695	1473	*1938*	*4107*	1657	3510
	Thurs AM	6556	13889	656	1389	*1288*	*2728*	1711	3625
	Thurs PM	6838	14488	684	1449	*1740*	*3687*	1675	3549
MABW05(02)	Wed AM	6104	12931	610	1293	*637*	*1350*	1750	3707
	Wed PM	5991	12692	599	1269	*0*	*0*	2028	4296
	Thurs AM	6443	13650	644	1365	*325*	*689*	1945	4121
	Thurs PM	6725	14248	673	1425	*41*	*87*	2115	4481
MABW06(01)	Wed AM	2112	4474	211	447	1965	4163	589	1249
	Wed PM	2085	4417	208	442	2013	4265	604	1279
	Thurs AM	1783	3776	178	378	1723	3651	517	1095
	Thurs PM	1728	3662	173	366	1675	3548	502	1065
MABW08(01)	Wed AM	12910	27352	1291	2735	*8083*	*17124*	1940	4110
	Wed PM	13508	28619	1351	2862	*9097*	*19273*	1891	4006
	Thurs AM	12597	26687	1260	2669	*6698*	*14191*	2172	4602
	Thurs PM	12910	27352	1291	2735	*7557*	*16011*	2061	4365
MABW08(02)	Wed AM	*12379*	*26225*	3588	7602	11952	25322	3586	7597
	Wed PM	*11883*	*25176*	3431	7269	11427	24210	3428	7263
	Thurs AM	*11537*	*24443*	3330	7055	11091	23498	3327	7049
	Thurs PM	*11686*	*24758*	3332	7059	11091	23498	3327	7049
MDDS01(01)	Wed AM	21258	45037	2126	4504	*2408*	*5101*	6041	12799
	Wed PM	22707	48108	2271	4811	*1439*	*3048*	6773	14349
	Thurs AM	20292	42990	2029	4299	*0*	*0*	7794	16512
	Thurs PM	19889	42137	1989	4214	*0*	*0*	6884	14585
MDDS03(01)	Wed AM	1329	2815	133	282	209	442	63	133
	Wed PM	1332	2823	133	282	176	372	53	112
	Thurs AM	1340	2838	134	284	191	404	57	121
	Thurs PM	1332	2823	133	282	181	383	54	115
MDDS03(02)	Wed AM	2129	4511	213	451	68	145	21	43
	Wed PM	1928	4084	193	408	31	65	9	19
	Thurs AM	2047	4336	205	434	65	137	19	41
	Thurs PM	1994	4224	199	422	64	135	19	41
MDDS04(01)	Wed AM	2558	5420	256	542	*293*	*620*	726	1539
	Wed PM	2531	5362	253	536	*284*	*601*	720	1525
	Thurs AM	2545	5391	254	539	*260*	*550*	731	1549
	Thurs PM	2434	5157	243	516	*206*	*437*	711	1507
MDDS04(02)	Wed AM	2142	4538	214	454	*572*	*1212*	517	1096
	Wed PM	1924	4077	192	408	*456*	*966*	481	1019
	Thurs AM	1993	4223	199	422	*446*	*945*	505	1070
	Thurs PM	1940	4111	194	411	*505*	*1070*	472	1000
MIBW01(01)	Wed AM	2857	6053	286	605	*1698*	*3598*	450	953
	Wed PM	2990	6336	299	634	*1949*	*4128*	433	916
	Thurs AM	2857	6053	286	605	*1599*	*3387*	473	1003
	Thurs PM	3009	6375	301	637	*1531*	*3243*	536	1135
MIBW01(02)	Wed AM	2295	4861	229	486	*202*	*428*	668	1416
	Wed PM	2765	5857	276	586	*1052*	*2230*	583	1236
	Thurs AM	2313	4901	231	490				
	Thurs PM	2443	5175	244	518				

		Supply airflow		Uncertainty in supply airflow		Outdoor airflow		Uncertainty in outdoor airflow	
System ID	**Day Period**	L/s	cfm	L/s	cfm	L/s	cfm	L/s	cfm
MIBW03(01)	Wed AM	16081	34070	1608	3407	*4577*	*9696*	3808	8067
	Wed PM	15998	33894	1600	3389	*3486*	*7385*	4080	8645
	Thurs AM	16367	34675	1637	3468	*3999*	*8472*	4055	8592
	Thurs PM	13975	29606	1397	2961	*4711*	*9981*	3111	6590
MIBW04(01)	Wed AM	4319	9151	432	915	*1317*	*2790*	999	2116
	Wed PM	4307	9124	431	912	*1606*	*3403*	917	1944
	Thurs AM	5031	10658	503	1066	*1264*	*2677*	1237	2621
	Thurs PM	5107	10819	511	1082	*1651*	*3499*	1156	2448
MIBW04(02)	Wed AM	5624	11915	562	1191	*2169*	*4594*	1179	2499
	Wed PM	5423	11489	542	1149	*1883*	*3989*	1193	2527
	Thurs AM	5122	10851	512	1085	*1327*	*2810*	1248	2645
	Thurs PM	5875	12447	588	1245	*2401*	*5087*	1196	2535
MNBW01(01)	Wed AM	4257	9019	426	902	1104	2340	331	702
	Wed PM	4816	10203	482	1020	1113	2359	334	708
	Thurs AM	4284	9076	428	908	1072	2272	322	682
	Thurs PM	4710	9978	471	998	1165	2469	350	741
MNBW02(01)	Wed AM	5487	11625	549	1162	1526	3232	458	970
	Wed PM	5869	12434	587	1243	1730	3666	519	1100
	Thurs AM	4342	9199	434	920	1805	3823	541	1147
	Thurs PM	5344	11322	534	1132	2233	4730	670	1419
MNBW02(02)	Wed AM	8190	17352	819	1735	2419	5124	726	1537
	Wed PM	10586	22427	1059	2243	4502	9539	1351	2862
	Thurs AM	6853	14519	685	1452	4279	9066	1284	2720
	Thurs PM	7689	16289	769	1629	3516	7450	1055	2235
MNBW04(01)	Wed AM	9340	19787	934	1979	6735	14269	2021	4281
	Wed PM	8931	18920	893	1892	7330	15530	2199	4659
	Thurs AM	10270	21758	1027	2176	7256	15373	2177	4612
	Thurs PM	9042	19157	904	1916	7740	16398	2322	4919
MOCS01(01)	Wed AM	24167	51200	2417	5120				
	Wed PM	28638	60672	2864	6067				
	Thurs AM	25979	55040	2598	5504				
	Thurs PM	28396	60160	2840	6016				
MOCS05(01)	Wed AM	45207	95775	4521	9578	14860	31482	4458	9445
	Wed PM	50117	106178	5012	10618	17710	37519	5313	11256
	Thurs AM	40690	86206	4069	8621	8957	18975	2687	5693
	Thurs PM	39282	83222	3928	8322	1018	2156	305	647
NCDW02(01)	Wed AM	10767	22811	1077	2281	10054	21300	3016	6390
	Wed PM	11227	23786	1123	2379	10622	22504	3187	6751
	Thurs AM	11043	23396	1104	2340	5595	11854	1679	3556
	Thurs PM	11227	23786	1123	2379	9311	19726	2793	5918
NCDW02(02)	Wed AM	11595	24566	1160	2457	10054	21300	3016	6390
	Wed PM	12976	27490	1298	2749	10622	22504	3187	6751
	Thurs AM	12055	25541	1206	2554	5595	11854	1679	3556
	Thurs PM	12239	25931	1224	2593	9311	19726	2793	5918
NCDW03(01)	Wed AM								
	Wed PM								
	Thurs AM								
	Thurs PM								
NCDW03(02)	Wed AM								
	Wed PM								
	Thurs AM								
	Thurs PM								
NCDW03(03)	Wed AM								
	Wed PM								
	Thurs AM								
	Thurs PM	49	104	12	25	37	79	11	24

		Supply airflow		Uncertainty in supply airflow		Outdoor airflow		Uncertainty in outdoor airflow	
System ID	**Day Period**	L/s	cfm	L/s	cfm	L/s	cfm	L/s	cfm
NCDW03(04)	Wed AM	85	181	22	47	74	156	22	47
	Wed PM	83	175	22	46	71	150	21	45
	Thurs AM	88	186	23	49	76	161	23	48
	Thurs PM	61	128	15	32	49	103	15	31
NCDW03(05)	Wed AM								
	Wed PM								
	Thurs AM								
	Thurs PM								
NCDW06(01)	Wed AM	6300	13348	630	1335	2419	5124	726	1537
	Wed PM	7078	14996	708	1500	4016	8508	1205	2552
	Thurs AM	5322	11276	532	1128	3814	8081	1144	2424
	Thurs PM	6300	13348	630	1335	2326	4927	698	1478
NECW01(01)	Wed AM	42102	89197	4210	8920	13910	29471	4173	8841
	Wed PM	40713	86254	4071	8625	16197	34315	4859	10295
	Thurs AM	43810	92816	4381	9282	15625	33104	4688	9931
	Thurs PM	43304	91744	4330	9174	25281	53560	7584	16068
NECW02(01)	Wed AM	67711	143453	6771	14345	53438	113213	16031	33964
	Wed PM	52310	110824	5231	11082	29626	62766	8888	18830
	Thurs AM	68229	144550	6823	14455	51499	109107	15450	32732
	Thurs PM	66517	140922	6652	14092	48731	103241	14619	30972
NECW03(01)	Wed AM	27504	58269	2750	5827	18860	39956	5658	11987
	Wed PM	31117	65925	3112	6593	20824	44118	6247	13236
	Thurs AM	32121	68052	3212	6805	14980	31736	4494	9521
	Thurs PM	28307	59971	2831	5997	24950	52859	7485	15858
NMES01(01)	Wed AM	*3517*	*7451*	746	1581	1799	3811	540	1143
	Wed PM	*3384*	*7168*	742	1571	2132	4516	640	1355
	Thurs AM	*3190*	*6758*	678	1437	1699	3599	510	1080
	Thurs PM	*3310*	*7013*	714	1512	1954	4140	586	1242
NMES01(02)	Wed AM	*5609*	*11884*	1408	2983	1030	2182	309	655
	Wed PM	*5878*	*12453*	1490	3157	1016	2152	305	645
	Thurs AM	*4957*	*10502*	1298	2749	687	1455	206	436
	Thurs PM	*5638*	*11944*	1440	3050	930	1970	279	591
NMES02(01)	Wed AM	6220	13177	622	1318	8612	18245	2584	5474
	Wed PM	6897	14612	690	1461	8561	18136	2568	5441
	Thurs AM	7405	15687	740	1569	8021	16993	2406	5098
	Thurs PM	5966	12640	597	1264	9075	19226	2722	5768
NMES03(01)	Wed AM	3423	7251	342	725	*248*	*526*	1012	2144
	Wed PM	3498	7410	350	741	*466*	*986*	975	2065
	Thurs AM	3122	6614	312	661	*319*	*677*	897	1900
	Thurs PM	3046	6454	305	645	*58*	*123*	947	2006
NMES03(02)	Wed AM	4992	10577	499	1058	*548*	*1161*	1424	3016
	Wed PM	6468	13704	647	1370	*959*	*2033*	1775	3760
	Thurs AM	5470	11589	547	1159	*1054*	*2233*	1433	3036
	Thurs PM	5991	12692	599	1269	*865*	*1833*	1650	3496
NVAW01(01)	Wed AM	46440	98387	4644	9839	46478	98468	13943	29540
	Wed PM	48395	102530	4840	10253	32571	69005	9771	20702
	Thurs AM	49699	105291	4970	10529	27074	57358	8122	17207
	Thurs PM	50350	106672	5035	10667	13962	29580	4189	8874
NVAW02(01)	Wed AM	24729	52391	2473	5239	23554	49902	7066	14971
	Wed PM	27597	58466	2760	5847	26457	56051	7937	16815
	Thurs AM	24045	50942	2405	5094	23145	49035	6943	14710
	Thurs PM	27465	58187	2746	5819	25638	54317	7691	16295
NVAW03(01)	Wed AM	5207	11033	521	1103	5679	12031	1704	3609
	Wed PM	5074	10751	507	1075	5747	12176	1724	3653
	Thurs AM	5188	10992	519	1099	5702	12079	1710	3624
	Thurs PM	5207	11033	521	1103	5724	12128	1717	3638

		Supply airflow		Uncertainty in supply airflow		Outdoor airflow		Uncertainty in outdoor airflow	
System ID	**Day Period**	L/s	cfm	L/s	cfm	L/s	cfm	L/s	cfm
NVAW03(02)	Wed AM	3695	7829	370	783	1802	3818	541	1146
	Wed PM	3582	7590	358	759	1802	3818	541	1146
	Thurs AM	3441	7291	344	729	1764	3737	529	1121
	Thurs PM	3653	7739	365	774	1818	3851	545	1155
NYBS01(01)	Wed AM	31613	66976	3161	6698	*4645*	*9841*	8686	18402
	Wed PM	32918	69739	3292	6974	*3897*	*8256*	9308	19720
	Thurs AM	31951	67692	3195	6769	*3478*	*7369*	9120	19322
	Thurs PM	32612	69091	3261	6909	*4138*	*8768*	9143	19371
NYBS01(02)	Wed AM	16430	34808	1643	3481	2423	5134	727	1540
	Wed PM	17456	36982	1746	3698	2594	5496	778	1649
	Thurs AM	17564	37211	1756	3721	2509	5315	753	1594
	Thurs PM	17411	36887	1741	3689	2680	5677	804	1703
NYBS02(01)	Wed AM	2861	6061	286	606	286	605	86	182
	Wed PM	2981	6315	298	632	286	605	86	182
	Thurs AM	3201	6781	320	678	235	498	71	150
	Thurs PM	2101	4450	210	445	286	605	86	182
NYBS02(02)	Wed AM	3901	8265	390	826	353	748	106	224
	Wed PM	3401	7205	340	721	429	908	129	272
	Thurs AM	3221	6824	322	682	378	801	113	240
	Thurs PM	2321	4917	232	492	378	801	113	240
NYBS04(01)	Wed AM	6706	14208	671	1421	91	193	27	58
	Wed PM	7003	14838	700	1484	91	193	27	58
	Thurs AM	7460	15805	746	1580	5717	12112	1715	3633
	Thurs PM	7334	15537	733	1554	84	177	25	53
NYBS04(02)	Wed AM	8252	17483	825	1748	306	648	92	195
	Wed PM	8005	16959	800	1696	281	594	84	178
	Thurs AM	8290	17563	829	1756	7559	16014	2268	4804
	Thurs PM	8402	17801	840	1780	298	630	89	189
NYBS05(01)	Wed AM	5655	11981	566	1198	1441	3052	432	916
	Wed PM	6101	12926	610	1293	1454	3080	436	924
	Thurs AM	5890	12478	589	1248	1454	3080	436	924
	Thurs PM	5936	12575	594	1258	1347	2854	404	856
NYBS07(01)	Wed AM	*5071*	*10743*	1256	2660	1008	2137	303	641
	Wed PM	*5311*	*11252*	1315	2785	1058	2242	317	673
	Thurs AM	*5230*	*11080*	1288	2729	1072	2272	322	682
	Thurs PM	*5006*	*10606*	1238	2624	1001	2122	300	636
ORIS03(01)	Wed AM	*26408*	*55948*	3083	6533	11842	25089	3553	7527
	Wed PM	*30621*	*64874*	3537	7494	12767	27048	3830	8115
	Thurs AM	*23088*	*48915*	2682	5683	10415	22065	3124	6619
	Thurs PM	*26075*	*55243*	3024	6407	12144	25728	3643	7718
ORIS03(03)	Wed AM								
	Wed PM								
	Thurs AM								
	Thurs PM								
ORIS04(01)	Wed AM								
	Wed PM	6117	12959	612	1296				
	Thurs AM	8734	18504	873	1850				
	Thurs PM	8528	18068	853	1807				
PABS03(01)	Wed AM	15911	33709	1591	3371	*0*	*0*	5214	11046
	Wed PM	14736	31220	1474	3122	*0*	*0*	5125	10857
	Thurs AM	14997	31773	1500	3177	*0*	*0*	5598	11860
	Thurs PM	16288	34508	1629	3451	*0*	*0*	5908	12516
PABS04(01)	Wed AM	11128	23577	1113	2358	2195	4651	659	1395
	Wed PM	10982	23267	1098	2327	2121	4494	636	1348
	Thurs AM	10311	21844	1031	2184	2009	4257	603	1277
	Thurs PM	10610	22478	1061	2248	2121	4494	636	1348
PABS04(02)	Wed AM	8150	17267	815	1727	309	655	93	196
	Wed PM	8070	17098	807	1710	309	655	93	196
	Thurs AM	7682	16275	768	1628	268	568	80	170
	Thurs PM	8130	17225	813	1722	288	611	87	183

		Supply airflow		Uncertainty in supply airflow		Outdoor airflow		Uncertainty in outdoor airflow	
System ID	**Day Period**	L/s	cfm	L/s	cfm	L/s	cfm	L/s	cfm
SCDW01(01)	Wed AM	6063	12844	606	1284	1463	3100	439	930
	Wed PM	5127	10863	513	1086	1279	2709	384	813
	Thurs AM	5634	11935	563	1194	1340	2839	402	852
	Thurs PM	4830	10234	483	1023	1063	2252	319	676
SCDW02(01)	Wed AM	24154	51173	2415	5117	4391	9302	1317	2791
	Wed PM	26087	55267	2609	5527	4875	10327	1462	3098
	Thurs AM	23560	49914	2356	4991	4502	9539	1351	2862
	Thurs PM	24526	51961	2453	5196	3795	8041	1139	2412
SDBW01(01)	Wed AM	6419	13600	642	1360	2930	6208	879	1862
	Wed PM	6870	14555	687	1455	3551	7524	1065	2257
	Thurs AM	6547	13870	655	1387	3425	7256	1028	2177
	Thurs PM	6776	14357	678	1436	3697	7832	1109	2350
SDBW02(01)	Wed AM	7185	15222	718	1522	3187	6752	956	2026
	Wed PM	6560	13898	656	1390	1923	4073	577	1222
	Thurs AM	7150	15148	715	1515	2026	4292	608	1288
	Thurs PM	6630	14045	663	1405	1561	3308	468	992
SDBW04(01)	Wed AM	11859	25125	1186	2512	*2541*	*5383*	3037	6433
	Wed PM	10063	21320	1006	2132	*2001*	*4239*	2620	5550
	Thurs AM	9689	20528	969	2053	*1891*	*4007*	2532	5365
	Thurs PM	9615	20369	961	2037	*2081*	*4408*	2456	5204
TNDS05(01)	Wed AM	9596	20329	960	2033	9596	20329	2879	6099
	Wed PM	10762	22800	1076	2280	10762	22800	3229	6840
	Thurs AM	10232	21677	1023	2168	10232	21677	3070	6503
	Thurs PM	9649	20442	965	2044	9649	20442	2895	6133
TNDS05(02)	Wed AM	4616	9780	462	978	4616	9780	1385	2934
	Wed PM	4454	9436	445	944	4454	9436	1336	2831
	Thurs AM	4259	9022	426	902	4259	9022	1278	2707
	Thurs PM	4031	8540	403	854	4031	8540	1209	2562
TNDS06(01)	Wed AM	86266	182763	8627	18276	*18357*	*38892*	22124	46871
	Wed PM	73705	156152	7371	15615	*6302*	*13352*	21522	45597
	Thurs AM	67711	143452	6771	14345	*8809*	*18663*	18923	40091
	Thurs PM	69550	147348	6955	14735	*1539*	*3262*	21556	45668
TNDS07(01)	Wed AM	4470	9470	447	947	107	226	32	68
	Wed PM	4318	9148	432	915	128	271	38	81
	Thurs AM	4470	9470	447	947	135	286	40	86
	Thurs PM	4516	9567	452	957	717	1520	215	456
TNFS08(01)	Wed AM	3023	6405	302	641	616	1305	185	391
	Wed PM	3047	6456	305	646	745	1579	224	474
	Thurs AM	3262	6910	326	691	745	1579	224	474
	Thurs PM	3952	8373	395	837	713	1511	214	453
TNFS08(02)	Wed AM	*1336*	*2830*	312	662	359	760	108	228
	Wed PM	*1352*	*2864*	328	695	300	636	90	191
	Thurs AM	*1364*	*2889*	330	699	308	653	92	196
	Thurs PM	*1316*	*2788*	319	675	296	628	89	188
TNFS09(01)	Wed AM	6846	14504	685	1450	*2527*	*5354*	1465	3105
	Wed PM	6295	13336	629	1334	*2035*	*4312*	1424	3018
	Thurs AM	5889	12476	589	1248	*1600*	*3389*	1415	2998
	Thurs PM	5932	12568	593	1257	*1762*	*3733*	1385	2933
TNFS09(02)	Wed AM	5493	11637	549	1164	420	890	126	267
	Wed PM	5925	12552	592	1255	420	890	126	267
	Thurs AM	4057	8595	406	860	216	458	65	137
	Thurs PM	4830	10233	483	1023	276	585	83	175
TNFS10(01)	Wed AM	10660	22585	1066	2258	*7334*	*15537*	1460	3094
	Wed PM	12565	26621	1257	2662	*6728*	*14254*	2155	4566
	Thurs AM	11859	25124	1186	2512	*8341*	*17672*	1587	3363
	Thurs PM	10446	22131	1045	2213	*7362*	*15597*	1395	2956

		Supply airflow		Uncertainty in supply airflow		Outdoor airflow		Uncertainty in outdoor airflow	
System ID	**Day Period**	L/s	cfm	L/s	cfm	L/s	cfm	L/s	cfm
TXFS01(01)	Wed AM	34668	73447	3467	7345				
	Wed PM	42496	90032	4250	9003	1933	4094	580	1228
	Thurs AM	41862	88689	4186	8869	1789	3791	537	1137
	Thurs PM	43118	91349	4312	9135	1720	3645	516	1094
TXFS02(01)	Wed AM	8906	18868	891	1887	416	881	125	264
	Wed PM	8008	16966	801	1697	400	847	120	254
	Thurs AM	10773	22824	1077	2282	386	818	116	245
	Thurs PM	9480	20085	948	2008	462	978	139	294
TXFS02(02)	Wed AM	9588	20313	959	2031	450	954	135	286
	Wed PM	10019	21226	1002	2123	462	978	139	294
	Thurs AM	10486	22215	1049	2222	448	950	134	285
	Thurs PM	9229	19552	923	1955	407	862	122	259
TXFS07(01)	Wed AM	31610	66968	3161	6697	4042	8562	1212	2569
	Wed PM	31610	66968	3161	6697	4475	9480	1342	2844
	Thurs AM	29436	62362	2944	6236	4193	8884	1258	2665
	Thurs PM	27596	58464	2760	5846	4382	9284	1315	2785
TXFS08(01)	Wed AM	8107	17175	811	1718	373	791	112	237
	Wed PM	8891	18837	889	1884	436	923	131	277
	Thurs AM	8293	17570	829	1757	479	1014	144	304
	Thurs PM	8646	18318	865	1832	512	1085	154	326
TXFS08(02)	Wed AM	6913	14646	691	1465	366	776	110	233
	Wed PM	7593	16087	759	1609	360	763	108	229
	Thurs AM	6985	14799	699	1480	366	776	110	233
	Thurs PM	7696	16305	770	1631	378	801	113	240
TXFS09(01)	Wed AM	5083	10770	508	1077	975	2065	292	619
	Wed PM	5168	10949	517	1095	947	2006	284	602
	Thurs AM	5245	11112	525	1111	989	2095	297	628
	Thurs PM	5191	10998	519	1100	1003	2124	301	637
TXFS09(02)	Wed AM	5156	10924	516	1092	975	2065	292	619
	Wed PM	5270	11164	527	1116	947	2006	284	602
	Thurs AM	5092	10788	509	1079	989	2095	297	628
	Thurs PM	5149	10909	515	1091	1003	2124	301	637
TXFW05(01)	Wed AM	35400	74999	3540	7500	*9156*	*19398*	8633	18289
	Wed PM	34115	72277	3412	7228	*8465*	*17934*	8417	17833
	Thurs AM	41709	88366	4171	8837	*24435*	*51768*	6652	14094
	Thurs PM	41826	88613	4183	8861	*26065*	*55220*	6313	13375
TXFW06(01)	Wed AM	47533	100703	4753	10070	47738	101137	14321	30341
	Wed PM	39884	84498	3988	8450	39878	84486	11963	25346
	Thurs AM	40703	86234	4070	8623	40752	86336	12225	25901
	Thurs PM	45621	96652	4562	9665	45700	96820	13710	29046
WAIW03(01)	Wed AM	2958	6266	296	627	2986	6327	896	1898
	Wed PM	4093	8672	409	867	3627	7684	1088	2305
	Thurs AM	3407	7217	341	722	3469	7350	1041	2205
	Thurs PM	4040	8560	404	856	3718	7877	1115	2363
WAIW04(01)	Wed AM	1570	3327	157	333	1528	3237	458	971
	Wed PM	1570	3327	157	333	1555	3294	466	988
	Thurs AM	1570	3327	157	333	1541	3266	462	980
	Thurs PM	1537	3256	154	326	1541	3266	462	980
# of values		536				510			
Mean		11676	24737	1243	2633	5033	10662	2102	4453
StdDev		12731	26972	1298	2750	9113	19307	3422	7250
Minimum		49	104	12	25	0	0	9	19
10th percentile		2462	5215	252	534	219	465	89	188
25th percentile		4450	9428	449	951	473	1002	251	532
Median		6861	14537	720	1525	1527	3235	590	1251
75th percentile		12259	25972	1514	3207	4606	9759	2580	5465
90th percentile		31161	66018	3200	6780	13374	28334	5921	12544
Maximum		86266	182763	8626	18276	53438	113213	22124	46871

		Recirculation Airflow		Uncertainty in recirc. airflow		Outdoor air fraction - volumetric	Uncert. in vol. OA fraction	OA fraction - CO_2	Uncert. in CO_2 OA fraction
System ID	**Day Period**	L/s	cfm	L/s	cfm				
ARFW01(01)	Wed AM					0.056	0.018	0.029	0.202
	Wed PM					0.054	0.017	0.000	0.203
	Thurs AM					0.056	0.018	0.086	0.203
	Thurs PM					0.055	0.017	0.125	0.178
ARFW01(02)	Wed AM					0.055	0.017	0.000	0.182
	Wed PM					0.054	0.017	0.051	0.182
	Thurs AM					0.058	0.018	0.125	0.178
	Thurs PM					0.054	0.017	0.063	0.177
ARFW02(01)	Wed AM					0.819	0.259	0.667	2.833
	Wed PM					0.841	0.266	0.611	0.921
	Thurs AM								
	Thurs PM					0.846	0.267	0.750	1.473
ARFW02(02)	Wed AM							0.833	0.767
	Wed PM					0.796	0.252	0.235	0.741
	Thurs AM								
	Thurs PM					0.817	0.258	0.850	0.928
ARFW03(01)	Wed AM					0.042	0.013	0.120	0.251
	Wed PM					0.024	0.008	0.014	0.249
	Thurs AM					0.027	0.009	0.041	0.207
	Thurs PM					0.027	0.009	0.055	0.279
ARFW03(02)	Wed AM					0.110	0.035	0.031	0.217
	Wed PM					0.114	0.036	0.032	0.228
	Thurs AM					0.127	0.040	0.054	0.175
	Thurs PM					0.121	0.038	0.233	0.202
AZHS02(01)	Wed AM	2909	6162	873	1849	0.365	0.218	0.418	0.341
	Wed PM	2761	5850	828	1755	0.485	0.190	0.320	0.594
	Thurs AM	2990	6334	897	1900	0.294	0.236	0.169	0.806
	Thurs PM	2769	5866	831	1760	0.370	0.217	0.400	1.015
AZHS02(02)	Wed AM	1364	2889	409	867	0.463	0.195	0.353	0.401
	Wed PM	1270	2691	381	807	0.494	0.188	0.547	0.630
	Thurs AM	1495	3168	449	950	0.267	0.243	0.465	0.549
	Thurs PM	1789	3789	537	1137	0.279	0.240	0.365	0.885
AZHS04(01)	Wed AM	10463	22167	3139	6650	0.000	0.316	0.100	0.142
	Wed PM	10875	23040	3262	6912	0.000	0.330	0.000	0.156
	Thurs AM	9160	19405	2748	5822	0.105	0.287	0.746	0.774
	Thurs PM	10635	22531	3190	6759	0.000	0.340	0.091	0.129
AZHS04(02)	Wed AM	599	1269	180	381	0.141	0.056	0.297	0.144
	Wed PM	598	1267	179	380	0.154	0.061	0.375	0.134
	Thurs AM	637	1350	191	405	0.109	0.044	0.570	0.546
	Thurs PM	691	1464	207	439	0.147	0.058	0.382	0.133
AZHW10(01)	Wed AM					0.854	0.264	0.246	0.597
	Wed PM					1.004	0.310	0.893	1.264
	Thurs AM					0.999	0.309	0.946	1.739
	Thurs PM					1.003	0.310	0.967	1.639
AZHW10(02)	Wed AM							0.139	0.585
	Wed PM							0.627	1.113
	Thurs AM							0.446	1.383
	Thurs PM							0.550	1.345
AZHW11(01)	Wed AM	11499	24361	3450	7308	0.190	0.263	0.162	0.227
	Wed PM	11827	25057	3548	7517	0.294	0.236	0.278	0.395
	Thurs AM	11006	23317	3302	6995	0.334	0.226	0.196	0.300
	Thurs PM	11909	25231	3573	7569	0.343	0.224	0.150	0.335
AZHW12(01)	Wed AM					0.206	0.065		
	Wed PM					0.241	0.076		
	Thurs AM					0.045	0.014	0.041	0.323
	Thurs PM					0.036	0.011	0.072	0.224

		Recirculation Airflow		Uncertainty in recirc. airflow		Outdoor air fraction - volumetric	Uncert. in vol. OA fraction	OA fraction - CO_2	Uncert. in CO_2 OA fraction
System ID	Day Period	L/s	cfm	L/s	cfm				
AZHW12(02)	Wed AM					0.305	0.096		
	Wed PM					0.305	0.096		
	Thurs AM					0.309	0.098	0.269	0.468
	Thurs PM					0.305	0.096	0.295	0.358
CAES17(01)	Wed AM	13246	28062	3974	8419	0.187	0.264	0.250	0.364
	Wed PM	13354	28292	4006	8488	0.142	0.277	0.250	0.364
	Thurs AM	7654	16216	2296	4865	0.564	0.174	0.167	0.478
	Thurs PM	11617	24612	3485	7383	0.306	0.233	0.259	0.541
CAEW07(01)	Wed AM					0.307	0.097	0.585	1.638
	Wed PM					0.869	0.275	1.148	2.340
	Thurs AM					0.763	0.241	0.222	0.805
	Thurs PM					1.050	0.332	1.200	4.418
CAEW09(01)	Wed AM					0.317	0.100	0.118	0.838
	Wed PM					0.268	0.085	0.368	0.603
	Thurs AM					0.144	0.045	0.500	1.976
	Thurs PM					0.149	0.047	0.281	0.480
CAJS01(01)	Wed AM					1.000	0.316	0.000	0.710
	Wed PM					1.000	0.316	0.000	0.986
	Thurs AM					1.000	0.316	0.000	0.710
	Thurs PM					1.000	0.316	0.000	1.775
CAJS01(02)	Wed AM					1.000	0.316	0.286	1.051
	Wed PM					1.000	0.316	0.722	0.969
	Thurs AM					1.000	0.316	0.537	0.743
	Thurs PM					1.000	0.316	0.556	0.899
CAJS01(03)	Wed AM					1.000	0.316		
	Wed PM					1.000	0.316		
	Thurs AM					1.000	0.316	0.200	0.577
	Thurs PM					1.000	0.316	0.538	1.236
CAJS02(01)	Wed AM					0.847	0.268	0.000	7.100
	Wed PM					0.918	0.290	1.000	4.000
	Thurs AM					0.979	0.310	0.400	1.523
	Thurs PM					1.082	0.342	0.444	1.433
CAJS03(01)	Wed AM					1.000	0.316	0.143	2.551
	Wed PM					1.000	0.316	0.900	2.378
	Thurs AM					1.000	0.316	0.488	1.919
	Thurs PM					0.996	0.315	0.667	1.889
CAJS21(01)	Wed AM					0.208	0.066	0.200	0.361
	Wed PM					0.244	0.077	0.333	0.497
	Thurs AM					0.361	0.114	0.278	0.815
	Thurs PM					0.287	0.091	0.327	0.715
CAJS21(02)	Wed AM					1.000	0.316		
	Wed PM					1.000	0.316		
	Thurs AM					1.000	0.316		
	Thurs PM					1.000	0.316		
CAJS222(01)	Wed AM	4260	9025	1278	2708	0.084	0.293	0.171	0.410
	Wed PM	4798	10165	1439	3050	0.144	0.276	0.175	0.359
	Thurs AM	3565	7553	1069	2266	0.207	0.259	0.133	0.476
	Thurs PM	4395	9310	1318	2793	0.211	0.258	0.070	0.330
CAJS23(01)	Wed AM					0.074	0.023	0.208	0.301
	Wed PM					0.102	0.032	0.053	0.373
	Thurs AM					0.086	0.027	0.000	0.394
	Thurs PM					0.095	0.030	0.000	0.394
CAJW18(01)	Wed AM					0.081	0.026	0.224	0.401
	Wed PM					0.076	0.024	0.174	0.353
	Thurs AM					0.088	0.028	0.170	0.597
	Thurs PM					0.078	0.025	0.148	0.379

		Recirculation Airflow		Uncertainty in recirc. airflow		Outdoor air fraction - volumetric	Uncert. in vol. OA fraction	OA fraction - CO_2	Uncert. in CO_2 OA fraction
System ID	**Day Period**	L/s	cfm	L/s	cfm				
CAJW19(01)	Wed AM	8940	18941	2682	5682	0.497	0.188	0.374	1.054
	Wed PM	10385	22001	3115	6600	0.404	0.209	0.506	1.014
	Thurs AM	9016	19101	2705	5730	0.493	0.189	0.419	0.776
	Thurs PM	11357	24062	3407	7218	0.327	0.228	0.379	1.030
CAJW20(01)	Wed AM					1.205	0.381	0.967	1.002
	Wed PM					1.144	0.362	0.955	1.051
	Thurs AM					1.137	0.360	1.061	0.609
	Thurs PM					1.123	0.355	0.970	0.743
CAJW24(01)	Tues AM					0.691	0.219	0.143	1.020
	Tues PM					0.036	0.011	0.033	0.236
	Wed AM					0.691	0.219	0.143	1.020
	Wed PM					0.033	0.011	0.033	0.236
	Thurs AM					0.700	0.222	0.750	1.105
	Thurs PM					0.886	0.280	0.400	1.523
CAJW25(01)	Wed AM					0.539	0.170	0.462	0.599
	Wed PM					0.956	0.302	0.842	0.973
	Thurs AM					0.710	0.225	0.333	0.828
	Thurs PM					1.024	0.324	0.842	0.973
CAJW26(01)	Wed AM					1.136	0.359	0.667	1.133
	Wed PM					1.112	0.351	0.500	1.129
	Thurs AM					1.067	0.338	1.000	1.250
	Thurs PM					0.944	0.298	1.000	0.870
COAS02(01)	Wed AM	10512	22272	3154	6681	0.072	0.029	0.000	0.568
	Wed PM	8969	19001	2691	5700	0.108	0.043	0.000	0.473
	Thurs AM	10022	21232	3007	6370	0.090	0.037	0.143	0.408
	Thurs PM	10512	22272	3154	6681	0.129	0.051	0.143	0.408
COAS04(01)	Wed AM	33430	70825	10029	21247	0.023	0.310	0.372	0.623
	Wed PM	32611	69091	9783	20727	0.065	0.298	0.270	0.495
	Thurs AM	33376	70711	10013	21213	0.005	0.315	0.114	0.407
	Thurs PM	34907	73953	10472	22186	0.000	0.321	0.000	0.507
COAS06(01)	Wed AM					0.241	0.076	0.216	0.289
	Wed PM					0.207	0.066	0.333	0.191
	Thurs AM					0.167	0.053	0.065	0.308
	Thurs PM					0.175	0.055	0.055	0.216
FLDW07(02)	Wed AM	6523	13819	1957	4146	0.130	0.052	0.000	0.309
	Wed PM	5764	12212	1729	3664	0.148	0.059	0.000	0.284
	Thurs AM	5357	11348	1607	3405	0.155	0.061	0.040	0.283
	Thurs PM	5873	12442	1762	3733	0.150	0.060	0.032	0.228
FLDW08(01)	Wed AM					0.187	0.059	0.255	0.265
	Wed PM					0.114	0.036	0.200	0.240
	Thurs AM					0.123	0.039	0.143	1.020
	Thurs PM					0.671	0.212	1.000	2.500
FLDW10(01)	Wed AM					0.077	0.024	0.250	0.729
	Wed PM					0.087	0.028	0.150	0.715
	Thurs AM					0.094	0.030	0.192	0.554
	Thurs PM					0.067	0.021	0.077	0.546
FLGS01(01)	Thurs AM					0.195	0.062	0.268	0.357
	Thurs PM					0.185	0.059	0.500	0.395
	Fri AM					0.196	0.062	0.237	0.382
	Fri PM					0.198	0.063	0.200	0.412
FLGS04(01)	Wed AM					0.035	0.011	0.084	0.157
	Wed PM					0.037	0.012	0.041	0.125
	Thurs AM					0.034	0.011	0.108	0.154
	Thurs PM					0.030	0.010	0.016	0.124
FLGS04(02)	Wed AM					0.042	0.013	0.053	0.156
	Wed PM					0.040	0.013	0.028	0.140
	Thurs AM					0.041	0.013	0.069	0.152
	Thurs PM					0.041	0.013	0.039	0.138

		Recirculation Airflow		Uncertainty in recirc. airflow		Outdoor air fraction - volumetric	Uncert. in vol. OA fraction	OA fraction - CO_2	Uncert. in CO_2 OA fraction
System ID	Day Period	L/s	cfm	L/s	cfm				
FLGS11(01)	Wed AM					0.161	0.051	0.045	0.211
	Wed PM					0.104	0.033	0.034	0.122
	Thurs AM					0.189	0.060	0.138	0.246
	Thurs PM					0.088	0.028	0.038	0.134
FLGS11(02)	Wed AM					0.144	0.045	0.036	0.257
	Wed PM					0.111	0.035	0.030	0.143
	Thurs AM					0.162	0.051	0.074	0.263
	Thurs PM					0.111	0.035	0.047	0.165
FLGS12(01)	Wed AM	8386	17766	2516	5330	0.164	0.065		
	Wed PM	8003	16955	2401	5086	0.171	0.067	0.125	0.178
	Thurs AM	7322	15512	2196	4653	0.185	0.072	0.085	0.241
	Thurs PM	7237	15331	2171	4599	0.175	0.069	0.156	0.159
GADS01(01)	Wed AM	3304	6999	991	2100	0.396	0.147	0.250	0.729
	Wed PM	3996	8465	1199	2540	0.322	0.121	0.364	0.684
	Thurs AM	3209	6799	963	2040	0.419	0.155	0.333	0.621
	Thurs PM	3524	7466	1057	2240	0.378	0.140	0.500	0.791
GADS02(01)	Wed AM					0.162	0.051	0.171	0.350
	Wed PM					0.159	0.050	0.167	0.239
	Thurs AM					0.220	0.069	0.083	0.394
	Thurs PM					0.162	0.051	0.185	0.266
GADS02(02)	Wed AM					0.253	0.080	0.125	0.356
	Wed PM					0.196	0.062	0.175	0.252
	Thurs AM					0.208	0.066	0.125	0.445
	Thurs PM					0.184	0.058	0.188	0.300
GADS03(01)	Wed AM					0.080	0.025	0.091	0.125
	Wed PM					0.085	0.027	0.000	0.101
	Thurs AM					0.085	0.027	0.049	0.137
	Thurs PM					0.087	0.027	0.000	0.105
ILBS01(01)	Wed AM							0.111	0.264
	Wed PM							0.000	0.189
	Thurs AM							0.222	0.402
	Thurs PM							0.160	0.286
ILBS01(02)	Wed AM							0.263	0.385
	Wed PM							0.222	0.322
	Thurs AM							0.000	0.458
	Thurs PM							0.000	0.167
ILBS02(01)	Wed AM	7636	16177	2291	4853	0.083	0.026	0.000	0.645
	Wed PM	6207	13149	1862	3945	0.073	0.023	0.074	0.525
	Thurs AM	6942	14706	2082	4412	0.068	0.021	0.125	0.891
	Thurs PM	6737	14274	2021	4282	0.076	0.024	0.000	0.789
ILBS03(01)	Wed AM	10354	21935	3106	6581	0.362	0.219	0.333	0.497
	Wed PM	10904	23101	3271	6930	0.356	0.220	0.286	0.420
	Thurs AM	8723	18481	2617	5544	0.468	0.194	0.333	0.497
	Thurs PM	9076	19229	2723	5769	0.421	0.205	0.167	0.478
LAGW04(01)	Wed AM					0.062	0.020	0.333	0.994
	Wed PM					0.045	0.014	0.000	0.568
	Thurs AM					0.061	0.019	0.286	0.420
	Thurs PM					0.054	0.017	0.152	0.433
LAGW04(02)	Wed AM					0.073	0.023	0.333	0.994
	Wed PM					0.077	0.025	0.125	0.356
	Thurs AM					0.081	0.026	0.125	0.356
	Thurs PM					0.075	0.024	0.111	0.316
LAGW05(01)	Wed AM	6913	14646	2074	4394	0.190	0.063		
	Wed PM	6780	14365	2034	4309	0.219	0.073		
	Thurs AM	6714	14224	2014	4267	0.202	0.067		
	Thurs PM	6758	14317	2027	4295	0.217	0.072		
LAGW05(02)	Wed AM								
	Wed PM							0.443	0.236
	Thurs AM								
	Thurs PM								

		Recirculation Airflow		Uncertainty in recirc. airflow		Outdoor air fraction - volumetric	Uncert. in vol. OA fraction	OA fraction - CO_2	Uncert. in CO_2 OA fraction
System ID	Day Period	L/s	cfm	L/s	cfm				
LAGW06(01)	Wed AM					0.126	0.040		
	Wed PM					0.122	0.039		
	Thurs AM					0.122	0.039		
	Thurs PM					0.123	0.039		
LAGW06(02)	Wed AM								
	Wed PM								
	Thurs AM								
	Thurs PM								
MABW05(01)	Wed AM	3767	7980	1130	2394	0.099	0.288	0.178	0.206
	Wed PM	5013	10621	1504	3186	0.279	0.240	0.292	0.192
	Thurs AM	5268	11161	1580	3348	0.196	0.262	0.383	0.246
	Thurs PM	5098	10801	1529	3240	0.254	0.246	0.250	0.190
MABW05(02)	Wed AM	5466	11581	1640	3474	0.104	0.287	0.137	0.192
	Wed PM	6458	13681	1937	4104	0.000	0.339	0.101	0.184
	Thurs AM	6118	12961	1835	3888	0.050	0.302	0.059	0.244
	Thurs PM	6684	14161	2005	4248	0.006	0.314	0.101	0.179
MABW06(01)	Wed AM					0.930	0.294	0.857	0.665
	Wed PM					0.966	0.305	0.926	0.714
	Thurs AM					0.967	0.306	0.839	0.595
	Thurs PM					0.969	0.306	0.778	0.398
MABW08(01)	Wed AM	4828	10228	1448	3068	0.626	0.163	0.500	0.791
	Wed PM	4411	9346	1323	2804	0.673	0.155	0.593	0.609
	Thurs AM	5898	12496	1769	3749	0.532	0.180	0.500	0.791
	Thurs PM	5353	11341	1606	3402	0.585	0.170	0.500	0.791
MABW08(02)	Wed AM	426	903	128	271	0.966	0.403	0.900	0.951
	Wed PM	456	966	137	290	0.962	0.400	0.963	0.727
	Thurs AM	446	945	134	284	0.961	0.400	1.000	1.000
	Thurs PM	595	1260	178	378	0.949	0.393	1.000	1.000
MDDS01(01)	Wed AM	18850	39936	5655	11981	0.113	0.284	0.138	0.615
	Wed PM	21269	45060	6381	13518	0.063	0.298	0.565	3.531
	Thurs AM	25084	53142	7525	15943	0.000	0.385	0.083	0.651
	Thurs PM	21969	46543	6591	13963	0.000	0.346	0.000	0.710
MDDS03(01)	Wed AM					0.157	0.050	0.143	0.204
	Wed PM					0.132	0.042	0.167	0.478
	Thurs AM					0.142	0.045	0.125	0.356
	Thurs PM					0.136	0.043	0.200	0.288
MDDS03(02)	Wed AM					0.032	0.010	0.333	2.485
	Wed PM					0.016	0.005	0.012	0.175
	Thurs AM					0.032	0.010	0.000	0.284
	Thurs PM					0.032	0.010	0.000	0.237
MDDS04(01)	Wed AM	2266	4800	680	1440	0.114	0.284	0.023	0.202
	Wed PM	2247	4760	674	1428	0.112	0.285	0.000	0.145
	Thurs AM	2285	4840	685	1452	0.102	0.288	0.070	0.166
	Thurs PM	2228	4720	668	1416	0.085	0.292	0.021	0.149
MDDS04(02)	Wed AM	1570	3325	471	998	0.267	0.243	0.197	0.295
	Wed PM	1469	3112	441	933	0.237	0.251	0.143	0.255
	Thurs AM	1547	3278	464	983	0.224	0.254	0.141	0.264
	Thurs PM	1435	3040	431	912	0.260	0.245	0.104	0.205
MIBW01(01)	Wed AM	1159	2455	348	737	0.594	0.168	0.469	0.319
	Wed PM	1042	2207	313	662	0.652	0.159	0.286	0.420
	Thurs AM	1259	2666	378	800	0.560	0.175	0.269	0.563
	Thurs PM	1478	3131	443	939	0.509	0.185	0.345	0.516
MIBW01(02)	Wed AM	2093	4433	628	1330	0.088	0.291	0.250	0.607
	Wed PM	1712	3627	514	1088	0.381	0.214	0.222	0.537
	Thurs AM							0.105	0.748
	Thurs PM							0.345	0.516

		Recirculation Airflow		Uncertainty in recirc. airflow		Outdoor air fraction - volumetric	Uncert. in vol. OA fraction	OA fraction - CO_2	Uncert. in CO_2 OA fraction
System ID	**Day Period**	L/s	cfm	L/s	cfm				
MIBW03(01)	Wed AM	11505	24374	3451	7312	0.285	0.238	0.250	0.364
	Wed PM	12512	26509	3754	7953	0.218	0.256	0.353	0.441
	Thurs AM	12368	26203	3710	7861	0.244	0.249	0.313	0.463
	Thurs PM	9264	19626	2779	5888	0.337	0.225	0.667	0.567
MIBW04(01)	Wed AM	3002	6361	901	1908	0.305	0.233	0.454	0.424
	Wed PM	2700	5720	810	1716	0.373	0.216	0.356	0.504
	Thurs AM	3767	7980	1130	2394	0.251	0.247	0.326	0.418
	Thurs PM	3455	7321	1037	2196	0.323	0.229	0.408	0.502
MIBW04(02)	Wed AM	3455	7321	1037	2196	0.386	0.213	0.333	0.414
	Wed PM	3540	7500	1062	2250	0.347	0.223	0.400	0.508
	Thurs AM	3795	8041	1139	2412	0.259	0.245	0.217	0.524
	Thurs PM	3474	7360	1042	2208	0.409	0.208	0.357	0.536
MNBW01(01)	Wed AM					0.259	0.082	0.500	0.395
	Wed PM					0.231	0.073	0.405	0.412
	Thurs AM					0.250	0.079	0.333	0.497
	Thurs PM					0.247	0.078	0.429	0.440
MNBW02(01)	Wed AM					0.278	0.088	0.412	0.450
	Wed PM					0.295	0.093	0.400	0.609
	Thurs AM					0.416	0.131	0.400	0.609
	Thurs PM					0.418	0.132	0.400	0.609
MNBW02(02)	Wed AM					0.295	0.093	0.250	0.729
	Wed PM					0.425	0.134	0.333	0.994
	Thurs AM					0.624	0.197	0.333	0.994
	Thurs PM					0.457	0.145	0.500	1.581
MNBW04(01)	Wed AM					0.721	0.228	0.714	0.414
	Wed PM					0.821	0.260	1.077	0.799
	Thurs AM					0.707	0.223	0.769	0.686
	Thurs PM					0.856	0.271	0.867	0.624
MOCS01(01)	Wed AM							0.200	0.288
	Wed PM							0.273	0.267
	Thurs AM							0.211	0.380
	Thurs PM							0.200	0.288
MOCS05(01)	Wed AM					0.329	0.104	0.333	0.497
	Wed PM					0.353	0.112	0.230	0.363
	Thurs AM					0.220	0.070	0.250	0.364
	Thurs PM					0.026	0.008	0.214	0.258
NCDW02(01)	Wed AM					0.934	0.295	0.800	1.207
	Wed PM					0.946	0.299	0.750	1.105
	Thurs AM					0.507	0.160	0.375	0.944
	Thurs PM					0.829	0.262	0.667	1.133
NCDW02(02)	Wed AM					0.867	0.274	0.800	1.207
	Wed PM					0.819	0.259	0.750	1.105
	Thurs AM					0.464	0.147	0.438	0.965
	Thurs PM					0.761	0.241	0.667	1.133
NCDW03(01)	Wed AM	185	391	55	117			0.288	0.142
	Wed PM	141	299	42	90			0.135	0.193
	Thurs AM	177	376	53	113			0.213	0.154
	Thurs PM	178	378	54	113			0.179	0.171
NCDW03(02)	Wed AM	79	167	24	50			0.119	0.170
	Wed PM	76	162	23	49			0.213	0.154
	Thurs AM	78	166	23	50			0.152	0.144
	Thurs PM	81	172	24	51			0.072	0.205
NCDW03(03)	Wed AM	12	25	4	8			0.000	0.125
	Wed PM	12	25	4	8			0.000	0.222
	Thurs AM	12	25	4	8			0.000	0.143
	Thurs PM	12	25	4	8	0.759	0.291	0.217	0.629

		Recirculation Airflow		Uncertainty in recirc. airflow		Outdoor air fraction - volumetric	Uncert. in vol. OA fraction	OA fraction - CO_2	Uncert. in CO_2 OA fraction
System ID	Day Period	L/s	cfm	L/s	cfm				
NCDW03(04)	Wed AM	12	25	4	7	0.862	0.343	0.000	3.550
	Wed PM	12	25	4	7	0.858	0.341		
	Thurs AM	12	25	4	7	0.866	0.345		
	Thurs PM	12	25	4	7	0.806	0.314		
NCDW03(05)	Wed AM	57	121	17	36				
	Wed PM	61	129	18	39				
	Thurs AM	63	134	19	40			0.160	0.152
	Thurs PM	59	126	18	38			0.119	0.170
NCDW06(01)	Wed AM					0.384	0.121	0.489	0.350
	Wed PM					0.567	0.179	0.429	0.550
	Thurs AM					0.717	0.227	0.529	0.471
	Thurs PM					0.369	0.117	0.333	0.331
NECW01(01)	Wed AM					0.330	0.104	0.454	0.359
	Wed PM					0.398	0.126	0.601	0.598
	Thurs AM					0.357	0.113	0.475	0.437
	Thurs PM					0.584	0.185	0.625	0.651
NECW02(01)	Wed AM					0.789	0.250	0.700	1.726
	Wed PM					0.566	0.179	0.667	1.133
	Thurs AM					0.755	0.239	0.700	1.726
	Thurs PM					0.733	0.232	0.800	1.811
NECW03(01)	Wed AM					0.686	0.217	0.331	0.426
	Wed PM					0.669	0.212	0.328	0.555
	Thurs AM					0.466	0.147	0.263	0.385
	Thurs PM					0.881	0.279	0.600	0.550
NMES01(01)	Wed AM	1718	3640	515	1092	0.511	0.188	0.536	0.573
	Wed PM	1252	2652	376	796	0.630	0.234	0.541	0.434
	Thurs AM	1491	3159	447	948	0.533	0.196	0.600	0.471
	Thurs PM	1356	2873	407	862	0.590	0.218	0.533	0.534
NMES01(02)	Wed AM	4579	9702	1374	2910	0.184	0.072	0.324	0.402
	Wed PM	4862	10301	1459	3090	0.173	0.068	0.194	0.400
	Thurs AM	4271	9048	1281	2714	0.139	0.055	0.225	0.362
	Thurs PM	4708	9974	1412	2992	0.165	0.065	0.108	0.384
NMES02(01)	Wed AM					1.385	0.438	0.500	0.791
	Wed PM					1.241	0.393	0.968	0.635
	Thurs AM					1.083	0.343	0.922	1.503
	Thurs PM					1.521	0.481	0.810	1.152
NMES03(01)	Wed AM	3174	6725	952	2018	0.073	0.296	0.231	0.279
	Wed PM	3032	6424	910	1927	0.133	0.279	0.250	0.243
	Thurs AM	2802	5937	841	1781	0.102	0.287	0.130	0.310
	Thurs PM	2988	6331	897	1899	0.019	0.311	0.083	0.237
NMES03(02)	Wed AM	4444	9416	1333	2825	0.110	0.285	0.120	0.285
	Wed PM	5509	11671	1653	3501	0.148	0.275	0.222	0.322
	Thurs AM	4416	9355	1325	2807	0.193	0.263	0.240	0.291
	Thurs PM	5126	10860	1538	3258	0.144	0.276	0.273	0.267
NVAW01(01)	Wed AM					1.001	0.316	0.910	1.427
	Wed PM					0.673	0.213	0.882	1.387
	Thurs AM					0.545	0.172	0.692	1.323
	Thurs PM					0.277	0.088	0.500	0.791
NVAW02(01)	Wed AM	1242	2632	373	790	0.950	0.139	0.655	0.768
	Wed PM	1210	2563	363	769	0.956	0.139	1.000	1.000
	Thurs AM	981	2078	294	623	0.959	0.139	1.000	4.000
	Thurs PM	1912	4052	574	1216	0.930	0.138	0.333	0.994
NVAW03(01)	Wed AM					1.091	0.345	0.444	1.720
	Wed PM					1.133	0.358	0.500	1.581
	Thurs AM					1.099	0.348	0.333	0.994
	Thurs PM					1.099	0.348	1.000	2.000

		Recirculation Airflow		Uncertainty in recirc. airflow		Outdoor air fraction - volumetric	Uncert. in vol. OA fraction	OA fraction - CO_2	Uncert. in CO_2 OA fraction
System ID	**Day Period**	L/s	cfm	L/s	cfm				
NVAW03(02)	Wed AM					0.488	0.154	0.444	1.720
	Wed PM					0.503	0.159	0.700	1.726
	Thurs AM					0.513	0.162	0.500	0.791
	Thurs PM					0.498	0.157	0.000	2.840
NYBS01(01)	Wed AM	26968	57134	8090	17140	0.147	0.275	0.167	0.597
	Wed PM	29021	61484	8706	18445	0.118	0.283	0.214	0.517
	Thurs AM	28473	60324	8542	18097	0.109	0.286	0.241	0.502
	Thurs PM	28473	60324	8542	18097	0.127	0.281	0.080	0.567
NYBS01(02)	Wed AM					0.147	0.047	0.308	0.569
	Wed PM					0.149	0.047	0.133	0.476
	Thurs AM					0.143	0.045	0.267	0.488
	Thurs PM					0.154	0.049	0.429	0.440
NYBS02(01)	Wed AM					0.100	0.032	0.115	0.583
	Wed PM					0.096	0.030	0.513	0.668
	Thurs AM					0.074	0.023	0.238	0.433
	Thurs PM					0.136	0.043	0.368	0.331
NYBS02(02)	Wed AM					0.090	0.029	0.714	1.241
	Wed PM					0.126	0.040	0.615	0.639
	Thurs AM					0.117	0.037	0.441	0.655
	Thurs PM					0.163	0.052	0.494	0.512
NYBS04(01)	Wed AM					0.014	0.004	0.000	0.473
	Wed PM					0.013	0.004	0.077	0.273
	Thurs AM					0.766	0.242	0.444	0.860
	Thurs PM					0.011	0.004	0.154	0.550
NYBS04(02)	Wed AM					0.037	0.012	0.000	0.473
	Wed PM					0.035	0.011	0.040	0.283
	Thurs AM					0.912	0.288	0.400	0.762
	Thurs PM					0.035	0.011	0.086	0.406
NYBS05(01)	Wed AM					0.255	0.081	0.326	0.216
	Wed PM					0.238	0.075	0.208	0.234
	Thurs AM					0.247	0.078	0.270	0.225
	Thurs PM					0.227	0.072	0.328	0.188
NYBS07(01)	Wed AM	4062	8606	1219	2582	0.199	0.077	0.400	0.762
	Wed PM	4253	9010	1276	2703	0.199	0.077	0.432	0.416
	Thurs AM	4157	8808	1247	2642	0.205	0.080	0.364	0.684
	Thurs PM	4005	8485	1201	2545	0.200	0.078	0.063	0.443
ORIS03(01)	Wed AM					0.448	0.144	0.364	0.684
	Wed PM					0.417	0.134	0.174	0.624
	Thurs AM					0.451	0.145	0.295	0.604
	Thurs PM					0.466	0.150	0.286	0.525
ORIS03(03)	Wed AM							0.364	0.684
	Wed PM							0.240	0.582
	Thurs AM							0.348	0.567
	Thurs PM							0.214	0.517
ORIS04(01)	Wed AM							0.833	1.534
	Wed PM							0.667	1.416
	Thurs AM							0.800	1.811
	Thurs PM							0.167	1.195
PABS03(01)	Wed AM	16550	35064	4965	10519	0.000	0.328	0.205	0.328
	Wed PM	16360	34661	4908	10398	0.000	0.348	0.000	0.374
	Thurs AM	17977	38087	5393	11426	0.000	0.374	0.091	0.323
	Thurs PM	18929	40102	5679	12031	0.000	0.363	0.053	0.373
PABS04(01)	Wed AM					0.197	0.062	0.125	0.165
	Wed PM					0.193	0.061	0.215	0.159
	Thurs AM					0.195	0.062	0.214	0.207
	Thurs PM					0.200	0.063	0.188	0.180
PABS04(02)	Wed AM					0.038	0.012	0.045	0.167
	Wed PM					0.038	0.012	0.047	0.157
	Thurs AM					0.035	0.011	0.096	0.208
	Thurs PM					0.035	0.011	0.063	0.177

System ID	Day Period	Recirculation Airflow		Uncertainty in recirc. airflow		Outdoor air fraction - volumetric	Uncert. in vol. OA fraction	OA fraction - CO_2	Uncert. in CO_2 OA fraction
		L/s	cfm	L/s	cfm				
SCDW01(01)	Wed AM					0.241	0.076	0.212	0.222
	Wed PM					0.249	0.079		
	Thurs AM					0.238	0.075	0.203	0.144
	Thurs PM					0.220	0.070	0.185	0.155
SCDW02(01)	Wed AM					0.182	0.057	0.286	0.420
	Wed PM					0.187	0.059	0.250	0.364
	Thurs AM					0.191	0.060	0.286	0.420
	Thurs PM					0.155	0.049	0.500	0.527
SDBW01(01)	Wed AM					0.456	0.144	0.385	0.389
	Wed PM					0.517	0.163	0.471	0.460
	Thurs AM					0.523	0.165	0.325	0.372
	Thurs PM					0.546	0.173	0.455	0.471
SDBW02(01)	Wed AM					0.444	0.140	0.444	0.344
	Wed PM					0.293	0.093	0.444	0.344
	Thurs AM					0.283	0.090	0.333	0.497
	Thurs PM					0.236	0.074	0.250	0.364
SDBW04(01)	Wed AM	9318	19742	2795	5922	0.214	0.257	0.094	0.444
	Wed PM	8062	17081	2419	5124	0.199	0.261	0.115	0.548
	Thurs AM	7798	16521	2339	4956	0.195	0.262	0.140	0.499
	Thurs PM	7534	15961	2260	4788	0.216	0.256	0.167	0.478
TNDS05(01)	Wed AM					1.000	0.316		
	Wed PM					1.000	0.316		
	Thurs AM					1.000	0.316		
	Thurs PM					1.000	0.316		
TNDS05(02)	Wed AM					1.000	0.316		
	Wed PM					1.000	0.316		
	Thurs AM					1.000	0.316		
	Thurs PM					1.000	0.316		
TNDS06(01)	Wed AM	67909	143871	20373	43161	0.213	0.257	0.276	0.343
	Wed PM	67403	142799	20221	42840	0.086	0.292	0.335	0.284
	Thurs AM	58901	124788	17670	37437	0.130	0.280	0.208	0.301
	Thurs PM	68010	144087	20403	43226	0.022	0.310	0.222	0.322
TNDS07(01)	Wed AM					0.024	0.008	0.000	0.710
	Wed PM					0.030	0.009	0.200	0.577
	Thurs AM					0.030	0.010	0.000	0.568
	Thurs PM					0.159	0.050	0.000	0.710
TNFS08(01)	Wed AM					0.204	0.064	0.196	0.160
	Wed PM					0.245	0.077	0.205	0.168
	Thurs AM					0.229	0.072	0.200	0.176
	Thurs PM					0.180	0.057	0.176	0.191
TNFS085(02)	Wed AM	977	2070	293	621	0.269	0.102	0.412	0.197
	Wed PM	1051	2227	315	668	0.222	0.086	0.231	0.186
	Thurs AM	1056	2236	317	671	0.226	0.087	0.202	0.221
	Thurs PM	1019	2160	306	648	0.225	0.087	0.211	0.206
TNFS09(01)	Wed AM	4319	9150	1296	2745	0.369	0.217	0.200	0.288
	Wed PM	4259	9024	1278	2707	0.323	0.229	0.185	0.266
	Thurs AM	4289	9087	1287	2726	0.272	0.242	0.231	0.279
	Thurs PM	4170	8835	1251	2650	0.297	0.235	0.200	0.180
TNFS09(02)	Wed AM					0.076	0.024	0.165	0.181
	Wed PM					0.071	0.022	0.000	0.151
	Thurs AM					0.053	0.017	0.056	0.157
	Thurs PM					0.057	0.018	0.050	0.142
TNFS10(01)	Wed AM	3326	7047	998	2114	0.688	0.153	0.634	0.681
	Wed PM	5837	12367	1751	3710	0.535	0.180	0.444	0.860
	Thurs AM	3518	7452	1055	2236	0.703	0.151	0.603	0.565
	Thurs PM	3084	6534	925	1960	0.705	0.151	0.529	0.941

		Recirculation Airflow		Uncertainty in recirc. airflow		Outdoor air fraction - volumetric	Uncert. in vol. OA fraction	OA fraction - CO_2	Uncert. in CO_2 OA fraction
System ID	Day Period	L/s	cfm	L/s	cfm				
TXFS01(01)	Wed AM							0.061	0.173
	Wed PM					0.045	0.014	0.058	0.131
	Thurs AM					0.043	0.014	0.071	0.204
	Thurs PM					0.040	0.013	0.059	0.139
TXFS02(01)	Wed AM					0.047	0.015	0.050	0.177
	Wed PM					0.050	0.016	0.000	0.167
	Thurs AM					0.036	0.011	0.000	0.215
	Thurs PM					0.049	0.015	0.000	0.151
TXFS02(02)	Wed AM					0.047	0.015	0.040	0.189
	Wed PM					0.046	0.015	0.000	0.189
	Thurs AM					0.043	0.014	0.000	0.237
	Thurs PM					0.044	0.014	0.021	0.150
TXFS07(01)	Wed AM					0.128	0.040	0.119	0.327
	Wed PM					0.142	0.045	0.240	0.291
	Thurs AM					0.142	0.045	0.214	0.258
	Thurs PM					0.159	0.050	0.182	0.327
TXFS08(01)	Wed AM					0.046	0.015	0.053	0.149
	Wed PM					0.049	0.015	0.053	0.149
	Thurs AM					0.058	0.018	0.063	0.177
	Thurs PM					0.059	0.019	0.080	0.113
TXFS08(02)	Wed AM					0.053	0.017	0.100	0.142
	Wed PM					0.047	0.015	0.091	0.129
	Thurs AM					0.052	0.017	0.056	0.157
	Thurs PM					0.049	0.016	0.091	0.129
TXFS09(01)	Wed AM					0.192	0.061	0.143	0.204
	Wed PM					0.183	0.058	0.200	0.096
	Thurs AM					0.188	0.060	0.125	0.178
	Thurs PM					0.193	0.061	0.167	0.119
TXFS09(02)	Wed AM					0.189	0.060	0.143	0.204
	Wed PM					0.180	0.057	0.192	0.111
	Thurs AM					0.194	0.061	0.125	0.178
	Thurs PM					0.195	0.062	0.083	0.118
TXFW05(01)	Wed AM	26244	55602	7873	16680	0.259	0.245	0.516	0.652
	Wed PM	25650	54343	7695	16303	0.248	0.248	0.400	0.609
	Thurs AM	17274	36598	5182	10979	0.586	0.170	0.161	0.462
	Thurs PM	15762	33393	4729	10018	0.623	0.163	0.333	0.497
TXFW06(01)	Wed AM					1.004	0.318	0.667	1.133
	Wed PM					1.000	0.316	1.000	1.333
	Thurs AM					1.001	0.317	0.800	0.724
	Thurs PM					1.002	0.317	0.800	0.724
WAIW03(01)	Wed AM					1.010	0.319	0.789	0.474
	Wed PM					0.886	0.280	0.938	0.606
	Thurs AM					1.018	0.322	0.905	0.908
	Thurs PM					0.920	0.291	0.929	0.689
WAIW04(01)	Wed AM					0.973	0.308	0.600	0.660
	Wed PM					0.990	0.313	0.833	0.614
	Thurs AM					0.982	0.310	0.500	0.527
	Thurs PM					1.003	0.317	0.571	0.465
# of values		186				509		520	
Mean		7930	16800	2379	5040	0.377	0.158	0.311	0.601
StdDev		11304	23948	3391	7185	0.350	0.120	0.270	0.625
Minimum		12	25	4	7	0.000	0.004	0.000	0.096
10th percentile		181	384	54	115	0.043	0.017	0.030	0.159
25th percentile		1508	3196	453	959	0.104	0.047	0.110	0.237
Median		4357	9230	1307	2769	0.222	0.144	0.231	0.433
75th percentile		9139	19361	2742	5808	0.594	0.275	0.444	0.711
90th percentile		18414	39012	5524	11703	1.000	0.316	0.750	1.133
Maximum		68010	144087	20403	43226	1.521	0.481	1.200	7.100

Appendix E: Measured Data for Study Spaces

This appendix presents the following information for the measurements in the study spaces:

Study space ID
Day and time of measurement
Supply airflow per unit floor area and associated uncertainty
Outdoor airflow per person, per unit floor area and in air changes per hour based on volumetric airflow measurements (VOL), and associated uncertainties
Outdoor airflow per person, per unit floor area and in air changes per hour based on volumetric supply airflow times CO_2 -based outdoor air fraction (RATIO), and associated uncertainties
Outdoor airflow rate per person based on peak CO_2 analysis (PEAK), and associated uncertainties

Changes in the table relative to the original 2004 report are highlighted in yellow.

		SUPPLY AIRFLOW				OUTDOOR AIRFLOW									
Study Space ID	**Period**	**Volumetric supply airflow**		Uncertainty in supply airflow		**Volumetric**					Uncertainty in volumetric OA				
		L/s•m^2	cfm/ft^2	L/s•m^2	cfm/ft^2	L/s•person	cfm/person	L/s•m^2	cfm/ft^2	h^{-1}	L/s•person	cfm/person	L/s•m^2	cfm/ft^2	h^{-1}
ARFW01	Wed AM	8.36	1.65	1.02	0.20	10.3	21.9	0.46	0.09	0.44	2.4	5.1	0.11	0.02	0.13
	Wed PM	8.29	1.63	1.02	0.20	14.8	31.4	0.45	0.09	0.42	3.5	7.4	0.11	0.02	0.12
	Thur AM	8.24	1.62	1.01	0.20	12.1	25.5	0.47	0.09	0.45	2.8	6.0	0.11	0.02	0.13
	Thur PM	8.37	1.65	1.02	0.20	12.6	26.7	0.45	0.09	0.43	3.0	6.3	0.11	0.02	0.12
ARFW02	Wed AM	2.41	0.47	0.34	0.07										
	Wed PM	2.32	0.46	0.33	0.06	112.7	238.7	1.88	0.37	1.51	27.6	58.5	0.46	0.09	0.45
	Thur AM														
	Thur PM	2.33	0.46	0.33	0.06	81.2	172.1	1.94	0.38	1.54	19.9	42.2	0.48	0.09	0.46
ARFW03	Wed AM	5.04	0.99	0.62	0.12	7.6	16.2	0.34	0.07	0.27	1.8	3.9	0.08	0.02	0.08
	Wed PM	5.46	1.08	0.68	0.13	8.1	17.1	0.32	0.06	0.25	2.1	4.4	0.08	0.02	0.08
	Thur AM	5.42	1.07	0.67	0.13	7.1	15.1	0.36	0.07	0.29	1.8	3.9	0.09	0.02	0.09
	Thur PM	5.35	1.05	0.66	0.13	7.9	16.8	0.34	0.07	0.27	2.0	4.3	0.09	0.02	0.08
AZHS02	Wed AM	6.18	1.22	0.77	0.15	45.9	97.3	2.47	0.49	2.43	18.3	38.7	0.98	0.19	1.05
	Wed PM	6.83	1.34	0.85	0.17	128.0	271.2	3.33	0.66	3.28	38.4	81.4	1.00	0.20	1.14
	Thur AM	5.44	1.07	0.68	0.13	24.8	52.6	1.55	0.31	1.53	15.6	33.0	0.97	0.19	0.99
	Thur PM	5.97	1.17	0.74	0.15	33.6	71.2	2.01	0.40	1.98	16.4	34.8	0.98	0.19	1.03
AZHS04	Wed AM	6.25	1.23	0.86	0.17	0.8	1.6	0.06	0.01	0.06	25.6	54.3	2.54	0.50	1.91
	Wed PM	6.21	1.22	0.86	0.17	1.8	3.9	0.06	0.01	0.06	58.0	122.9	2.64	0.52	1.97
	Thur AM	6.13	1.21	0.85	0.17	1.9	4.0	0.04	0.01	0.05	71.5	151.5	2.29	0.45	1.69
	Thur PM	5.96	1.17	0.82	0.16	2.3	4.9	0.07	0.01	0.07	65.5	138.7	2.59	0.51	1.92
AZHW10	Wed AM	5.72	1.13	0.86	0.17	199.5	422.7	5.72	1.13	6.15	30.1	63.8	0.86	0.17	1.41
	Wed PM	5.56	1.09	0.83	0.16	247.3	523.8	5.56	1.09	5.97	37.1	78.5	0.83	0.16	1.37
	Thur AM	6.21	1.22	0.94	0.18	228.7	484.6	6.21	1.22	6.67	34.6	73.3	0.94	0.18	1.53
	Thur PM	6.25	1.23	0.95	0.19	230.2	487.7	6.25	1.23	6.71	34.9	74.0	0.95	0.19	1.55
AZHW11	Wed AM	5.26	1.03	0.91	0.18	25.1	53.1	1.00	0.20	0.98	34.7	73.6	1.39	0.27	1.37
	Wed PM	6.20	1.22	1.07	0.21	57.2	121.1	1.82	0.36	1.78	46.3	98.2	1.47	0.29	1.47
	Thur AM	6.12	1.20	1.06	0.21	60.1	127.4	2.05	0.40	2.00	41.0	86.9	1.40	0.27	1.41
	Thur PM	6.70	1.32	1.16	0.23	75.7	160.3	2.30	0.45	2.25	50.0	106.0	1.52	0.30	1.53
AZHW12	Wed AM	1.40	0.28	0.20	0.04	10.7	22.7	0.38	0.08	0.37	2.9	6.1	0.10	0.02	0.12
	Wed PM	1.39	0.27	0.20	0.04	12.6	26.7	0.40	0.08	0.39	3.3	7.1	0.11	0.02	0.12
	Thur AM	1.35	0.27	0.20	0.04	9.6	20.3	0.31	0.06	0.30	3.0	6.4	0.10	0.02	0.11
	Thur PM	1.42	0.28	0.21	0.04	11.1	23.6	0.33	0.06	0.32	3.6	7.5	0.11	0.02	0.12
CAES17	Wed AM	19.59	3.86	2.77	0.55	64.7	137.0	3.66	0.72	3.60	91.6	194.1	5.18	1.02	5.13
	Wed PM	18.72	3.68	2.65	0.52	50.2	106.4	2.66	0.52	2.61	97.8	207.2	5.18	1.02	5.11
	Thur AM	21.11	4.15	2.99	0.59	235.6	499.1	11.90	2.34	11.71	72.7	154.1	3.67	0.72	4.14
	Thur PM	20.13	3.96	2.85	0.56	113.8	241.0	6.16	1.21	6.06	86.7	183.6	4.69	0.92	4.73
CAEW07	Wed AM	5.28	1.04	0.91	0.18	57.2	121.2	1.62	0.32	1.44	19.0	40.2	0.54	0.11	0.54
	Wed PM	5.60	1.10	0.97	0.19	161.3	341.8	4.86	0.96	4.33	53.5	113.4	1.61	0.32	1.62
	Thur AM	5.28	1.04	0.91	0.18	155.9	330.3	4.03	0.79	3.59	51.7	109.6	1.34	0.26	1.34
	Thur PM	5.20	1.02	0.90	0.18	180.9	383.3	5.45	1.07	4.86	60.0	127.1	1.81	0.36	1.82

		SUPPLY AIRFLOW				OUTDOOR AIRFLOW									
		Volumetric supply airflow		Uncertainty in supply airflow		Volumetric					Uncertainty in volumetric OA				
Study Space ID	Period	L/s•m²	cfm/ft²	L/s•m²	cfm/ft²	L/s•person	cfm/person	L/s•m²	cfm/ft²	h^{-1}	L/s•person	cfm/person	L/s•m²	cfm/ft²	h^{-1}
CAEW09	Wed AM	1.82	0.36	0.26	0.05	38.2	80.9	0.58	0.11	0.51	12.1	25.6	0.18	0.04	0.18
	Wed PM	1.87	0.37	0.26	0.05	16.3	34.6	0.50	0.10	0.45	5.2	11.0	0.16	0.03	0.16
	Thur AM	1.91	0.38	0.27	0.05	18.1	38.3	0.28	0.05	0.25	5.7	12.1	0.09	0.02	0.09
	Thur PM	1.76	0.35	0.25	0.05	11.4	24.2	0.26	0.05	0.23	3.6	7.7	0.08	0.02	0.08
CAJS01	Wed AM	1.80	0.35	0.22	0.04	53.4	113.2	1.80	0.35	1.74	9.0	19.2	0.31	0.06	0.42
	Wed PM	1.91	0.38	0.23	0.05	67.8	143.7	1.91	0.38	1.84	10.9	23.2	0.31	0.06	0.44
	Thur AM	1.89	0.37	0.23	0.05	60.4	128.0	1.89	0.37	1.82	10.3	21.8	0.32	0.06	0.44
	Thur PM	1.86	0.37	0.23	0.04	66.0	139.8	1.86	0.37	1.79	10.9	23.0	0.31	0.06	0.43
CAJS02	Wed AM	11.65	2.29	1.65	0.32			9.87	1.94	10.60			3.12	0.61	3.82
	Wed PM	10.89	2.14	1.54	0.30	206.6	437.6	10.00	1.97	10.75	65.3	138.4	3.16	0.62	3.88
	Thur AM	11.65	2.29	1.65	0.32	224.5	475.6	11.41	2.24	12.26	71.0	150.4	3.61	0.71	4.42
	Thur PM	11.38	2.24	1.61	0.32	212.4	450.1	12.31	2.42	13.23	67.2	142.3	3.89	0.77	4.77
CAJS03	Wed AM	4.04	0.79	0.70	0.14	128.5	272.3	4.04	0.79	4.34	42.6	90.3	1.34	0.26	1.62
	Wed PM	4.16	0.82	0.72	0.14	94.2	199.6	4.16	0.82	4.46	31.2	66.2	1.38	0.27	1.67
	Thur AM	4.25	0.84	0.74	0.14	113.5	240.5	4.25	0.84	4.57	37.7	79.8	1.41	0.28	1.71
	Thur PM	4.17	0.82	0.72	0.14	101.9	215.9	4.16	0.82	4.46	33.8	71.6	1.38	0.27	1.67
CAJS21	Wed AM	8.86	1.74	1.11	0.22	53.4	113.2	3.93	0.77	3.64	13.1	27.8	0.97	0.19	1.09
	Wed PM	7.93	1.56	0.98	0.19	69.7	147.7	4.14	0.81	3.83	17.4	36.9	1.03	0.20	1.16
	Thur AM	7.59	1.49	0.94	0.18	85.1	180.3	4.61	0.91	4.27	20.6	43.5	1.11	0.22	1.27
	Thur PM	8.20	1.61	1.02	0.20	104.1	220.6	4.47	0.88	4.14	25.5	53.9	1.09	0.22	1.24
CAJS22	Wed AM	2.45	0.48	0.35	0.07	5.7	12.0	0.21	0.04	0.19	19.7	41.8	0.72	0.14	0.66
	Wed PM	2.95	0.58	0.42	0.08	12.0	25.5	0.42	0.08	0.39	23.1	48.9	0.81	0.16	0.75
	Thur AM	2.36	0.47	0.33	0.07	16.6	35.1	0.49	0.10	0.45	20.8	44.0	0.61	0.12	0.57
	Thur PM	2.93	0.58	0.41	0.08	16.1	34.0	0.62	0.12	0.56	19.7	41.7	0.76	0.15	0.70
CAJS23	Wed AM	12.80	2.52	1.81	0.36	16.7	35.5	0.94	0.19	0.86	5.3	11.2	0.30	0.06	0.31
	Wed PM	11.29	2.22	1.60	0.31	21.6	45.8	1.15	0.23	1.05	6.8	14.5	0.36	0.07	0.38
	Thur AM	12.67	2.49	1.79	0.35	20.6	43.6	1.09	0.21	1.00	6.5	13.8	0.34	0.07	0.36
	Thur PM	13.01	2.56	1.84	0.36	28.9	61.2	1.24	0.24	1.13	9.1	19.4	0.39	0.08	0.41
CAJW18	Wed AM	6.72	1.32	0.95	0.19	17.2	36.5	0.54	0.11	0.53	5.5	11.6	0.17	0.03	0.19
	Wed PM	7.02	1.38	0.99	0.20	18.1	38.3	0.53	0.11	0.52	5.7	12.1	0.17	0.03	0.19
	Thur AM	6.88	1.35	0.97	0.19	22.9	48.4	0.60	0.12	0.58	7.2	15.3	0.19	0.04	0.21
	Thur PM	7.76	1.53	1.10	0.22	22.3	47.3	0.60	0.12	0.58	7.1	15.0	0.19	0.04	0.21
CAJW19	Wed AM	7.19	1.41	1.24	0.24	116.4	246.5	3.57	0.70	3.46	45.5	96.4	1.40	0.27	1.48
	Wed PM	7.05	1.39	1.22	0.24	90.8	192.4	2.85	0.56	2.76	47.8	101.2	1.50	0.30	1.53
	Thur AM	7.19	1.41	1.24	0.24	112.8	239.0	3.54	0.70	3.43	44.7	94.6	1.40	0.28	1.48
	Thur PM	6.83	1.34	1.18	0.23	71.3	151.0	2.24	0.44	2.17	50.0	106.0	1.57	0.31	1.57
CAJW20	Wed AM	1.88	0.37	0.33	0.06	71.7	151.9	2.29	0.45	1.99	23.8	50.4	0.75	0.15	0.75
	Wed PM	2.07	0.41	0.36	0.07	84.5	179.1	2.39	0.47	2.08	28.0	59.4	0.78	0.15	0.78
	Thur AM	1.82	0.36	0.32	0.06	72.9	154.5	2.08	0.41	1.82	24.2	51.2	0.68	0.14	0.68
	Thur PM	1.87	0.37	0.32	0.06	69.9	148.0	2.08	0.41	1.84	23.2	49.1	0.69	0.14	0.69

		SUPPLY AIRFLOW				OUTDOOR AIRFLOW									
		Volumetric supply airflow		Uncertainty in supply airflow		**Volumetric**					Uncertainty in volumetric OA				
Study Space ID	**Period**	L/s•m²	cfm/ft²	L/s•m²	cfm/ft²	L/s•person	cfm/person	L/s•m²	cfm/ft²	h^{-1}	L/s•person	cfm/person	L/s•m²	cfm/ft²	h^{-1}
CAJW24	Tues AM	6.26	1.23	1.08	0.21	63.2	133.8	4.33	0.85	4.12	20.9	44.4	1.44	0.28	1.54
	Tues PM	6.72	1.32	1.16	0.23	3.3	7.0	0.24	0.05	0.23	1.1	2.3	0.08	0.02	0.09
	Wed AM	6.26	1.23	1.08	0.21	64.1	135.8	4.33	0.85	4.12	21.3	45.0	1.44	0.28	1.54
	Wed PM	7.14	1.41	1.24	0.24	3.8	8.0	0.24	0.05	0.23	1.2	2.6	0.08	0.02	0.09
	Thur AM	7.56	1.49	1.31	0.26	77.3	163.8	5.30	1.04	5.04	25.6	54.3	1.76	0.35	1.89
	Thur PM	7.60	1.50	1.32	0.26	113.0	239.4	6.73	1.33	6.41	37.5	79.4	2.23	0.44	2.40
CAJW25	Wed AM	4.96	0.98	0.86	0.17	47.6	100.9	2.67	0.53	2.56	15.8	33.5	0.89	0.17	0.96
	Wed PM	5.23	1.03	0.91	0.18	85.0	180.0	5.00	0.98	4.79	28.2	59.7	1.66	0.33	1.79
	Thur AM	4.62	0.91	0.80	0.16	61.5	130.3	3.28	0.65	3.14	20.4	43.2	1.09	0.21	1.18
	Thur PM	5.14	1.01	0.89	0.18	78.5	166.4	5.26	1.04	5.04	26.0	55.2	1.74	0.34	1.88
CAJW26	Wed AM	5.26	1.04	0.91	0.18	133.7	283.3	5.98	1.18	5.73	44.4	94.0	1.98	0.39	2.14
	Wed PM	5.92	1.17	1.03	0.20	115.1	243.8	6.58	1.30	6.30	38.2	80.9	2.18	0.43	2.36
	Thur AM	5.52	1.09	0.96	0.19	88.5	187.5	5.89	1.16	5.64	29.3	62.2	1.95	0.38	2.11
	Thur PM	5.80	1.14	1.00	0.20	87.7	185.7	5.47	1.08	5.24	29.1	61.6	1.81	0.36	1.96
COAS02	Wed AM	3.37	0.66	1.06	0.21	6.9	14.6	0.24	0.05	0.17	2.3	4.8	0.08	0.02	0.06
	Wed PM	2.99	0.59	0.91	0.18	9.5	20.2	0.32	0.06	0.23	3.2	6.7	0.11	0.02	0.09
	Thur AM	3.28	0.65	1.01	0.20	9.6	20.4	0.29	0.06	0.21	3.2	6.8	0.10	0.02	0.08
	Thur PM	3.59	0.71	1.08	0.21	15.8	33.4	0.46	0.09	0.33	5.2	11.1	0.15	0.03	0.12
COAS04	Wed AM	5.83	1.15	1.01	0.20	4.4	9.4	0.13	0.03	0.10	60.0	127.1	1.81	0.36	1.30
	Wed PM	5.94	1.17	1.03	0.20	12.7	26.8	0.39	0.08	0.28	57.7	122.3	1.77	0.35	1.28
	Thur AM	5.71	1.12	0.99	0.19	1.0	2.1	0.03	0.01	0.02	67.4	142.8	1.80	0.35	1.30
	Thur PM	5.85	1.15	1.01	0.20	0.0	0.0	0.00	0.00	0.00	60.1	127.3	1.9	0.37	1.35
COAS06	Wed AM	2.80	0.55	0.40	0.08	27.3	57.7	0.68	0.13	0.64	8.6	18.3	0.21	0.04	0.23
	Wed PM	3.52	0.69	0.50	0.10	25.6	54.3	0.73	0.14	0.69	8.1	17.2	0.23	0.05	0.25
	Thur AM	4.71	0.93	0.67	0.13	22.8	48.4	0.78	0.15	0.75	7.2	15.3	0.25	0.05	0.27
	Thur PM	3.70	0.73	0.52	0.10	21.6	45.8	0.65	0.13	0.62	6.8	14.5	0.20	0.04	0.22
FLDW07	Wed AM	3.75	0.74	1.06	0.21	22.7	48.1	0.49	0.10	0.40	7.2	15.2	0.15	0.03	0.15
	Wed PM	3.38	0.67	0.94	0.19	25.0	53.0	0.50	0.10	0.41	7.9	16.8	0.16	0.03	0.15
	Thur AM	3.17	0.62	0.88	0.17	25.2	53.4	0.49	0.10	0.40	8.0	16.9	0.16	0.03	0.15
	Thur PM	3.46	0.68	0.96	0.19	24.7	52.4	0.52	0.10	0.43	7.8	16.6	0.16	0.03	0.15
FLDW08	Wed AM	4.55	0.90	0.79	0.16	25.0	53.0	0.85	0.17	0.72	8.3	17.6	0.28	0.06	0.27
	Wed PM	4.99	0.98	0.86	0.17	16.3	34.6	0.57	0.11	0.48	5.4	11.5	0.19	0.04	0.18
	Thur AM	4.62	0.91	0.80	0.16	12.0	25.4	0.57	0.11	0.48	4.0	8.4	0.19	0.04	0.18
	Thur PM	4.64	0.91	0.80	0.16	89.4	189.3	3.11	0.61	2.62	29.6	62.8	1.03	0.20	0.98
FLDW10	Wed AM	2.38	0.47	0.34	0.07	3.7	7.7	0.18	0.04	0.18	1.2	2.4	0.06	0.01	0.06
	Wed PM	2.39	0.47	0.34	0.07	4.5	9.5	0.21	0.04	0.20	1.4	3.0	0.07	0.01	0.07
	Thur AM	2.43	0.48	0.34	0.07	3.8	8.0	0.23	0.05	0.23	1.2	2.5	0.07	0.01	0.08
	Thur PM	2.20	0.43	0.31	0.06	3.3	7.0	0.15	0.03	0.14	1.0	2.2	0.05	0.01	0.05
FLGS01	Thur AM	2.99	0.59	0.42	0.08	16.3	34.6	0.58	0.11	0.57	5.2	10.9	0.18	0.04	0.21
	Thur PM	3.31	0.65	0.47	0.09	17.2	36.3	0.61	0.12	0.60	5.4	11.5	0.19	0.04	0.22
	Fri AM	2.89	0.57	0.41	0.08	18.1	38.3	0.57	0.11	0.56	5.7	12.1	0.18	0.04	0.20
	Fri PM	3.14	0.62	0.44	0.09	18.0	38.2	0.62	0.12	0.61	5.7	12.1	0.20	0.04	0.22

		SUPPLY AIRFLOW				OUTDOOR AIRFLOW									
		Volumetric supply airflow		Uncertainty in supply airflow		**Volumetric**					Uncertainty in volumetric OA				
Study Space ID	**Period**	L/s•m^2	cfm/ft^2	L/s•m^2	cfm/ft^2	L/s•person	cfm/person	L/s•m^2	cfm/ft^2	h^{-1}	L/s•person	cfm/person	L/s•m^2	cfm/ft^2	h^{-1}
FLGS04	Wed AM	9.70	1.91	1.41	0.28	6.9	14.6	0.38	0.08	0.38	1.8	3.8	0.10	0.02	0.12
	Wed PM	9.90	1.95	1.43	0.28	7.5	15.8	0.39	0.08	0.38	1.9	4.1	0.10	0.02	0.12
	Thur AM	9.93	1.95	1.44	0.28	7.8	16.6	0.38	0.08	0.38	2.1	4.4	0.10	0.02	0.12
	Thur PM	10.24	2.01	1.49	0.29	7.9	16.6	0.39	0.08	0.38	2.1	4.4	0.10	0.02	0.12
FLGS11	Wed AM	2.15	0.42	0.26	0.05	11.9	25.2	0.32	0.06	0.37	2.8	5.9	0.08	0.02	0.11
	Wed PM	3.00	0.59	0.37	0.07	13.1	27.8	0.32	0.06	0.36	3.1	6.5	0.08	0.01	0.11
	Thur AM	1.77	0.35	0.22	0.04	12.0	25.5	0.31	0.06	0.35	2.8	6.0	0.07	0.01	0.10
	Thur PM	2.96	0.58	0.36	0.07	11.6	24.6	0.29	0.06	0.33	2.7	5.8	0.07	0.01	0.10
FLGS12	Wed AM	9.03	1.78	2.48	0.49	37.3	79.1	1.48	0.29	1.58	11.8	25.0	0.47	0.09	0.57
	Wed PM	8.69	1.71	2.37	0.47	34.5	73.1	1.49	0.29	1.60	10.9	23.1	0.47	0.09	0.58
	Thur AM	8.09	1.59	2.18	0.43	35.4	75.0	1.50	0.29	1.60	11.2	23.7	0.47	0.09	0.58
	Thur PM	7.90	1.55	2.15	0.42	25.6	54.3	1.38	0.27	1.48	8.1	17.2	0.44	0.09	0.53
GADS01	Wed AM	2.42	0.48	0.58	0.11	32.8	69.5	0.96	0.19	0.91	10.4	22.0	0.30	0.06	0.33
	Wed PM	2.61	0.51	0.64	0.13	35.7	75.7	0.84	0.17	0.79	11.3	24.0	0.27	0.05	0.29
	Thur AM	2.44	0.48	0.58	0.11	41.3	87.5	1.02	0.20	0.97	13.1	27.7	0.32	0.06	0.35
	Thur PM	2.51	0.49	0.60	0.12	39.0	82.6	0.95	0.19	0.90	12.3	26.1	0.30	0.06	0.32
GADS02	Wed AM	3.06	0.60	0.37	0.07	36.0	76.3	0.63	0.12	0.60	8.6	18.2	0.15	0.03	0.18
	Wed PM	3.52	0.69	0.43	0.08	29.9	63.4	0.62	0.12	0.59	7.0	14.9	0.15	0.03	0.17
	Thur AM	3.05	0.60	0.37	0.07	35.4	74.9	0.65	0.13	0.61	8.3	17.6	0.15	0.03	0.18
	Thur PM	3.71	0.73	0.45	0.09	33.9	71.8	0.64	0.13	0.61	8.0	16.9	0.15	0.03	0.18
GADS03	Wed AM	5.79	1.14	0.82	0.16	11.7	24.7	0.46	0.09	0.46	3.7	7.8	0.15	0.03	0.17
	Wed PM	5.53	1.09	0.78	0.15	9.9	21.0	0.47	0.09	0.47	3.1	6.6	0.15	0.03	0.17
	Thur AM	5.51	1.08	0.78	0.15	10.8	22.9	0.47	0.09	0.47	3.4	7.2	0.15	0.03	0.17
	Thur PM	5.44	1.07	0.77	0.15	11.6	24.7	0.47	0.09	0.47	3.7	7.8	0.15	0.03	0.17
ILBS01	Wed AM	5.55	1.09	0.72	0.14										
	Wed PM	5.61	1.10	0.73	0.14										
	Thur AM	5.34	1.05	0.69	0.14										
	Thur PM	5.68	1.12	0.74	0.15										
ILBS02	Wed AM	7.32	1.44	1.04	0.20	18.1	38.4	0.61	0.12	0.68	5.7	12.1	0.19	0.04	0.25
	Wed PM	7.60	1.50	1.08	0.21	18.9	40.1	0.56	0.11	0.63	6.0	12.7	0.18	0.03	0.23
	Thur AM	7.12	1.40	1.01	0.20	21.6	45.8	0.48	0.10	0.55	6.8	14.5	0.15	0.03	0.20
	Thur PM	7.28	1.43	1.03	0.20	23.6	50.0	0.55	0.11	0.62	7.5	15.8	0.17	0.03	0.22
ILBS03	Wed AM	10.25	2.02	1.45	0.29	139.9	296.3	3.71	0.73	3.82	84.6	179.2	2.24	0.44	2.40
	Wed PM	10.70	2.11	1.51	0.30	113.7	240.9	3.81	0.75	3.92	70.4	149.2	2.36	0.46	2.52
	Thur AM	10.35	2.04	1.46	0.29	218.9	463.7	4.84	0.95	4.98	90.9	192.6	2.01	0.40	2.24
	Thur PM	9.91	1.95	1.40	0.28	132.1	279.9	4.17	0.82	4.29	64.2	136.1	2.03	0.40	2.21
LAGW04	Wed AM	5.49	1.08	0.78	0.15	14.9	31.5	0.36	0.07	0.37	3.7	7.7	0.09	0.02	0.11
	Wed PM	5.65	1.11	0.81	0.16	12.4	26.4	0.33	0.06	0.34	3.1	6.5	0.08	0.02	0.10
	Thur AM	5.32	1.05	0.76	0.15	15.6	33.0	0.37	0.07	0.38	3.8	8.1	0.09	0.02	0.11
	Thur PM	5.67	1.12	0.81	0.16	15.2	32.2	0.35	0.07	0.36	3.7	7.9	0.09	0.02	0.11

		SUPPLY AIRFLOW				OUTDOOR AIRFLOW									
		Volumetric supply airflow		Uncertainty in supply airflow		**Volumetric**					Uncertainty in volumetric OA				
Study Space ID	**Period**	L/s•m²	cfm/ft²	L/s•m²	cfm/ft²	L/s•person	cfm/person	L/s•m²	cfm/ft²	h^{-1}	L/s•person	cfm/person	L/s•m²	cfm/ft²	h^{-1}
LAGW05	Wed AM	16.24	3.20	2.02	0.40	56.8	120.3	3.09	0.61	3.05	18.0	38.0	0.98	0.19	1.10
	Wed PM	15.81	3.11	1.97	0.39	95.4	202.2	3.46	0.68	3.41	30.2	63.9	1.09	0.22	1.23
	Thur AM	16.12	3.17	2.00	0.39	34.1	72.3	3.25	0.64	3.21	10.8	22.9	1.03	0.20	1.16
	Thur PM	15.76	3.10	1.96	0.39	63.0	133.4	3.43	0.67	3.38	19.9	42.2	1.08	0.21	1.22
LAGW06	Wed AM	5.11	1.00	0.72	0.14	14.8	31.4	0.65	0.13	0.64	4.7	9.9	0.20	0.04	0.23
	Wed PM	5.14	1.01	0.73	0.14	23.0	48.7	0.63	0.12	0.62	7.3	15.4	0.20	0.04	0.22
	Thur AM	5.12	1.01	0.72	0.14	19.9	42.2	0.62	0.12	0.62	6.3	13.4	0.20	0.04	0.22
	Thur PM	5.15	1.01	0.73	0.14	17.8	37.8	0.63	0.12	0.62	5.6	12.0	0.20	0.04	0.23
MABW05	Wed AM	0.88	0.17	0.13	0.03	2.7	5.7	0.09	0.02	0.08	6.4	13.5	0.21	0.04	0.19
	Wed PM	1.34	0.26	0.21	0.04	10.9	23.0	0.32	0.06	0.30	9.6	20.4	0.29	0.06	0.27
	Thur AM	1.29	0.25	0.20	0.04	6.9	14.6	0.23	0.04	0.21	9.0	19.0	0.29	0.06	0.28
	Thur PM	1.34	0.26	0.21	0.04	9.3	19.8	0.29	0.06	0.27	9.3	19.6	0.29	0.06	0.27
MABW06	Wed AM	2.23	0.44	0.31	0.06	39.3	83.3	2.07	0.41	2.08	12.4	26.3	0.65	0.13	0.75
	Wed PM	2.20	0.43	0.31	0.06	41.1	87.0	2.12	0.42	2.13	13.0	27.5	0.67	0.13	0.77
	Thur AM	1.88	0.37	0.27	0.05	41.0	86.9	1.82	0.36	1.82	13.0	27.5	0.57	0.11	0.66
	Thur PM	1.82	0.36	0.26	0.05	32.2	68.2	1.77	0.35	1.77	10.2	21.6	0.56	0.11	0.64
MABW08	Wed AM	4.48	0.88	0.76	0.15	54.1	114.6	3.30	0.65	3.30	24.7	52.3	1.50	0.30	1.61
	Wed PM	4.56	0.90	0.77	0.15	44.9	95.1	3.47	0.68	3.48	19.9	42.1	1.54	0.30	1.66
	Thur AM	4.31	0.85	0.73	0.14	38.3	81.1	2.87	0.56	2.88	9.8	20.7	0.73	0.14	0.89
	Thur PM	4.40	0.87	0.74	0.15	36.4	77.1	3.07	0.60	3.08	8.6	18.2	0.73	0.14	0.90
MDDS01	Wed AM	5.06	1.00	0.88	0.17	14.6	30.9	0.57	0.11	0.44	36.7	77.7	1.44	0.28	1.10
	Wed PM	5.41	1.06	0.94	0.18	13.7	29.0	0.34	0.07	0.26	64.5	136.7	1.61	0.32	1.23
	Thur AM	4.83	0.95	0.84	0.16	0.0	0.0	0.0	0.00	0.00	57.7	122.3	1.88	0.37	1.41
	Thur PM	4.73	0.93	0.82	0.16	0.0	0.0	0.0	0.00	0.00	45.9	97.2	1.63	0.32	1.25
MDDS03	Wed AM	2.29	0.45	0.28	0.06	3.8	8.0	0.18	0.04	0.22	1.0	2.1	0.05	0.01	0.07
	Wed PM	2.16	0.43	0.27	0.05	2.9	6.2	0.14	0.03	0.16	0.8	1.7	0.04	0.01	0.05
	Thur AM	2.25	0.44	0.28	0.05	3.6	7.5	0.17	0.03	0.20	0.9	1.9	0.04	0.01	0.06
	Thur PM	2.21	0.43	0.27	0.05	4.0	8.5	0.16	0.03	0.19	1.0	2.2	0.04	0.01	0.06
MDDS04	Wed AM	4.02	0.79	0.49	0.10	17.6	37.4	0.74	0.15	0.60	18.3	38.7	0.77	0.15	0.63
	Wed PM	3.81	0.75	0.47	0.09	15.7	33.3	0.63	0.12	0.52	18.5	39.2	0.74	0.15	0.61
	Thur AM	3.88	0.76	0.48	0.09	16.4	34.8	0.60	0.12	0.49	20.7	43.9	0.76	0.15	0.63
	Thur PM	3.74	0.74	0.46	0.09	13.9	29.5	0.61	0.12	0.50	16.8	35.6	0.73	0.14	0.60
MIBW01	Wed AM	3.08	0.61	0.40	0.08	32.0	67.9	1.15	0.23	1.12	13.6	28.8	0.49	0.10	0.51
	Wed PM	3.43	0.67	0.45	0.09	45.4	96.1	1.80	0.35	1.74	11.8	25.1	0.47	0.09	0.55
	Thur AM	3.09	0.61	0.40	0.08										
	Thur PM	3.25	0.64	0.42	0.08										
MIBW03	Wed AM	5.37	1.06	0.93	0.18	36.0	76.3	1.53	0.30	1.53	30.4	64.4	1.29	0.25	1.32
	Wed PM	5.35	1.05	0.93	0.18	21.2	44.9	1.16	0.23	1.16	25.0	52.9	1.37	0.27	1.39
	Thur AM	5.47	1.08	0.95	0.19	27.4	58.1	1.34	0.26	1.34	28.1	59.5	1.37	0.27	1.39
	Thur PM	4.67	0.92	0.81	0.16	24.8	52.6	1.57	0.31	1.57	16.8	35.5	1.06	0.21	1.10

		SUPPLY AIRFLOW				OUTDOOR AIRFLOW									
		Volumetric supply airflow		Uncertainty in supply airflow		Volumetric					Uncertainty in volumetric OA				
Study Space ID	Period	L/s•m²	cfm/ft²	L/s•m²	cfm/ft²	L/s•person	cfm/person	L/s•m²	cfm/ft²	h⁻¹	L/s•person	cfm/person	L/s•m²	cfm/ft²	h⁻¹
MIBW04	Wed AM	2.71	0.53	0.39	0.08	21.8	46.1	0.97	0.19	0.97	10.0	21.3	0.45	0.09	0.48
	Wed PM	2.64	0.52	0.38	0.08	22.6	47.9	0.94	0.19	0.94	10.6	22.4	0.44	0.09	0.47
	Thur AM	2.70	0.53	0.39	0.08	17.5	37.1	0.69	0.14	0.69	12.2	25.9	0.48	0.10	0.50
	Thur PM	2.96	0.58	0.43	0.08	37.8	80.2	1.12	0.22	1.12	16.1	34.1	0.47	0.09	0.51
MNBW01	Wed AM	2.81	0.55	0.40	0.08	38.1	80.7	0.73	0.14	0.72	12.0	25.5	0.23	0.05	0.26
	Wed PM	3.18	0.63	0.45	0.09	39.8	84.2	0.74	0.14	0.72	12.6	26.6	0.23	0.05	0.26
	Thur AM	2.83	0.56	0.40	0.08	39.7	84.1	0.71	0.14	0.70	12.6	26.6	0.22	0.04	0.25
	Thur PM	3.11	0.61	0.44	0.09	50.7	107.3	0.77	0.15	0.76	16.0	33.9	0.24	0.05	0.27
MNBW02	Wed AM	3.58	0.70	0.51	0.10	49.6	105.1	1.02	0.20	1.10	12.2	25.8	0.25	0.05	0.33
	Wed PM	4.20	0.83	0.59	0.12	58.3	123.5	1.52	0.30	1.63	14.6	30.9	0.38	0.07	0.50
	Thur AM	2.91	0.57	0.41	0.08	54.7	115.8	1.50	0.30	1.61	13.6	28.7	0.37	0.07	0.49
	Thur PM	3.42	0.67	0.48	0.10	62.0	131.4	1.49	0.29	1.60	15.2	32.2	0.37	0.07	0.48
MNBW04	Wed AM	2.71	0.53	0.47	0.09	108.6	230.1	1.95	0.38	2.14	36.0	76.3	0.65	0.13	0.80
	Wed PM	2.59	0.51	0.45	0.09	229.1	485.3	2.12	0.42	2.33	76.0	161.0	0.70	0.14	0.87
	Thur AM	2.97	0.59	0.52	0.10	98.1	207.7	2.10	0.41	2.31	32.5	68.9	0.70	0.14	0.86
	Thur PM	2.62	0.52	0.45	0.09	101.8	215.8	2.24	0.44	2.46	33.8	71.6	0.74	0.15	0.92
MOCS01	Wed AM	2.61	0.51	0.45	0.09										
	Wed PM	3.10	0.61	0.54	0.11										
	Thur AM	2.81	0.55	0.49	0.10										
	Thur PM	3.07	0.60	0.53	0.10										
MOCS05	Wed AM	3.10	0.61	0.54	0.11	31.8	67.5	1.02	0.20	0.91	10.6	22.4	0.34	0.07	0.34
	Wed PM	3.43	0.68	0.59	0.12	39.8	84.4	1.21	0.24	1.08	13.2	28.0	0.40	0.08	0.40
	Thur AM	2.79	0.55	0.48	0.09	21.2	44.9	0.61	0.12	0.55	7.0	14.9	0.20	0.04	0.20
	Thur PM	2.69	0.53	0.47	0.09	2.1	4.5	0.07	0.01	0.06	0.7	1.5	0.02	0.00	0.02
NCDW02	Wed AM	2.83	0.56	0.41	0.08	98.6	208.8	2.54	0.50	3.28	24.5	52.0	0.61	0.12	0.99
	Wed PM	3.08	0.61	0.44	0.09	88.5	187.5	2.64	0.52	3.47	22.0	46.7	0.66	0.13	1.05
	Thur AM	2.92	0.58	0.42	0.08	37.8	80.1	1.42	0.28	1.83	9.4	19.9	0.36	0.07	0.55
	Thur PM	2.97	0.58	0.43	0.08	61.3	129.8	2.34	0.46	3.04	15.2	32.3	0.56	0.11	0.92
NCDW03	Wed AM														
	Wed PM														
	Thur AM														
	Thur PM														
NCDW06	Wed AM	5.74	1.13	0.99	0.20	39.7	84.2	2.20	0.43	2.00	13.2	27.9	0.73	0.14	0.75
	Wed PM	6.45	1.27	1.12	0.22	56.0	118.6	3.66	0.72	3.32	18.6	39.3	1.21	0.24	1.24
	Thur AM	4.85	0.95	0.84	0.17	47.4	100.5	3.47	0.68	3.16	15.7	33.3	1.15	0.23	1.18
	Thur PM	5.74	1.13	0.99	0.20	33.4	70.8	2.12	0.42	1.93	11.1	23.5	0.70	0.14	0.72
NECW01	Wed AM	3.07	0.61	0.53	0.10	20.1	42.7	1.02	0.20	0.77	6.7	14.1	0.34	0.07	0.29
	Wed PM	2.97	0.59	0.51	0.10	24.1	51.0	1.18	0.23	0.89	8.0	16.9	0.39	0.08	0.33
	Thur AM	3.20	0.63	0.55	0.11	21.5	45.5	1.14	0.22	0.86	7.1	15.1	0.38	0.07	0.32
	Thur PM	3.16	0.62	0.55	0.11			1.85	0.36	1.40			0.61	0.12	0.52

		SUPPLY AIRFLOW				**OUTDOOR AIRFLOW**									
Study Space ID	**Period**	**Volumetric supply airflow**		Uncertainty in supply airflow		**Volumetric**					Uncertainty in volumetric OA				
		L/s•m²	cfm/ft²	L/s•m²	cfm/ft²	L/s•person	cfm/person	L/s•m²	cfm/ft²	h^{-1}	L/s•person	cfm/person	L/s•m²	cfm/ft²	h^{-1}
NECW02	Wed AM	8.20	1.61	1.42	0.28	226.7	480.3	6.47	1.27	4.89	75.2	159.3	2.15	0.42	1.83
	Wed PM	6.34	1.25	1.10	0.22	109.1	231.2	3.59	0.71	2.71	36.2	76.7	1.19	0.23	1.02
	Thur AM	8.26	1.63	1.43	0.28	175.9	372.6	6.24	1.23	4.72	58.3	123.6	2.07	0.41	1.76
	Thur PM	8.06	1.59	1.40	0.27	310.1	657.0	5.90	1.16	4.46	102.8	217.9	1.96	0.39	1.67
NECW03	Wed AM	6.28	1.24	1.09	0.21	65.8	139.4	4.31	0.85	4.32	21.8	46.2	1.43	0.28	1.62
	Wed PM	7.11	1.40	1.23	0.24	78.1	165.4	4.76	0.94	4.77	25.9	54.9	1.58	0.31	1.79
	Thur AM	7.34	1.44	1.27	0.25	51.7	109.4	3.42	0.67	3.43	17.1	36.3	1.14	0.22	1.28
	Thur PM	6.47	1.27	1.12	0.22	87.0	184.4	5.70	1.12	5.72	28.9	61.2	1.89	0.37	2.14
NMES01	Wed AM	4.88	0.96	0.98	0.19	72.5	153.7	1.51	0.30	1.52	17.5	37.1	0.37	0.07	0.45
	Wed PM	4.95	0.97	1.02	0.20	69.9	148.2	1.68	0.33	1.69	17.2	36.5	0.41	0.08	0.51
	Thur AM	4.35	0.86	0.90	0.18	68.2	144.4	1.27	0.25	1.28	17.1	36.3	0.32	0.06	0.39
	Thur PM	4.78	0.94	0.98	0.19	57.7	122.2	1.54	0.30	1.55	14.2	30.1	0.38	0.07	0.47
NMES02	Wed AM	5.30	1.04	0.75	0.15	183.2	388.2	7.34	1.44	6.85	57.9	122.8	2.32	0.46	2.47
	Wed PM	5.88	1.16	0.83	0.16	203.8	431.8	7.30	1.44	6.81	64.5	136.6	2.31	0.45	2.45
	Thur AM	6.31	1.24	0.89	0.18	186.5	395.2	6.84	1.35	6.38	59.0	125.0	2.16	0.43	2.30
	Thur PM	5.09	1.00	0.72	0.14	201.7	427.2	7.74	1.52	7.21	63.8	135.1	2.45	0.48	2.60
NMES03	Wed AM	4.69	0.92	0.58	0.11	7.2	15.3	0.44	0.09	0.41	15.9	33.7	0.97	0.19	0.91
	Wed PM	5.55	1.09	0.69	0.14	20.4	43.1	0.79	0.16	0.74	29.0	61.4	1.13	0.22	1.06
	Thur AM	4.79	0.94	0.59	0.12	17.0	35.9	0.77	0.15	0.71	20.9	44.4	0.95	0.19	0.89
	Thur PM	5.04	0.99	0.63	0.12	12.3	26.1	0.51	0.10	0.48	25.4	53.8	1.06	0.21	0.99
NVAW01	Wed AM	6.31	1.24	1.09	0.22	151.8	321.5	6.31	1.24	6.62	50.3	106.6	2.09	0.41	2.48
	Wed PM	6.57	1.29	1.14	0.22	104.2	220.8	4.42	0.87	4.64	34.6	73.2	1.47	0.29	1.74
	Thur AM	6.75	1.33	1.17	0.23	86.6	183.5	3.68	0.72	3.86	28.7	60.9	1.22	0.24	1.44
	Thur PM	6.84	1.35	1.18	0.23	50.8	107.6	1.90	0.37	1.99	16.8	35.7	0.63	0.12	0.74
NVAW02	Wed AM	4.15	0.82	0.72	0.14	82.9	175.6	3.95	0.78	3.73	27.5	58.2	1.31	0.26	1.40
	Wed PM	4.63	0.91	0.80	0.16	132.3	280.3	4.44	0.87	4.19	43.9	93.0	1.47	0.29	1.57
	Thur AM	4.04	0.79	0.70	0.14	133.3	282.3	3.88	0.76	3.67	44.2	93.6	1.29	0.25	1.37
	Thur PM	4.61	0.91	0.80	0.16	121.8	258.0	4.30	0.85	4.07	40.4	85.6	1.43	0.28	1.52
NVAW03	Wed AM	8.78	1.73	1.08	0.21	174.0	368.6	7.38	1.45	6.97	45.1	95.5	1.91	0.38	2.17
	Wed PM	8.54	1.68	1.05	0.21	148.0	313.6	7.44	1.47	7.03	38.4	81.4	1.93	0.38	2.19
	Thur AM	8.51	1.67	1.05	0.21	106.6	225.9	7.36	1.45	6.95	27.7	58.7	1.91	0.38	2.17
	Thur PM	8.74	1.72	1.08	0.21	127.8	270.8	7.44	1.46	7.03	33.1	70.1	1.93	0.38	2.19
NYBS01	Wed AM	9.42	1.85	1.37	0.27	35.3	74.9	1.39	0.27	1.43	43.8	92.8	1.72	0.34	1.78
	Wed PM	9.88	1.94	1.43	0.28	54.1	114.6	1.27	0.25	1.31	78.1	165.5	1.84	0.36	1.90
	Thur AM	9.71	1.91	1.40	0.28	40.8	86.5	1.17	0.23	1.21	62.6	132.6	1.80	0.35	1.86
	Thur PM	9.81	1.93	1.42	0.28	35.3	74.7	1.34	0.26	1.38	47.7	101.0	1.81	0.36	1.87
NYBS02	Wed AM	6.72	1.32	0.83	0.16	16.4	34.7	0.63	0.12	0.58	3.9	8.2	0.15	0.03	0.17
	Wed PM	6.34	1.25	0.78	0.15	14.6	30.9	0.71	0.14	0.65	3.5	7.4	0.17	0.03	0.19
	Thur AM	6.38	1.26	0.78	0.15	13.6	28.9	0.61	0.12	0.55	3.3	6.9	0.15	0.03	0.16
	Thur PM	4.39	0.86	0.54	0.11	17.5	37.0	0.66	0.13	0.60	4.1	8.7	0.16	0.03	0.18

		SUPPLY AIRFLOW				OUTDOOR AIRFLOW									
Study Space ID	Period	**Volumetric supply airflow**		Uncertainty in supply airflow		**Volumetric**					Uncertainty in volumetric OA				
		L/s•m^2	cfm/ft^2	L/s•m^2	cfm/ft^2	L/s•person	cfm/person	L/s•m^2	cfm/ft^2	h^{-1}	L/s•person	cfm/person	L/s•m^2	cfm/ft^2	h^{-1}
NYBS04	Wed AM	5.40	1.06	0.76	0.15	3.3	7.1	0.14	0.03	0.14	0.9	1.9	0.04	0.01	0.05
	Wed PM	5.42	1.07	0.77	0.15	3.9	8.3	0.13	0.03	0.13	1.0	2.2	0.04	0.01	0.04
	Thur AM	5.70	1.12	0.81	0.16	99.0	209.8	4.78	0.94	4.84	24.4	51.6	1.18	0.23	1.46
	Thur PM	5.69	1.12	0.80	0.16	3.5	7.5	0.14	0.03	0.14	1.0	2.0	0.04	0.01	0.04
NYBS05	Wed AM	2.50	0.49	0.43	0.09	12.8	27.1	0.64	0.13	0.54	4.2	9.0	0.21	0.04	0.20
	Wed PM	2.69	0.53	0.47	0.09	13.8	29.2	0.64	0.13	0.55	4.6	9.7	0.21	0.04	0.20
	Thur AM	2.60	0.51	0.45	0.09	14.5	30.8	0.64	0.13	0.55	4.8	10.2	0.21	0.04	0.20
	Thur PM	2.62	0.52	0.45	0.09	12.3	26.2	0.59	0.12	0.51	4.1	8.7	0.20	0.04	0.19
NYBS07	Wed AM	4.87	0.96	1.30	0.26	18.3	38.8	0.97	0.19	0.90	5.8	12.3	0.31	0.06	0.32
	Wed PM	5.10	1.00	1.36	0.27	27.1	57.5	1.02	0.20	0.94	8.6	18.2	0.32	0.06	0.34
	Thur AM	5.03	0.99	1.34	0.26	21.4	45.4	1.03	0.20	0.96	6.8	14.4	0.33	0.06	0.34
	Thur PM	4.81	0.95	1.28	0.25	23.8	50.5	0.96	0.19	0.89	7.5	16.0	0.30	0.06	0.32
ORIS03	Wed AM	3.89	0.77	0.71	0.14	64.9	137.6	1.75	0.34	1.62	21.5	45.6	0.58	0.11	0.61
	Wed PM	4.52	0.89	0.82	0.16	74.8	158.6	1.88	0.37	1.75	24.8	52.6	0.62	0.12	0.65
	Thur AM	3.40	0.67	0.62	0.12	65.6	138.9	1.54	0.30	1.42	21.7	46.1	0.51	0.10	0.53
	Thur PM	3.84	0.76	0.70	0.14	108.7	230.2	1.79	0.35	1.66	36.0	76.3	0.59	0.12	0.62
ORIS04	Wed AM														
	Wed PM	3.98	0.78	0.69	0.14										
	Thur AM	5.68	1.12	0.98	0.19										
	Thur PM	5.55	1.09	0.96	0.19										
PABS03	Wed AM	3.37	0.66	0.58	0.11	0.0	0.0	0.00	0.00	0.00	34.7	73.6	1.12	0.22	1.09
	Wed PM	3.12	0.61	0.54	0.11	0.0	0.0	0.00	0.00	0.00	38.7	81.9	1.07	0.21	1.07
	Thur AM	3.18	0.63	0.55	0.11	0.0	0.0	0.00	0.00	0.00	43.9	93.0	1.17	0.23	1.17
	Thur PM	3.45	0.68	0.60	0.12	0.0	0.0	0.00	0.00	0.00	42.2	89.4	1.27	0.25	1.23
PABS04	Wed AM	4.88	0.96	0.69	0.14	8.5	17.9	0.63	0.12	0.60	2.5	5.3	0.19	0.04	0.21
	Wed PM	4.82	0.95	0.69	0.13	9.0	19.1	0.61	0.12	0.58	2.7	5.6	0.18	0.04	0.20
	Thur AM	4.55	0.90	0.65	0.13	7.5	16.0	0.58	0.11	0.54	2.3	4.8	0.17	0.03	0.19
	Thur PM	4.74	0.93	0.67	0.13	9.2	19.5	0.61	0.12	0.58	2.7	5.8	0.18	0.04	0.20
SCDW01	Wed AM	5.88	1.16	0.83	0.16	18.5	39.2	1.42	0.28	1.42	5.9	12.4	0.45	0.09	0.51
	Wed PM	4.97	0.98	0.70	0.14	18.3	38.7	1.24	0.24	1.24	5.8	12.2	0.39	0.08	0.45
	Thur AM	5.46	1.08	0.77	0.15	18.1	38.4	1.30	0.26	1.30	5.7	12.1	0.41	0.08	0.47
	Thur PM	4.68	0.92	0.66	0.13	15.9	33.6	1.03	0.20	1.03	5.0	10.6	0.33	0.06	0.37
SCDW02	Wed AM	7.58	1.49	1.31	0.26	26.1	55.4	1.38	0.27	1.15	8.7	18.4	0.46	0.09	0.43
	Wed PM	8.18	1.61	1.42	0.28	25.9	54.9	1.53	0.30	1.28	8.6	18.2	0.51	0.10	0.48
	Thur AM	7.39	1.45	1.28	0.25	23.9	50.7	1.41	0.28	1.18	7.9	16.8	0.47	0.09	0.44
	Thur PM	7.69	1.51	1.33	0.26	22.6	47.9	1.19	0.23	0.99	7.5	15.9	0.39	0.08	0.37
SDBW01	Wed AM	3.87	0.76	0.55	0.11	43.1	91.3	1.77	0.35	1.96	13.6	28.9	0.56	0.11	0.71
	Wed PM	4.15	0.82	0.59	0.12	64.6	136.8	2.14	0.42	2.37	20.4	43.3	0.68	0.13	0.86
	Thur AM	3.95	0.78	0.56	0.11	56.1	119.0	2.07	0.41	2.29	17.8	37.6	0.65	0.13	0.83
	Thur PM	4.09	0.80	0.58	0.11	60.6	128.4	2.23	0.44	2.47	19.2	40.6	0.71	0.14	0.89

		SUPPLY AIRFLOW				**OUTDOOR AIRFLOW**									
Study Space ID	**Period**	**Volumetric supply airflow**		Uncertainty in supply airflow		**Volumetric**					Uncertainty in volumetric OA				
		$L/s \cdot m^2$	cfm/ft^2	$L/s \cdot m^2$	cfm/ft^2	L/s•person	cfm/person	$L/s \cdot m^2$	cfm/ft^2	h^{-1}	L/s•person	cfm/person	$L/s \cdot m^2$	cfm/ft^2	h^{-1}
SDBW02	Wed AM	3.66	0.72	0.63	0.12	49.9	105.6	1.62	0.32	1.80	16.5	35.0	0.54	0.11	0.67
	Wed PM	3.34	0.66	0.58	0.11	53.3	112.9	0.98	0.19	1.08	17.7	37.5	0.32	0.06	0.41
	Thur AM	3.64	0.72	0.63	0.12	35.3	74.8	1.03	0.20	1.14	11.7	24.8	0.34	0.07	0.43
	Thur PM	3.37	0.66	0.58	0.12	31.7	67.3	0.79	0.16	0.88	10.5	22.3	0.26	0.05	0.33
SDBW04	Wed AM	11.17	2.20	1.58	0.31	47.1	99.7	2.39	0.47	2.68	56.4	119.6	2.87	0.57	3.24
	Wed PM	9.48	1.87	1.34	0.26	55.6	117.8	1.89	0.37	2.11	73.0	154.6	2.48	0.49	2.79
	Thur AM	9.13	1.80	1.29	0.25	44.0	93.2	1.78	0.35	1.99	59.1	125.1	2.39	0.47	2.70
	Thur PM	9.06	1.78	1.28	0.25	39.3	83.2	1.96	0.39	2.19	46.5	98.5	2.32	0.46	2.62
TNDS05	Wed AM	2.08	0.41	0.32	0.06	59.1	125.1	2.08	0.41	2.32	16.7	35.3	0.59	0.12	0.77
	Wed PM	2.27	0.45	0.35	0.07	89.6	189.8	2.27	0.45	2.54	25.7	54.5	0.65	0.13	0.85
	Thur AM	2.16	0.42	0.34	0.07	65.3	138.3	2.16	0.42	2.41	18.7	39.7	0.62	0.12	0.81
	Thur PM	2.04	0.40	0.32	0.06	82.7	175.3	2.04	0.40	2.28	23.7	50.2	0.58	0.11	0.76
TNDS06	Wed AM	2.64	0.52	0.46	0.09	17.3	36.7	0.56	0.11	0.51	21.0	44.5	0.68	0.13	0.62
	Wed PM	2.25	0.44	0.39	0.08	6.7	14.2	0.19	0.04	0.17	22.9	48.5	0.66	0.13	0.59
	Thur AM	2.07	0.41	0.36	0.07	5.4	11.5	0.27	0.05	0.24	11.7	24.8	0.58	0.11	0.52
	Thur PM	2.13	0.42	0.37	0.07	1.3	2.8	0.05	0.01	0.04	18.3	38.7	0.66	0.13	0.59
TNDS07	Wed AM	5.55	1.09	0.79	0.15	3.1	6.6	0.13	0.03	0.14	1.0	2.1	0.04	0.01	0.05
	Wed PM	5.36	1.06	0.76	0.15	2.6	5.5	0.16	0.03	0.17	0.8	1.7	0.05	0.01	0.06
	Thur AM	5.55	1.09	0.79	0.15	2.6	5.6	0.17	0.03	0.18	0.8	1.8	0.05	0.01	0.06
	Thur PM	5.61	1.10	0.79	0.16	14.6	31.0	0.89	0.18	0.96	4.6	9.8	0.28	0.06	0.35
TNFS08	Wed AM	3.59	0.71	0.51	0.10	14.5	30.8	0.80	0.16	0.86	3.5	7.4	0.19	0.04	0.26
	Wed PM	3.63	0.71	0.52	0.10	20.9	44.3	0.86	0.17	0.93	5.3	11.1	0.22	0.04	0.28
	Thur AM	3.81	0.75	0.54	0.11	15.7	33.3	0.87	0.17	0.93	3.9	8.3	0.22	0.04	0.28
	Thur PM	4.34	0.85	0.60	0.12	15.3	32.4	0.83	0.16	0.89	3.8	8.1	0.21	0.04	0.27
TNFS09	Wed AM	3.29	0.65	0.48	0.10	10.7	22.8	0.93	0.18	0.96	5.9	12.5	0.51	0.10	0.55
	Wed PM	3.18	0.63	0.46	0.09	12.2	25.8	0.76	0.15	0.78	7.9	16.7	0.49	0.10	0.53
	Thur AM	2.71	0.53	0.40	0.08	7.5	15.8	0.58	0.11	0.60	6.2	13.2	0.49	0.10	0.51
	Thur PM	2.86	0.56	0.42	0.08	8.4	17.9	0.65	0.13	0.66	6.2	13.2	0.48	0.09	0.50
TNFS10	Wed AM	6.20	1.22	1.07	0.21	84.9	179.9	4.27	0.84	3.53	20.7	43.9	1.04	0.21	1.06
	Wed PM	7.31	1.44	1.27	0.25	75.3	159.5	3.92	0.77	3.24	26.4	55.8	1.37	0.27	1.27
	Thur AM	6.90	1.36	1.20	0.24	103.9	220.1	4.85	0.96	4.02	24.6	52.2	1.15	0.23	1.18
	Thur PM	6.08	1.20	1.05	0.21	81.0	171.6	4.28	0.84	3.55	19.2	40.6	1.01	0.20	1.04
TXFS01	Wed AM	3.58	0.71	0.62	0.12										
	Wed PM	4.39	0.86	0.76	0.15	5.9	12.4	0.20	0.04	0.17	1.9	4.1	0.07	0.01	0.06
	Thur AM	4.33	0.85	0.75	0.15	4.6	9.7	0.19	0.04	0.15	1.5	3.2	0.06	0.01	0.06
	Thur PM	4.46	0.88	0.77	0.15	6.5	13.8	0.18	0.04	0.15	2.2	4.6	0.06	0.01	0.06
TXFS02	Wed AM	6.64	1.31	0.81	0.16	10.8	22.9	0.31	0.06	0.35	2.5	5.4	0.07	0.01	0.10
	Wed PM	6.47	1.27	0.79	0.16	12.9	27.2	0.31	0.06	0.35	3.0	6.4	0.07	0.01	0.10
	Thur AM	7.63	1.50	0.93	0.18	9.5	20.1	0.30	0.06	0.34	2.2	4.7	0.07	0.01	0.10
	Thur PM	6.71	1.32	0.82	0.16	14.7	31.2	0.31	0.06	0.35	3.5	7.3	0.07	0.01	0.10

Study Space ID	Period	SUPPLY AIRFLOW				OUTDOOR AIRFLOW									
		Volumetric supply airflow		Uncertainty in supply airflow		Volumetric					Uncertainty in volumetric OA				
		L/s•m²	cfm/ft²	L/s•m²	cfm/ft²	L/s•person	cfm/person	L/s•m²	cfm/ft²	h⁻¹	L/s•person	cfm/person	L/s•m²	cfm/ft²	h⁻¹
TXFS07	Wed AM	4.72	0.93	0.82	0.16	7.0	14.8	0.60	0.12	0.69	2.3	4.9	0.20	0.04	0.26
	Wed PM	4.72	0.93	0.82	0.16	7.9	16.7	0.67	0.13	0.77	2.6	5.5	0.22	0.04	0.29
	Thur AM	4.39	0.86	0.76	0.15	7.5	15.8	0.63	0.12	0.72	2.5	5.2	0.21	0.04	0.27
	Thur PM	4.12	0.81	0.71	0.14	6.7	14.2	0.65	0.13	0.75	2.2	4.7	0.22	0.04	0.28
TXFS08	Wed AM	4.45	0.88	0.64	0.13	6.0	12.7	0.22	0.04	0.25	1.5	3.2	0.05	0.01	0.08
	Wed PM	4.89	0.96	0.71	0.14	6.6	13.9	0.24	0.05	0.27	1.7	3.5	0.06	0.01	0.08
	Thur AM	4.54	0.89	0.66	0.13	8.9	18.8	0.25	0.05	0.29	2.3	4.8	0.07	0.01	0.09
	Thur PM	4.82	0.95	0.70	0.14	7.2	15.2	0.27	0.05	0.31	1.9	3.9	0.07	0.01	0.10
TXFS09	Wed AM	4.30	0.85	0.53	0.10	28.3	59.9	0.82	0.16	0.78	6.6	14.0	0.19	0.04	0.23
	Wed PM	4.39	0.86	0.54	0.11	32.6	69.2	0.80	0.16	0.76	7.7	16.2	0.19	0.04	0.22
	Thur AM	4.34	0.86	0.53	0.10	31.9	67.6	0.83	0.16	0.80	7.5	15.8	0.19	0.04	0.23
	Thur PM	4.35	0.86	0.53	0.10	29.9	63.4	0.84	0.17	0.81	7.0	14.9	0.20	0.04	0.24
TXFW05	Wed AM	1.98	0.39	0.34	0.07	13.5	28.5	0.51	0.10	0.58	12.8	27.2	0.49	0.10	0.56
	Wed PM	1.91	0.38	0.33	0.07	11.6	24.6	0.47	0.09	0.54	11.6	24.7	0.48	0.09	0.55
	Thur AM	2.34	0.46	0.40	0.08	33.0	70.0	1.37	0.27	1.56	10.1	21.5	0.42	0.08	0.55
	Thur PM	2.34	0.46	0.41	0.08	38.9	82.4	1.46	0.29	1.66	10.9	23.1	0.41	0.08	0.55
TXFW06	Wed AM	3.39	0.67	0.59	0.12	143.9	304.8	3.41	0.67	3.87	47.7	101.1	1.13	0.22	1.45
	Wed PM	2.85	0.56	0.49	0.10	130.9	277.4	2.85	0.56	3.23	43.4	92.0	0.94	0.19	1.21
	Thur AM	2.91	0.57	0.50	0.10	116.4	246.7	2.91	0.57	3.30	38.6	81.8	0.96	0.19	1.24
	Thur PM	3.26	0.64	0.56	0.11	201.1	426.0	3.26	0.64	3.70	66.7	141.3	1.08	0.21	1.39
WAIW03	Wed AM	1.54	0.30	0.22	0.04	45.2	95.9	1.56	0.31	1.60	14.3	30.3	0.49	0.10	0.58
	Wed PM	2.14	0.42	0.30	0.06	68.4	145.0	1.89	0.37	1.95	21.6	45.8	0.60	0.12	0.70
	Thur AM	1.78	0.35	0.25	0.05	51.8	109.7	1.81	0.36	1.86	16.4	34.7	0.57	0.11	0.67
	Thur PM	2.11	0.41	0.30	0.06	70.2	148.6	1.94	0.38	2.00	22.2	47.0	0.61	0.12	0.72
WAIW04	Wed AM	1.29	0.25	0.18	0.04	58.8	124.5	1.25	0.25	1.20	18.6	39.4	0.40	0.08	0.43
	Wed PM	1.29	0.25	0.18	0.04	48.6	102.9	1.28	0.25	1.22	15.4	32.6	0.40	0.08	0.44
	Thur AM	1.29	0.25	0.18	0.04	49.7	105.3	1.26	0.25	1.21	15.7	33.3	0.40	0.08	0.44
	Thur PM	1.26	0.25	0.18	0.04	51.4	108.9	1.26	0.25	1.21	16.2	34.4	0.40	0.08	0.44
# of values		384				367		369		369					
Mean		5.12	1.01	0.80	0.16	49.4	104.7	1.87	0.37	1.83	20.5	43.4	0.78	0.15	0.83
StdDev		3.02	0.59	0.45	0.09	53.6	113.5	2.08	0.41	2.07	20.6	43.6	0.82	0.16	0.86
Minimum		0.88	0.17	0.13	0.03	0.0	0.0	0.00	0.00	0.00	0.7	1.5	0.02	0.00	0.02
10th percentile		2.16	0.43	0.32	0.06	6.3	13.3	0.24	0.05	0.22	2.4	5.0	0.09	0.02	0.10
25th percentile		2.99	0.59	0.46	0.09	12.6	26.8	0.50	0.10	0.47	5.7	12.0	0.19	0.04	0.21
Median		4.69	0.92	0.74	0.15	29.9	63.4	1.03	0.20	0.98	13.0	27.5	0.48	0.09	0.53
75th percentile		6.25	1.23	1.01	0.20	65.9	139.6	2.30	0.45	2.46	28.0	59.4	1.13	0.22	1.24
90th percentile		8.47	1.67	1.34	0.26	115.6	244.9	4.64	0.91	4.46	50.9	107.8	1.88	0.37	1.88
Maximum		21.11	4.15	2.99	0.59	310.1	657.0	12.31	2.42	13.23	102.8	217.9	5.18	1.02	5.13

		OUTDOOR AIRFLOW													
Study Space ID	Period	CO_2 Ratio					Uncertainty in CO_2 ratio OA					Peak CO_2		Uncertainty in peak CO_2 OA	
		L/s•person	cfm/person	L/s•m²	cfm/ft²	h⁻¹	L/s•person	cfm/person	L/s•m²	cfm/ft²	h⁻¹	L/s•person	cfm/person	L/s•person	cfm/person
ARFW01	Wed AM	2.8	5.9	0.13	0.03	0.12	25.5	54.1	1.14	0.23	1.08	11.9	25.2	1.9	4.1
	Wed PM	6.9	14.6	0.21	0.04	0.20	37.4	79.2	1.13	0.22	1.07	13.3	28.1	2.3	4.9
	Thur AM	22.2	46.9	0.87	0.17	0.82	28.6	60.6	1.12	0.22	1.07	11.6	24.6	1.9	3.9
	Thur PM	21.8	46.3	0.79	0.15	0.74	29.3	62.2	1.06	0.21	1.01	11.1	23.5	1.7	3.7
ARFW02	Wed AM	68.0	144.1	1.81	0.36	1.44	133.2	282.1	3.54	0.70	2.83	22.0	46.7	5.7	12.0
	Wed PM	58.1	123.2	0.98	0.19	0.78	81.8	173.2	1.38	0.27	1.10	20.2	42.8	4.8	10.2
	Thur AM											12.4	26.3	2.1	4.4
	Thur PM	78.2	165.8	1.87	0.37	1.49	85.4	180.9	2.04	0.40	1.64	25.0	53.0	7.2	15.2
ARFW03	Wed AM	9.6	20.4	0.43	0.08	0.34	19.8	41.9	0.89	0.17	0.70	11.0	23.3	1.7	3.6
	Wed PM	2.9	6.1	0.11	0.02	0.09	24.3	51.4	0.97	0.19	0.76	11.8	25.1	1.9	4.1
	Thur AM	5.0	10.5	0.25	0.05	0.20	15.4	32.5	0.78	0.15	0.62	11.1	23.5	1.7	3.6
	Thur PM	15.4	32.7	0.66	0.13	0.53	23.4	49.5	1.01	0.20	0.80	10.4	22.0	1.6	3.3
AZHS02	Wed AM	45.3	96.0	2.44	0.48	2.40	30.6	64.8	1.65	0.32	1.67	27.0	57.1	8.5	18.0
	Wed PM	103.0	218.1	2.68	0.53	2.64	119.2	252.5	3.10	0.61	3.09	35.2	74.6	14.2	30.1
	Thur AM	23.1	48.9	1.44	0.28	1.42	49.9	105.8	3.12	0.61	3.08	25.5	54.1	7.7	16.3
	Thur PM	38.6	81.8	2.31	0.45	2.27	72.3	153.1	4.33	0.85	4.27	28.7	60.9	9.6	20.4
AZHS04	Wed AM	9.7	20.6	0.70	0.14	0.72	11.6	24.6	0.84	0.17	0.87	7.3	15.5	0.9	2.0
	Wed PM	4.5	9.5	0.15	0.03	0.15	27.5	58.3	0.91	0.18	0.94	8.2	17.3	1.1	2.3
	Thur AM	196.0	415.2	4.50	0.89	4.63	195.2	413.5	4.48	0.88	4.68				
	Thur PM	23.6	50.0	0.67	0.13	0.69	25.2	53.4	0.72	0.14	0.75	10.5	22.3	1.6	3.4
AZHW10	Wed AM	44.0	93.2	1.26	0.25	1.36	95.2	201.6	2.73	0.54	2.94	20.7	43.9	5.2	11.0
	Wed PM	204.3	432.8	4.59	0.90	4.93	246.0	521.1	5.53	1.09	6.00	31.1	65.8	11.2	23.6
	Thur AM	189.8	402.2	5.15	1.01	5.53	315.3	667.9	8.55	1.68	9.24	33.0	70.0	12.6	26.6
	Thur PM	200.9	425.6	5.45	1.07	5.86	302.2	640.2	8.20	1.61	8.87	26.1	55.4	8.0	17.0
AZHW11	Wed AM	21.3	45.1	0.85	0.17	0.83	30.0	63.6	1.20	0.24	1.18	13.7	29.0	2.5	5.3
	Wed PM	54.1	114.7	1.72	0.34	1.68	77.6	164.3	2.47	0.49	2.43	22.3	47.3	6.0	12.7
	Thur AM	35.2	74.5	1.20	0.24	1.17	54.3	115.0	1.85	0.36	1.82	15.8	33.5	3.2	6.8
	Thur PM	33.1	70.1	1.00	0.20	0.98	74.2	157.1	2.25	0.44	2.21	15.8	33.4	3.2	6.7
AZHW12	Wed AM											14.3	30.4	2.7	5.7
	Wed PM											14.1	29.8	2.6	5.5
	Thur AM	8.4	17.8	0.27	0.05	0.27	14.3	30.4	0.47	0.09	0.46	15.6	33.0	3.1	6.6
	Thur PM	11.3	23.9	0.33	0.07	0.33	13.0	27.5	0.38	0.08	0.38	11.9	25.2	2.0	4.2
CAES17	Wed AM	86.6	183.5	4.90	0.96	4.82	126.9	268.8	7.17	1.41	7.10	15.2	32.1	3.0	6.3
	Wed PM	88.4	187.4	4.68	0.92	4.60	129.5	274.4	6.86	1.35	6.79	10.7	22.6	1.7	3.5
	Thur AM	69.6	147.5	3.52	0.69	3.46	199.9	423.6	10.10	1.99	9.95	16.7	35.3	3.5	7.4
	Thur PM	96.4	204.3	5.22	1.03	5.13	201.7	427.3	10.92	2.15	10.78	14.1	29.9	2.6	5.6
CAEW07	Wed AM	109.2	231.3	3.09	0.61	2.75	306.4	649.1	8.67	1.71	7.74	43.5	92.1	21.5	45.5
	Wed PM	213.1	451.6	6.42	1.26	5.72	436.1	923.9	13.15	2.59	11.75	10.7	22.7	1.7	3.5
	Thur AM	45.4	96.2	1.17	0.23	1.05	164.7	349.0	4.26	0.84	3.80	68.9	146.0	53.3	112.9
	Thur PM	206.8	438.2	6.23	1.23	5.55	762.4	1615.1	22.98	4.52	20.50				

		OUTDOOR AIRFLOW													
		CO_2 Ratio					Uncertainty in CO_2 ratio OA					Peak CO_2		Uncertainty in peak CO_2 OA	
Study Space ID	Period	L/s•person	cfm/person	L/s•m²	cfm/ft²	h⁻¹	L/s•person	cfm/person	L/s•m²	cfm/ft²	h⁻¹	L/s•person	cfm/person	L/s•person	cfm/person
CAEW09	Wed AM	14.2	30.0	0.21	0.04	0.19	101.0	214.0	1.52	0.30	1.36				
	Wed PM	22.5	47.6	0.69	0.14	0.61	36.9	78.2	1.13	0.22	1.01	17.4	36.8	3.8	8.0
	Thur AM	62.8	133.1	0.96	0.19	0.85	248.6	526.6	3.78	0.74	3.37				
	Thur PM	21.6	45.7	0.50	0.10	0.44	37.0	78.3	0.85	0.17	0.76	19.0	40.2	4.4	9.4
CAJS01	Wed AM														
	Wed PM														
	Thur AM	21.2	45.0	0.67	0.13	0.62	27.7	58.6	0.79	0.16	0.82				
	Thur PM	35.3	74.7	1.00	0.20	0.93	51.4	109.0	1.33	0.26	1.37				
CAJS02	Wed AM			0.00	0.00	0.00			82.69	16.27	88.84	61.8	131.0	42.9	91.0
	Wed PM	224.9	476.5	10.89	2.14	11.70	900.2	1907.2	43.59	8.58	46.88	32.8	69.5	12.4	26.3
	Thur AM	91.7	194.3	4.66	0.92	5.01	349.4	740.2	17.75	3.49	19.09	79.3	167.9	70.3	149.0
	Thur PM	87.3	184.8	5.06	1.00	5.43	281.6	596.6	16.32	3.21	17.56				
CAJS03	Wed AM	18.4	38.9	0.58	0.11	0.62	327.9	694.8	10.30	2.03	11.07	74.8	158.5	62.7	132.8
	Wed PM	84.8	179.6	3.74	0.74	4.02	224.5	475.7	9.90	1.95	10.66	23.9	50.7	6.8	14.4
	Thur AM	55.4	117.3	2.07	0.41	2.23	218.1	462.0	8.16	1.61	8.78	87.1	184.6	84.9	179.9
	Thur PM	68.2	144.6	2.78	0.55	2.99	193.7	410.4	7.90	1.55	8.50				
CAJS21	Wed AM											25.4	53.8	7.4	15.7
	Wed PM											25.6	54.2	10.3	21.9
	Thur AM											31.7	67.2	11.3	23.9
	Thur PM											28.5	60.4	9.2	19.5
CAJS22	Wed AM	11.6	24.5	0.42	0.08	0.38	27.7	58.7	1.00	0.20	0.92				
	Wed PM	14.6	31.0	0.52	0.10	0.47	30.1	63.8	1.06	0.21	0.97	14.9	31.6	2.8	6.0
	Thur AM	10.7	22.7	0.32	0.06	0.29	38.2	80.9	1.12	0.22	1.03				
	Thur PM	5.3	11.3	0.20	0.04	0.19	25.2	53.3	0.97	0.19	0.89				
CAJS23	Wed AM	47.3	100.2	2.67	0.52	2.44	68.6	145.4	3.87	0.76	3.57	13.9	29.5	2.5	5.3
	Wed PM	11.2	23.7	0.59	0.12	0.54	79.4	168.2	4.21	0.83	3.85	22.5	47.7	5.9	12.5
	Thur AM	0.0	0.0	0.00	0.00	0.00	94.3	199.8	5.00	0.98	4.58	22.8	48.3	6.0	12.8
	Thur PM	0.0	0.0	0.00	0.00	0.00	119.7	253.7	5.13	1.01	4.70	16.1	34.2	3.2	6.9
CAJW18	Wed AM	47.8	101.2	1.50	0.30	1.46	85.9	182.1	2.71	0.53	2.64	12.9	27.3	2.3	4.8
	Wed PM	41.3	87.5	1.22	0.24	1.18	84.0	177.9	2.48	0.49	2.42	13.0	27.6	2.3	4.9
	Thur AM	44.3	93.9	1.17	0.23	1.13	156.0	330.4	4.11	0.81	3.99	14.9	31.6	2.9	6.1
	Thur PM	42.7	90.4	1.15	0.23	1.12	109.1	231.1	2.94	0.58	2.86	12.0	25.5	2.0	4.3
CAJW19	Wed AM	87.7	185.7	2.69	0.53	2.61	247.5	524.3	7.59	1.49	7.38	32.1	68.1	11.9	25.3
	Wed PM	113.8	241.0	3.57	0.70	3.46	228.5	484.2	7.17	1.41	6.98	27.1	57.4	8.6	18.2
	Thur AM	96.0	203.3	3.01	0.59	2.92	178.5	378.2	5.60	1.10	5.46	24.3	51.4	7.0	14.8
	Thur PM	82.4	174.6	2.59	0.51	2.51	224.7	476.0	7.05	1.39	6.85				
CAJW20	Wed AM	57.6	122.0	1.82	0.36	1.60	60.4	128.1	1.91	0.38	1.70	22.4	47.4	6.0	12.7
	Wed PM	70.6	149.6	1.97	0.39	1.74	78.7	166.7	2.20	0.43	1.96	21.7	46.0	5.7	12.0
	Thur AM	68.1	144.2	1.93	0.38	1.70	40.8	86.5	1.16	0.23	1.06	25.3	53.5	7.5	16.0
	Thur PM	60.3	127.8	1.81	0.36	1.59	47.4	100.4	1.42	0.28	1.28	21.6	45.7	5.6	11.9

		OUTDOOR AIRFLOW													
Study Space ID	Period	CO_2 Ratio					Uncertainty in CO_2 ratio OA					Peak CO_2		Uncertainty in peak CO_2 OA	
		L/s•person	cfm/person	L/s•m^2	cfm/ft^2	h^{-1}	L/s•person	cfm/person	L/s•m^2	cfm/ft^2	h^{-1}	L/s•person	cfm/person	L/s•person	cfm/person
CAJW24	Tues AM	13.1	27.7	0.89	0.18	0.85	93.3	197.6	6.39	1.26	6.09	33.8	71.6	12.8	27.0
	Tues PM	3.0	6.5	0.22	0.04	0.21	21.6	45.7	1.58	0.31	1.51	12.9	27.4	2.2	4.7
	Wed AM	13.2	28.1	0.89	0.18	0.85	94.6	200.5	6.39	1.26	6.09	28.8	61.1	9.4	19.9
	Wed PM	3.7	7.9	0.24	0.05	0.23	26.5	56.1	1.68	0.33	1.60	11.9	25.3	1.9	4.1
	Thur AM	82.8	175.4	5.67	1.12	5.40	122.8	260.1	8.41	1.66	8.06	41.3	87.4	18.8	39.8
	Thur PM	51.0	108.1	3.04	0.60	2.89	194.4	411.9	11.58	2.28	11.04	30.0	63.6	10.2	21.5
CAJW25	Wed AM	40.8	86.5	2.29	0.45	2.19	53.4	113.2	3.00	0.59	2.90	24.1	51.1	6.7	14.2
	Wed PM	74.8	158.5	4.40	0.87	4.21	87.4	185.2	5.14	1.01	4.98	28.1	59.6	9.0	19.0
	Thur AM	28.9	61.1	1.54	0.30	1.48	71.9	152.3	3.84	0.76	3.68	19.6	41.6	4.6	9.7
	Thur PM	64.6	136.8	4.33	0.85	4.14	75.5	159.9	5.06	1.00	4.89				
CAJW26	Wed AM	78.5	166.3	3.51	0.69	3.36	134.1	284.0	6.00	1.18	5.77	26.3	55.8	7.9	16.8
	Wed PM	51.8	109.7	2.96	0.58	2.83	117.3	248.4	6.71	1.32	6.44	29.2	61.9	9.7	20.5
	Thur AM	82.9	175.6	5.52	1.09	5.28	104.6	221.6	6.96	1.37	6.73	23.1	49.0	6.2	13.1
	Thur PM	92.9	196.8	5.80	1.14	5.55	82.3	174.5	5.14	1.01	5.01	33.6	71.1	12.6	26.6
COAS02	Wed AM	0.0	0.0	0.00	0.00	0.00	54.6	115.6	1.92	0.38	1.38	25.4	53.8	7.6	16.1
	Wed PM	0.0	0.0	0.00	0.00	0.00	41.9	88.8	1.42	0.28	1.02	18.9	40.1	4.4	9.4
	Thur AM	15.3	32.4	0.47	0.09	0.34	43.9	93.0	1.35	0.26	0.97	20.0	42.4	4.9	10.3
	Thur PM	17.5	37.1	0.51	0.10	0.37	50.3	106.5	1.47	0.29	1.06	18.7	39.6	4.3	9.2
COAS04	Wed AM	72.0	152.6	2.17	0.43	1.56	121.4	257.1	3.65	0.72	2.64	21.2	44.9	5.4	11.5
	Wed PM	52.4	111.0	1.61	0.32	1.16	96.4	204.1	2.96	0.58	2.14	17.2	36.4	3.7	7.8
	Thur AM	24.5	51.8	0.65	0.13	0.47	87.1	184.6	2.33	0.46	1.68	18.8	39.8	4.4	9.2
	Thur PM	0.0	0.0	0.00	0.00	0.00	95.0	201.2	2.97	0.58	2.14	16.9	35.9	3.6	7.6
COAS06	Wed AM	24.4	51.7	0.61	0.12	0.58	32.8	69.6	0.82	0.16	0.78	12.8	27.2	2.2	4.7
	Wed PM	41.2	87.2	1.17	0.23	1.12	24.3	51.5	0.69	0.14	0.69	10.0	21.1	1.5	3.1
	Thur AM	8.9	19.0	0.31	0.06	0.29	42.3	89.6	1.45	0.29	1.38	14.1	29.9	2.6	5.6
	Thur PM	6.8	14.4	0.20	0.04	0.19	26.7	56.6	0.80	0.16	0.76	11.4	24.1	1.8	3.9
FLDW07	Wed AM	0.0	0.0	0.00	0.00	0.00	53.9	114.1	1.16	0.23	0.95	14.4	30.6	2.7	5.7
	Wed PM	0.0	0.0	0.00	0.00	0.00	48.1	101.8	0.96	0.19	0.79	12.7	26.8	2.1	4.5
	Thur AM	6.5	13.8	0.13	0.02	0.10	46.0	97.6	0.90	0.18	0.74	12.0	25.5	2.0	4.2
	Thur PM	5.3	11.2	0.11	0.02	0.09	37.6	79.6	0.79	0.16	0.65	11.8	25.0	1.9	4.0
FLDW08	Wed AM	34.0	72.0	1.16	0.23	0.98	35.9	76.1	1.22	0.24	1.05	15.0	31.7	2.8	6.0
	Wed PM	28.6	60.7	1.00	0.20	0.84	34.8	73.7	1.21	0.24	1.03	14.3	30.4	2.6	5.6
	Thur AM	13.9	29.5	0.66	0.13	0.56	99.5	210.8	4.72	0.93	3.98	21.9	46.3	5.6	11.8
	Thur PM	133.2	282.3	4.64	0.91	3.91	333.9	707.3	11.63	2.29	9.83	23.2	49.1	6.2	13.2
FLDW10	Wed AM	11.9	25.1	0.59	0.12	0.58	34.6	73.4	1.74	0.34	1.71	21.4	45.3	5.4	11.4
	Wed PM	7.8	16.4	0.36	0.07	0.35	37.0	78.3	1.71	0.34	1.68	20.9	44.3	5.2	10.9
	Thur AM	7.7	16.4	0.47	0.09	0.46	22.3	47.3	1.35	0.27	1.33	16.6	35.2	3.4	7.2
	Thur PM	3.8	8.1	0.17	0.03	0.17	27.0	57.2	1.20	0.24	1.18				
FLGS01	Thur AM	22.4	47.6	0.80	0.16	0.79	30.0	63.7	1.07	0.21	1.07	15.9	33.6	3.2	6.8
	Thur PM	46.3	98.1	1.65	0.33	1.63	37.2	78.7	1.33	0.26	1.34	14.4	30.5	2.7	5.8
	Fri AM	21.9	46.3	0.69	0.13	0.67	35.4	75.1	1.11	0.22	1.10	15.6	33.0	3.1	6.6
	Fri PM	20.0	42.4	0.63	0.12	0.62	41.3	87.6	1.30	0.26	1.28	17.8	37.8	4.0	8.4

		OUTDOOR AIRFLOW													
		CO_2 Ratio					Uncertainty in CO_2 ratio OA					Peak CO_2		Uncertainty in peak CO_2 OA	
Study Space ID	**Period**	L/s•person	cfm/person	L/s•m²	cfm/ft²	h⁻¹	L/s•person	cfm/person	L/s•m²	cfm/ft²	h⁻¹	L/s•person	cfm/person	L/s•person	cfm/person
FLGS04	Wed AM	11.0	23.2	0.61	0.12	0.60	20.2	42.8	1.13	0.22	1.12	9.9	21.0	1.5	3.1
	Wed PM	6.1	13.0	0.32	0.06	0.31	19.3	40.9	1.00	0.20	0.99	8.4	17.8	1.2	2.4
	Thur AM	16.6	35.1	0.81	0.16	0.80	23.1	48.9	1.13	0.22	1.12	9.6	20.3	1.4	3.0
	Thur PM	6.6	13.9	0.32	0.06	0.32	21.2	45.0	1.04	0.20	1.03	8.8	18.6	1.2	2.6
FLGS11	Wed AM	3.1	6.7	0.09	0.02	0.10	13.7	29.0	0.37	0.07	0.42				
	Wed PM	3.9	8.4	0.10	0.02	0.11	11.5	24.5	0.28	0.06	0.32				
	Thur AM	7.1	14.9	0.18	0.04	0.20	12.7	26.9	0.32	0.06	0.37				
	Thur PM	4.9	10.4	0.12	0.02	0.14	12.4	26.2	0.31	0.06	0.35	6.8	14.4	0.8	1.8
FLGS12	Wed AM											12.5	26.5	2.1	4.4
	Wed PM	25.2	53.3	1.09	0.21	1.16	36.5	77.3	1.58	0.31	1.70	8.9	18.9	1.2	2.6
	Thur AM	16.2	34.3	0.69	0.13	0.73	46.2	97.9	1.95	0.38	2.10	11.2	23.7	1.8	3.7
	Thur PM	22.7	48.2	1.23	0.24	1.32	24.1	51.0	1.30	0.26	1.41	9.1	19.4	1.3	2.7
GADS01	Wed AM	20.7	43.9	0.61	0.12	0.57	60.6	128.4	1.77	0.35	1.68	22.4	47.5	5.9	12.4
	Wed PM	40.4	85.6	0.95	0.19	0.90	76.7	162.4	1.80	0.35	1.71	18.2	38.5	4.0	8.5
	Thur AM	32.9	69.6	0.81	0.16	0.77	61.7	130.8	1.53	0.30	1.45	27.5	58.3	8.6	18.2
	Thur PM	51.5	109.2	1.25	0.25	1.19	82.4	174.6	2.01	0.39	1.91				
GADS02	Wed AM	25.9	55.0	0.45	0.09	0.43	43.7	92.7	0.77	0.15	0.73	14.2	30.0	2.6	5.5
	Wed PM	29.0	61.3	0.60	0.12	0.57	29.6	62.7	0.61	0.12	0.59	14.4	30.5	2.7	5.6
	Thur AM	17.3	36.7	0.32	0.06	0.30	49.5	104.8	0.91	0.18	0.86	17.6	37.3	3.8	8.0
	Thur PM	36.4	77.2	0.69	0.14	0.65	39.6	83.8	0.75	0.15	0.72				
GADS03	Wed AM	13.3	28.3	0.53	0.10	0.53	18.3	38.8	0.72	0.14	0.73	7.7	16.4	1.0	2.1
	Wed PM	0.0	0.0	0.00	0.00	0.00	11.8	25.1	0.56	0.11	0.56	6.5	13.7	0.8	1.7
	Thur AM	6.2	13.0	0.27	0.05	0.27	17.5	37.0	0.76	0.15	0.76	9.3	19.6	1.3	2.8
	Thur PM	0.0	0.0	0.00	0.00	0.00	14.1	29.9	0.57	0.11	0.57				
ILBS01	Wed AM	31.9	67.7	1.09	0.21	1.08	40.0	84.8	1.36	0.27	1.37	15.8	33.5	3.1	6.6
	Wed PM	23.6	50.0	0.76	0.15	0.75	36.8	78.0	1.18	0.23	1.18	12.0	25.5	2.0	4.2
	Thur AM	16.2	34.4	0.46	0.09	0.46	60.1	127.4	1.71	0.34	1.71	14.4	30.5	2.7	5.6
	Thur PM	14.9	31.6	0.39	0.08	0.38	34.3	72.6	0.88	0.17	0.88	11.3	24.0	1.8	3.8
ILBS02	Wed AM	0.0	0.0	0.00	0.00	0.00	141.1	298.9	4.73	0.93	5.33	26.8	56.8	8.2	17.3
	Wed PM	19.1	40.5	0.56	0.11	0.64	135.6	287.4	3.99	0.79	4.51	25.3	53.5	7.3	15.5
	Thur AM	39.9	84.4	0.89	0.18	1.00	284.1	601.9	6.35	1.25	7.16	29.2	61.9	9.7	20.5
	Thur PM	0.0	0.0	0.00	0.00	0.00	246.0	521.2	5.75	1.13	6.48				
ILBS03	Wed AM	128.8	272.9	3.42	0.67	3.51	192.9	408.6	5.12	1.01	5.30	23.1	49.0	6.2	13.1
	Wed PM	91.3	193.4	3.06	0.60	3.14	134.9	285.7	4.52	0.89	4.68	18.0	38.1	3.9	8.3
	Thur AM	156.0	330.6	3.45	0.68	3.55	233.7	495.0	5.17	1.02	5.35	42.3	89.5	19.7	41.7
	Thur PM	52.3	110.7	1.65	0.32	1.70	150.1	318.0	4.74	0.93	4.88				
LAGW04	Wed AM	74.7	158.3	1.83	0.36	1.88	159.9	338.8	3.92	0.77	4.04	16.3	34.6	3.4	7.2
	Wed PM	10.8	22.8	0.28	0.06	0.29	78.9	167.2	2.08	0.41	2.14	10.2	21.5	1.5	3.2
	Thur AM	49.0	103.9	1.16	0.23	1.20	64.7	137.0	1.53	0.30	1.59	14.6	31.0	2.8	5.9
	Thur PM	32.9	69.6	0.77	0.15	0.79	70.4	149.1	1.64	0.32	1.70				

Study Space ID	Period	OUTDOOR AIRFLOW													
		CO_2 Ratio					Uncertainty in CO_2 ratio OA					**Peak CO_2**		Uncertainty in peak CO_2 OA	
		L/s•person	cfm/person	L/s•m²	cfm/ft²	h⁻¹	L/s•person	cfm/person	L/s•m²	cfm/ft²	h⁻¹	L/s•person	cfm/person	L/s•person	cfm/person
LAGW05	Wed AM											11.0	23.3	1.7	3.7
	Wed PM											11.0	23.2	1.7	3.7
	Thur AM											12.2	25.8	2.1	4.3
	Thur PM											12.9	27.3	2.2	4.8
LAGW06	Wed AM											12.9	27.4	2.3	4.8
	Wed PM											12.6	26.7	2.2	4.6
	Thur AM											12.2	26.0	2.1	4.4
	Thur PM											12.0	25.4	2.0	4.2
MABW05	Wed AM	4.5	9.6	0.15	0.03	0.14	4.6	9.7	0.15	0.03	0.14	9.8	20.8	1.4	3.1
	Wed PM	12.0	25.3	0.36	0.07	0.33	7.8	16.6	0.23	0.05	0.22	8.4	17.7	1.1	2.4
	Thur AM	13.2	27.9	0.43	0.09	0.40	8.7	18.3	0.28	0.06	0.27	10.6	22.4	1.6	3.4
	Thur PM	9.8	20.7	0.31	0.06	0.28	7.2	15.3	0.23	0.04	0.22	9.5	20.2	1.4	2.9
MABW06	Wed AM	36.2	76.7	1.91	0.38	1.91	28.6	60.5	1.51	0.30	1.55	22.3	47.2	6.0	12.6
	Wed PM	39.4	83.5	2.03	0.40	2.04	30.9	65.4	1.59	0.31	1.64	18.1	38.4	4.1	8.6
	Thur AM	35.6	75.4	1.58	0.31	1.58	25.8	54.6	1.14	0.22	1.18	16.5	35.0	3.4	7.3
	Thur PM	25.9	54.8	1.42	0.28	1.42	13.7	29.1	0.75	0.15	0.79	15.8	33.4	3.2	6.7
MABW08	Wed AM	46.3	98.0	2.82	0.55	2.83	46.2	97.8	2.81	0.55	2.86	24.6	52.1	7.2	15.2
	Wed PM	41.6	88.1	3.22	0.63	3.23	29.1	61.8	2.25	0.44	2.33	29.1	61.7	9.9	20.9
	Thur AM	37.7	79.9	2.83	0.56	2.84	36.7	77.7	2.75	0.54	2.80	32.0	67.7	11.8	25.0
	Thur PM	34.2	72.4	2.88	0.57	2.89	33.3	70.6	2.81	0.55	2.86	31.4	66.6	11.4	24.2
MDDS01	Wed AM	17.8	37.6	0.70	0.14	0.53	79.3	168.1	3.12	0.61	2.37	23.4	49.7	6.4	13.5
	Wed PM	122.2	259.0	3.06	0.60	2.33	764.0	1618.6	19.10	3.76	14.54	27.3	57.8	8.5	17.9
	Thur AM	12.4	26.3	0.40	0.08	0.30	97.9	207.3	3.15	0.62	2.39	35.6	75.3	14.1	29.8
	Thur PM	0.0	0.0	0.00	0.00	0.00	94.1	199.4	3.36	0.66	2.56	30.8	65.2	10.7	22.6
MDDS03	Wed AM	12.3	26.1	0.60	0.12	0.70	72.6	153.8	3.51	0.69	4.12	8.5	18.0	1.1	2.4
	Wed PM	3.5	7.3	0.16	0.03	0.19	10.2	21.5	0.48	0.09	0.56	7.6	16.0	1.0	2.1
	Thur AM	2.3	4.9	0.11	0.02	0.32	10.4	22.1	0.50	0.10	0.59	8.9	18.9	1.2	2.6
	Thur PM	4.4	9.3	0.18	0.04	0.18	10.0	21.2	0.41	0.08	0.47	7.9	16.8	1.0	2.2
MDDS04	Wed AM	9.8	20.7	0.41	0.08	0.33	16.7	35.4	0.70	0.14	0.57	11.1	23.5	1.7	3.6
	Wed PM	5.9	12.4	0.23	0.05	0.19	13.1	27.7	0.52	0.10	0.43	9.6	20.4	1.4	2.9
	Thur AM	10.7	22.6	0.39	0.08	0.32	15.8	33.4	0.58	0.11	0.48	10.3	21.9	1.5	3.3
	Thur PM	5.0	10.5	0.22	0.04	0.18	10.6	22.4	0.46	0.09	0.38	8.5	17.9	1.1	2.4
MIBW01	Wed AM	32.0	67.7	1.15	0.23	1.11	27.6	58.4	0.99	0.20	0.98	19.9	42.2	4.8	10.2
	Wed PM	22.1	46.9	0.88	0.17	0.85	29.2	61.8	1.16	0.23	1.13	18.2	38.5	4.1	8.7
	Thur AM	15.2	32.1	0.61	0.12	0.59	34.9	74.0	1.41	0.28	1.37	18.1	38.3	4.1	8.6
	Thur PM	31.7	67.1	1.12	0.22	1.09	34.0	72.1	1.21	0.24	1.18	18.8	39.8	4.4	9.2
MIBW03	Wed AM	31.6	67.0	1.34	0.26	1.34	46.4	98.4	1.97	0.39	1.99	19.9	42.2	4.9	10.3
	Wed PM	34.3	72.7	1.89	0.37	1.89	43.3	91.7	2.38	0.47	2.40	18.7	39.5	4.3	9.1
	Thur AM	35.1	74.3	1.71	0.34	1.71	52.3	110.8	2.55	0.50	2.57	21.4	45.2	5.5	11.7
	Thur PM	49.1	104.1	3.11	0.61	3.11	42.6	90.3	2.70	0.53	2.75	18.4	39.0	4.2	8.9

		OUTDOOR AIRFLOW													
		CO_2 Ratio					Uncertainty in CO_2 ratio OA					**Peak CO_2**		Uncertainty in peak CO_2 OA	
Study Space ID	**Period**	L/s•person	cfm/person	L/s•m^2	cfm/ft^2	h^{-1}	L/s•person	cfm/person	L/s•m^2	cfm/ft^2	h^{-1}	L/s•person	cfm/person	L/s•person	cfm/person
MIBW04	Wed AM	22.8	48.3	1.02	0.20	1.02	19.0	40.3	0.85	0.17	0.87	21.9	46.4	5.8	12.2
	Wed PM	24.4	51.7	1.02	0.20	1.02	24.0	50.8	1.00	0.20	1.01	21.8	46.2	5.7	12.1
	Thur AM	17.8	37.8	0.71	0.14	0.71	24.5	51.9	0.97	0.19	0.98	20.3	43.0	5.0	10.6
	Thur PM	37.8	80.0	1.11	0.22	1.11	39.1	82.7	1.15	0.23	1.17	20.6	43.7	5.2	10.9
MNBW01	Wed AM	73.4	155.5	1.41	0.28	1.38	58.9	124.9	1.13	0.22	1.14	17.2	36.4	3.7	7.9
	Wed PM	69.7	147.7	1.29	0.25	1.27	71.6	151.7	1.32	0.26	1.32	15.4	32.6	3.1	6.5
	Thur AM	52.9	112.0	0.94	0.19	0.93	79.2	167.8	1.41	0.28	1.40	18.3	38.8	4.2	8.8
	Thur PM	87.8	185.9	1.33	0.26	1.31	90.9	192.5	1.38	0.27	1.38	18.0	38.1	4.0	8.5
MNBW02	Wed AM	58.1	123.2	1.20	0.24	1.28	73.0	154.6	1.51	0.30	1.63	29.4	62.4	10.1	21.4
	Wed PM	58.7	124.5	1.54	0.30	1.64	95.8	203.0	2.50	0.49	2.70	29.8	63.2	10.3	21.9
	Thur AM	38.8	82.3	1.07	0.21	1.14	61.1	129.4	1.68	0.33	1.81	28.3	60.0	9.4	19.8
	Thur PM	63.5	134.5	1.53	0.30	1.64	114.5	242.5	2.75	0.54	2.96	41.1	87.1	19.2	40.7
MNBW04	Wed AM	107.6	228.0	1.93	0.38	2.12	65.1	137.8	1.17	0.23	1.33	20.2	42.8	5.2	11.1
	Wed PM	300.5	636.7	2.79	0.55	3.06	229.1	485.3	2.12	0.42	2.39	44.7	94.8	24.0	50.9
	Thur AM	106.8	226.2	2.29	0.45	2.51	97.0	205.5	2.08	0.41	2.32	30.5	64.7	11.4	24.2
	Thur PM	103.1	218.5	2.27	0.45	2.49	76.3	161.7	1.68	0.33	1.89	36.2	76.6	15.8	33.6
MOCS01	Wed AM	14.9	31.7	0.52	0.10	0.57	21.7	46.0	0.76	0.15	0.84	19.4	41.1	4.6	9.8
	Wed PM	24.1	51.1	0.84	0.17	0.93	24.0	50.8	0.84	0.17	0.93	21.9	46.3	5.8	12.2
	Thur AM	14.8	31.3	0.59	0.12	0.65	26.8	56.7	1.07	0.21	1.18	21.8	46.1	5.7	12.1
	Thur PM	18.2	38.6	0.61	0.12	0.67	26.5	56.1	0.89	0.18	0.99				
MOCS05	Wed AM	32.3	68.4	1.03	0.20	0.92	48.5	102.7	1.55	0.30	1.39	29.9	63.3	10.4	22.0
	Wed PM	25.9	54.9	0.79	0.16	0.70	41.2	87.2	1.25	0.25	1.12	27.2	57.7	8.7	18.4
	Thur AM	24.1	51.0	0.70	0.14	0.62	35.4	74.9	1.02	0.20	0.92	22.3	47.3	6.0	12.7
	Thur PM	17.6	37.3	0.58	0.11	0.51	21.5	45.4	0.70	0.14	0.63	18.7	39.6	4.3	9.1
NCDW02	Wed AM	88.4	187.2	2.26	0.45	2.94	97.7	206.9	2.50	0.49	3.29	24.5	51.9	6.9	14.7
	Wed PM	76.7	162.6	2.31	0.45	3.00	83.5	176.9	2.52	0.50	3.31	31.3	66.3	11.0	23.3
	Thur AM	32.6	69.0	1.21	0.24	1.57	55.1	116.8	2.05	0.40	2.68	25.8	54.6	7.6	16.1
	Thur PM	51.9	110.0	1.98	0.39	2.57	64.6	136.9	2.47	0.49	3.23	30.5	64.7	10.5	22.2
NCDW03	Wed AM											15.8	33.6	3.1	6.6
	Wed PM											13.0	27.6	2.2	4.8
	Thur AM											11.9	25.2	1.9	4.1
	Thur PM											14.5	30.6	2.7	5.7
NCDW06	Wed AM	50.6	107.2	2.81	0.55	2.55	37.3	78.9	2.07	0.41	1.93	18.2	38.5	4.0	8.5
	Wed PM	42.3	89.6	2.76	0.54	2.51	54.7	115.9	3.57	0.70	3.28	17.5	37.1	3.7	7.9
	Thur AM	35.0	74.2	2.57	0.51	2.33	31.7	67.2	2.32	0.46	2.15	22.8	48.3	6.0	12.8
	Thur PM	30.2	64.0	1.91	0.38	1.74	30.5	64.5	1.93	0.38	1.78	17.4	37.0	3.7	7.9
NECW01	Wed AM	27.6	58.6	1.39	0.27	1.05	22.4	47.5	1.13	0.22	0.87	19.2	40.7	4.5	9.6
	Wed PM	36.4	77.1	1.79	0.35	1.35	36.7	77.8	1.80	0.36	1.38	22.1	46.7	5.8	12.4
	Thur AM	28.6	60.6	1.52	0.30	1.15	26.8	56.8	1.42	0.28	1.09	21.5	45.5	5.6	11.8
	Thur PM			1.98	0.39	1.49			2.09	0.41	1.60	25.0	52.9	7.4	15.6

		OUTDOOR AIRFLOW																
		CO_2 Ratio					Uncertainty in CO_2 ratio OA					**Peak CO_2**		Uncertainty in peak CO_2 OA	
Study Space ID	**Period**	L/s•person	cfm/person	L/s•m²	cfm/ft²	h⁻¹	L/s•person	cfm/person	L/s•m²	cfm/ft²	h⁻¹	L/s•person	cfm/person	L/s•person	cfm/person
NECW02	Wed AM	201.1	426.0	5.74	1.13	4.34	497.1	1053.2	14.19	2.79	10.76	70.2	148.6	55.2	116.9
	Wed PM	128.5	272.2	4.22	0.83	3.19	219.5	465.0	7.22	1.42	5.48	74.0	156.8	61.4	130.0
	Thur AM	163.1	345.5	5.78	1.14	4.37	403.2	854.2	14.30	2.81	10.84	83.1	176.0	77.2	163.5
	Thur PM	338.6	717.4	6.45	1.27	4.87	768.8	1628.9	14.63	2.88	11.10	42.2	89.3	20.2	42.8
NECW03	Wed AM	31.8	67.4	2.08	0.41	2.09	41.2	87.3	2.70	0.53	2.73	24.2	51.3	7.0	14.8
	Wed PM	38.3	81.2	2.33	0.46	2.34	65.1	138.0	3.97	0.78	4.00	30.7	65.1	11.0	23.2
	Thur AM	29.1	61.8	1.93	0.38	1.94	42.9	90.9	2.84	0.56	2.87	27.1	57.4	8.6	18.2
	Thur PM	59.2	125.5	3.88	0.76	3.89	55.2	117.0	3.62	0.71	3.69				
NMES01	Wed AM	95.0	201.2	1.98	0.39	1.98	79.6	168.7	1.66	0.33	1.70	20.6	43.6	5.0	10.6
	Wed PM	66.0	139.9	1.59	0.31	1.59	63.0	133.4	1.51	0.30	1.54	18.4	39.0	4.1	8.7
	Thur AM	86.6	183.4	1.62	0.32	1.62	69.0	146.1	1.29	0.25	1.32	22.2	47.1	5.8	12.2
	Thur PM	47.5	100.6	1.27	0.25	1.27	56.7	120.2	1.52	0.30	1.54	17.5	37.1	3.7	7.9
NMES02	Wed AM	66.2	140.2	2.65	0.52	2.47	105.0	222.5	4.21	0.83	3.95	31.3	66.3	11.0	23.3
	Wed PM	158.9	336.7	5.69	1.12	5.31	106.6	225.9	3.82	0.75	3.68	24.0	50.8	6.6	14.1
	Thur AM	158.7	336.3	5.82	1.15	5.43	259.7	550.3	9.52	1.87	8.93	35.2	74.6	13.8	29.2
	Thur PM	107.4	227.5	4.12	0.81	3.84	153.5	325.2	5.89	1.16	5.53	34.2	72.4	13.0	27.6
NMES03	Wed AM	12.6	26.8	0.77	0.15	0.72	15.7	33.2	0.96	0.19	0.90	12.9	27.4	2.2	4.7
	Wed PM	33.0	70.0	1.29	0.25	1.20	32.4	68.6	1.26	0.25	1.20	12.1	25.7	2.0	4.2
	Thur AM	21.2	45.0	0.96	0.19	0.89	23.2	49.0	1.04	0.21	0.99	11.0	23.4	1.7	3.6
	Thur PM	25.2	53.3	1.05	0.21	0.98	23.6	50.0	0.99	0.19	0.93				
NVAW01	Wed AM	138.1	292.5	5.74	1.13	6.03	217.7	461.3	9.06	1.78	9.56	36.0	76.2	14.8	31.4
	Wed PM	136.6	289.5	5.80	1.14	6.09	216.1	457.8	9.17	1.80	9.68	34.7	73.5	13.8	29.3
	Thur AM	110.1	233.3	4.67	0.92	4.90	211.3	447.6	8.97	1.77	9.45	34.3	72.7	13.5	28.7
	Thur PM	91.5	193.9	3.42	0.67	3.59	145.6	308.5	5.44	1.07	5.74	29.3	62.1	10.0	21.2
NVAW02	Wed AM	57.0	120.7	2.72	0.53	2.57	67.6	143.2	3.22	0.63	3.08	31.5	66.8	11.5	24.4
	Wed PM	138.0	292.3	4.63	0.91	4.38	140.0	296.7	4.70	0.93	4.50	30.7	65.0	10.9	23.1
	Thur AM	138.4	293.3	4.04	0.79	3.81	554.3	1174.3	16.16	3.18	15.28	25.2	53.3	7.5	15.8
	Thur PM	43.5	92.1	1.54	0.30	1.45	129.9	275.1	4.59	0.90	4.34	20.2	42.7	5.0	10.5
NVAW03	Wed AM	92.0	194.9	3.90	0.77	3.69	255.6	541.5	10.84	2.13	10.26	33.4	70.8	12.9	27.3
	Wed PM	98.9	209.6	4.97	0.98	4.70	199.0	421.6	10.01	1.97	9.49	39.7	84.2	18.0	38.1
	Thur AM	49.3	104.4	3.40	0.67	3.21	83.5	176.9	5.76	1.13	5.47	42.3	89.5	20.3	43.0
	Thur PM	88.3	187.0	5.14	1.01	4.85	249.5	528.5	14.52	2.86	13.74	55.5	117.6	34.7	73.6
NYBS01	Wed AM	51.6	109.4	2.02	0.40	2.08	105.6	223.8	4.14	0.82	4.28	25.4	53.8	7.4	15.6
	Wed PM	78.2	165.6	1.84	0.36	1.89	158.1	335.0	3.72	0.73	3.84	22.8	48.3	6.0	12.8
	Thur AM	84.5	179.1	2.43	0.48	2.50	124.5	263.8	3.58	0.70	3.71	22.4	47.4	5.8	12.4
	Thur PM	52.1	110.4	1.98	0.39	2.03	103.9	220.1	3.94	0.78	4.07	19.1	40.5	4.4	9.3
NYBS02	Wed AM	79.9	169.2	3.10	0.61	2.81	131.8	279.2	5.11	1.01	4.67	18.1	38.4	4.0	8.4
	Wed PM	73.9	156.6	3.60	0.71	3.27	60.8	128.8	2.96	0.58	2.75	14.1	29.9	2.6	5.4
	Thur AM	48.5	102.7	2.17	0.43	1.97	56.4	119.5	2.52	0.50	2.32	16.0	33.8	3.2	6.7
	Thur PM	50.5	107.0	1.91	0.38	1.73	36.7	77.9	1.39	0.27	1.30				

		OUTDOOR AIRFLOW													
Study Space ID	Period	CO_2 Ratio					Uncertainty in CO_2 ratio OA					Peak CO_2		Uncertainty in peak CO_2 OA	
		L/s•person	cfm/person	L/s•m²	cfm/ft²	h⁻¹	L/s•person	cfm/person	L/s•m²	cfm/ft²	h⁻¹	L/s•person	cfm/person	L/s•person	cfm/person
NYBS04	Wed AM	0.0	0.0	0.00	0.00	0.00	43.0	91.0	1.81	0.36	1.83	16.9	35.9	3.5	7.5
	Wed PM	9.3	19.8	0.31	0.06	0.32	31.7	67.2	1.07	0.21	1.08	14.9	31.6	2.8	6.0
	Thur AM	49.7	105.4	2.40	0.47	2.43	68.0	144.0	3.28	0.65	3.35	13.1	27.6	2.3	4.8
	Thur PM	17.7	37.5	0.68	0.13	0.68	50.5	107.0	1.93	0.38	1.96	11.3	24.0	1.8	3.8
NYBS05	Wed AM	16.3	34.6	0.81	0.16	0.69	11.2	23.7	0.56	0.11	0.49	12.9	27.3	2.2	4.7
	Wed PM	12.0	25.5	0.56	0.11	0.48	13.7	29.1	0.64	0.13	0.55	12.2	25.9	2.0	4.3
	Thur AM	15.9	33.7	0.70	0.14	0.60	13.5	28.6	0.60	0.12	0.52	12.2	25.9	2.0	4.3
	Thur PM	17.9	37.8	0.86	0.17	0.73	10.7	22.6	0.51	0.10	0.46				
NYBS07	Wed AM	36.9	78.1	1.95	0.38	1.81	70.9	150.2	3.75	0.74	3.49	19.0	40.3	4.3	9.2
	Wed PM	58.9	124.8	2.21	0.43	2.05	58.8	124.7	2.21	0.43	2.08	22.1	46.8	5.7	12.1
	Thur AM	38.0	80.6	1.83	0.36	1.70	72.3	153.1	3.47	0.68	3.23	21.9	46.3	5.6	11.8
	Thur PM	7.4	15.8	0.30	0.06	0.28	52.8	111.9	2.13	0.42	1.98				
ORIS03	Wed AM											38.3	81.2	16.8	35.5
	Wed PM											38.2	81.0	16.7	35.4
	Thur AM											44.1	93.4	22.0	46.7
	Thur PM														
ORIS04	Wed AM											122.6	259.8	167.7	355.3
	Wed PM	69.2	146.7	2.65	0.52	2.85	147.6	312.7	5.65	1.11	6.10	41.2	87.3	19.3	40.9
	Thur AM	103.1	218.4	4.55	0.89	4.88	234.1	495.9	10.32	2.03	11.12	213.4	452.1	506.7	1073.5
	Thur PM	25.6	54.2	0.92	0.18	0.99	183.5	388.7	6.63	1.30	7.13	49.6	105.1	27.8	58.9
PABS03	Wed AM	24.1	51.1	0.69	0.14	0.68	38.9	82.4	1.11	0.22	1.10	14.4	30.5	2.7	5.8
	Wed PM	0.0	0.0	0.00	0.00	0.00	43.2	91.5	1.17	0.23	1.15	14.4	30.6	2.7	5.8
	Thur AM	10.7	22.7	0.29	0.06	0.28	38.0	80.5	1.03	0.20	1.01	13.6	28.8	2.5	5.2
	Thur PM	6.1	13.0	0.18	0.04	0.18	43.4	91.9	1.29	0.25	1.27	13.9	29.4	2.5	5.4
PABS04	Wed AM	5.9	12.6	0.44	0.09	0.42	7.8	16.5	0.58	0.11	0.55	9.6	20.3	1.4	3.0
	Wed PM	10.1	21.5	0.69	0.14	0.65	8.1	17.3	0.56	0.11	0.54	9.8	20.7	1.4	3.1
	Thur AM	9.8	20.7	0.75	0.15	0.71	8.9	18.9	0.68	0.13	0.66	10.1	21.4	1.5	3.2
	Thur PM	9.5	20.2	0.63	0.12	0.60	9.2	19.6	0.61	0.12	0.59	10.7	22.6	1.7	3.5
SCDW01	Wed AM	16.3	34.5	1.25	0.25	1.25	17.2	36.5	1.32	0.26	1.34	11.8	25.1	2.0	4.2
	Wed PM											12.0	25.4	2.0	4.2
	Thur AM	15.4	32.7	1.11	0.22	1.11	11.2	23.7	0.80	0.16	0.83	12.0	25.5	2.0	4.3
	Thur PM	13.3	28.2	0.87	0.17	0.86	11.3	24.0	0.74	0.14	0.75				
SCDW02	Wed AM	41.1	87.0	2.16	0.43	1.81	60.8	128.9	3.21	0.63	2.70	19.3	40.9	4.6	9.7
	Wed PM	34.7	73.5	2.05	0.40	1.71	50.9	107.9	3.00	0.59	2.53	9.5	20.1	1.4	2.9
	Thur AM	35.8	75.9	2.11	0.42	1.76	53.0	112.3	3.13	0.62	2.63	19.9	42.1	4.8	10.2
	Thur PM	73.0	154.6	3.85	0.76	3.21	78.0	165.2	4.11	0.81	3.48	15.0	31.8	2.9	6.2
SDBW01	Wed AM	36.3	76.9	1.49	0.29	1.65	37.0	78.5	1.52	0.30	1.71	18.3	38.7	4.0	8.6
	Wed PM	58.8	124.5	1.95	0.38	2.16	58.0	122.9	1.93	0.38	2.17	19.1	40.5	4.4	9.3
	Thur AM	34.9	73.9	1.28	0.25	1.42	40.2	85.2	1.48	0.29	1.66	17.7	37.5	3.8	8.1
	Thur PM	50.5	107.0	1.86	0.37	2.06	52.8	111.8	1.94	0.38	2.18	19.5	41.2	4.5	9.6

		OUTDOOR AIRFLOW													
		CO_2 Ratio					Uncertainty in CO_2 ratio OA					Peak CO_2		Uncertainty in peak CO_2 OA	
Study Space ID	**Period**	L/s•person	cfm/person	L/s•m²	cfm/ft²	h⁻¹	L/s•person	cfm/person	L/s•m²	cfm/ft²	h⁻¹	L/s•person	cfm/person	L/s•person	cfm/person
SDBW02	Wed AM	49.9	105.8	1.63	0.32	1.80	39.6	83.9	1.29	0.25	1.46	16.6	35.2	3.4	7.2
	Wed PM	80.8	171.3	1.48	0.29	1.64	64.1	135.8	1.18	0.23	1.33	20.2	42.9	4.9	10.3
	Thur AM	41.5	88.0	1.21	0.24	1.34	62.3	132.1	1.82	0.36	2.03	18.7	39.7	4.2	8.9
	Thur PM	33.7	71.4	0.84	0.17	0.93	49.5	104.8	1.24	0.24	1.38				
SDBW04	Wed AM	20.6	43.6	1.05	0.21	1.17	97.5	206.6	4.96	0.98	5.55	19.0	40.2	4.3	9.2
	Wed PM	32.3	68.3	1.09	0.22	1.22	153.1	324.4	5.19	1.02	5.81	20.0	42.3	4.7	10.0
	Thur AM	31.5	66.8	1.28	0.25	1.43	112.6	238.5	4.56	0.90	5.11	26.5	56.2	8.0	17.0
	Thur PM	30.2	64.1	1.51	0.30	1.69	86.8	183.9	4.33	0.85	4.85	23.8	50.4	6.5	13.8
TNDS05	Wed AM											18.1	38.4	4.1	8.6
	Wed PM											21.3	45.1	5.5	11.6
	Thur AM											20.2	42.9	5.0	10.6
	Thur PM											26.4	55.9	8.2	17.4
TNDS06	Wed AM	22.4	47.5	0.73	0.14	0.66	28.2	59.7	0.91	0.18	0.83	13.8	29.2	2.5	5.3
	Wed PM	26.2	55.6	0.75	0.15	0.68	22.7	48.1	0.65	0.13	0.60	13.3	28.2	2.4	5.1
	Thur AM	8.7	18.4	0.43	0.08	0.39	12.7	26.8	0.63	0.12	0.57	15.8	33.4	3.2	6.7
	Thur PM	13.1	27.7	0.47	0.09	0.43	19.1	40.5	0.69	0.14	0.63	13.6	28.9	2.5	5.2
TNDS07	Wed AM	0.0	0.0	0.00	0.00	0.00	93.4	197.8	3.94	0.78	4.24	23.0	48.7	6.3	13.4
	Wed PM	17.6	37.3	1.07	0.21	1.15	50.9	107.8	3.10	0.61	3.34	19.5	41.3	4.6	9.8
	Thur AM	0.0	0.0	0.00	0.00	0.00	49.8	105.5	3.16	0.62	3.39	18.2	38.6	4.1	8.7
	Thur PM	0.0	0.0	0.00	0.00	0.00	65.4	138.6	3.98	0.78	4.28	18.1	38.4	4.1	8.6
TNFS08	Wed AM	17.0	36.1	0.94	0.19	1.01	8.7	18.4	0.48	0.09	0.54	10.5	22.3	1.6	3.4
	Wed PM	18.7	39.6	0.77	0.15	0.83	11.7	24.8	0.48	0.10	0.54	10.0	21.2	1.5	3.1
	Thur AM	13.9	29.4	0.77	0.15	0.82	9.9	20.9	0.55	0.11	0.60	10.2	21.7	1.5	3.2
	Thur PM	14.7	31.2	0.80	0.16	0.86	12.3	26.1	0.67	0.13	0.74	10.1	21.4	1.5	3.2
TNFS09	Wed AM	7.2	15.2	0.62	0.12	0.64	8.1	17.1	0.70	0.14	0.73	10.1	21.4	1.5	3.2
	Wed PM	6.3	13.3	0.40	0.08	0.41	9.4	20.0	0.59	0.12	0.61	9.2	19.6	1.3	2.8
	Thur AM	6.4	13.6	0.50	0.10	0.51	7.4	15.6	0.57	0.11	0.60	9.9	21.0	1.5	3.1
	Thur PM	5.8	12.3	0.45	0.09	0.46	5.1	10.8	0.39	0.08	0.41	8.4	17.9	1.1	2.4
TNFS10	Wed AM	78.3	165.8	3.93	0.77	3.26	85.1	180.3	4.28	0.84	3.58	23.8	50.5	6.6	13.9
	Wed PM	62.5	132.4	3.25	0.64	2.69	121.3	257.1	6.31	1.24	5.24	21.1	44.6	5.2	11.1
	Thur AM	89.0	188.6	4.16	0.82	3.44	84.9	179.9	3.97	0.78	3.34	28.1	59.6	9.0	19.0
	Thur PM	60.8	128.9	3.22	0.63	2.66	108.7	230.2	5.75	1.13	4.78	26.1	55.2	7.8	16.4
TXFS01	Wed AM	6.6	14.0	0.22	0.04	0.18	18.8	39.7	0.62	0.12	0.51	13.1	27.7	2.3	4.9
	Wed PM	7.4	15.7	0.25	0.05	0.21	17.0	36.0	0.58	0.11	0.48	8.8	18.7	1.2	2.6
	Thur AM	7.6	16.1	0.31	0.06	0.25	21.9	46.4	0.88	0.17	0.73	13.7	29.1	2.5	5.3
	Thur PM	9.6	20.4	0.26	0.05	0.22	22.7	48.2	0.62	0.12	0.52				
TXFS02	Wed AM	10.4	21.9	0.30	0.06	0.33	30.0	63.6	0.86	0.17	0.97	13.0	27.5	2.3	4.8
	Wed PM	0.0	0.0	0.00	0.00	0.00	34.6	73.4	0.83	0.16	0.94	10.6	22.4	1.6	3.5
	Thur AM	0.0	0.0	0.00	0.00	0.00	38.6	81.8	1.22	0.24	1.37	13.8	29.2	2.5	5.4
	Thur PM	3.4	7.1	0.07	0.01	0.08	33.8	71.6	0.72	0.14	0.81	10.5	22.3	1.6	3.4

Study Space ID	Period	OUTDOOR AIRFLOW													
		CO_2 Ratio					Uncertainty in CO_2 ratio OA					**Peak CO_2**		Uncertainty in peak CO_2 OA	
		L/s•person	cfm/person	L/s•m^2	cfm/ft^2	h^{-1}	L/s•person	cfm/person	L/s•m^2	cfm/ft^2	h^{-1}	L/s•person	cfm/person	L/s•person	cfm/person
TXFS07	Wed AM	6.5	13.8	0.56	0.11	0.65	17.9	38.0	1.54	0.30	1.77	13.4	28.5	2.4	5.0
	Wed PM	13.3	28.2	1.13	0.22	1.30	16.3	34.6	1.39	0.27	1.61	12.0	25.5	2.0	4.2
	Thur AM	11.2	23.8	0.94	0.19	1.08	13.7	29.0	1.15	0.23	1.33	12.7	26.8	2.1	4.5
	Thur PM	7.7	16.3	0.75	0.15	0.86	13.9	29.3	1.35	0.27	1.56	12.8	27.2	2.2	4.6
TXFS08	Wed AM	8.5	18.1	0.31	0.06	0.35	13.5	28.5	0.49	0.10	0.56	8.7	18.4	1.2	2.5
	Wed PM	8.9	19.0	0.32	0.06	0.37	14.5	30.7	0.52	0.10	0.60	6.4	13.5	0.8	1.6
	Thur AM	9.5	20.2	0.27	0.05	0.31	20.3	43.0	0.58	0.11	0.67	8.0	17.0	1.1	2.2
	Thur PM	10.9	23.0	0.41	0.08	0.46	11.2	23.8	0.42	0.08	0.49				
TXFS09	Wed AM	21.2	44.9	0.61	0.12	0.59	21.6	45.7	0.63	0.12	0.61	8.1	17.1	1.1	2.3
	Wed PM	35.3	74.8	0.86	0.17	0.82	13.9	29.5	0.34	0.07	0.35	6.3	13.4	0.8	1.6
	Thur AM	20.8	44.2	0.54	0.11	0.52	21.2	44.8	0.55	0.11	0.54	8.3	17.6	1.1	2.4
	Thur PM	19.3	40.9	0.54	0.11	0.52	13.2	28.0	0.37	0.07	0.37				
TXFW05	Wed AM	26.9	57.0	1.02	0.20	1.16	34.3	72.6	1.31	0.26	1.50	20.1	42.5	4.9	10.4
	Wed PM	18.7	39.6	0.76	0.15	0.87	28.7	60.7	1.17	0.23	1.34	14.2	30.0	2.6	5.6
	Thur AM	9.1	19.3	0.38	0.07	0.43	26.1	55.3	1.08	0.21	1.23	29.8	63.2	10.3	21.9
	Thur PM	20.8	44.1	0.78	0.15	0.89	31.2	66.2	1.17	0.23	1.34	25.7	54.4	7.8	16.5
TXFW06	Wed AM	95.5	202.3	2.26	0.45	2.57	163.2	345.7	3.86	0.76	4.41	34.3	72.7	13.5	28.7
	Wed PM	131.0	277.5	2.85	0.56	3.23	176.1	373.0	3.83	0.75	4.38	22.8	48.2	6.2	13.1
	Thur AM	93.0	197.1	2.32	0.46	2.64	85.8	181.7	2.14	0.42	2.48	20.6	43.6	5.1	10.9
	Thur PM	160.6	340.2	2.61	0.51	2.96	148.1	313.7	2.40	0.47	2.78	17.8	37.6	3.9	8.3
WAIW03	Wed AM	35.4	75.0	1.22	0.24	1.25	21.8	46.2	0.75	0.15	0.80	16.1	34.2	3.3	7.0
	Wed PM	72.4	153.4	2.00	0.39	2.06	47.9	101.5	1.32	0.26	1.41	14.4	30.5	2.7	5.8
	Thur AM	46.0	97.5	1.61	0.32	1.65	46.6	98.8	1.63	0.32	1.70	17.5	37.1	3.8	8.1
	Thur PM	70.8	150.0	1.96	0.39	2.01	53.5	113.3	1.48	0.29	1.56	16.8	35.6	3.6	7.5
WAIW04	Wed AM	36.2	76.8	0.77	0.15	0.74	40.2	85.1	0.86	0.17	0.83	14.2	30.0	2.6	5.6
	Wed PM	40.9	86.6	1.07	0.21	1.03	30.7	65.0	0.80	0.16	0.79	13.6	28.8	2.5	5.2
	Thur AM	25.3	53.7	0.64	0.13	0.62	26.9	57.1	0.68	0.13	0.66	14.7	31.2	2.8	6.0
	Thur PM	29.3	62.0	0.72	0.14	0.69	24.2	51.3	0.60	0.12	0.58	13.6	28.9	2.5	5.2
# of values		356		358		358						353			
Mean		44.3	93.8	1.59	0.31	1.54	84.5	179.0	3.27	0.64	3.22	21.4	45.3	8.5	18.1
StdDev		47.4	100.5	1.55	0.31	1.51	111.1	235.4	5.76	1.13	5.98	16.6	35.3	29.7	62.9
Minimum		0.0	0.0	0.00	0.00	0.00	4.6	9.7	0.15	0.03	0.14	6.3	13.4	0.8	1.6
10th percentile		5.3	11.3	0.20	0.04	0.19	13.6	28.8	0.60	0.12	0.58	10.0	21.3	1.5	3.1
25th percentile		12.2	25.9	0.52	0.10	0.47	26.0	55.1	0.97	0.19	0.93	12.8	27.2	2.2	4.7
Median		30.9	65.4	1.06	0.21	1.05	48.0	101.6	1.59	0.31	1.63	18.1	38.4	4.1	8.6
75th percentile		59.0	125.0	2.17	0.43	2.15	95.3	202.0	3.84	0.76	3.69	25.0	53.0	7.3	15.5
90th percentile		95.7	202.8	3.89	0.77	3.56	199.5	422.6	6.99	1.38	6.89	33.3	70.7	12.6	26.6
Maximum		338.6	717.4	10.89	2.14	11.70	900.2	1907.2	82.69	16.27	88.84	213.4	452.1	506.7	1073.5

Appendix F: Reanalysis of BASE Ventilation Data

This appendix presents the letter report published in October 2008 discussing the BASE ventilation data reanalysis that led to the revision of the original (2004) NIST report.

Reanalysis of BASE Ventilation Data

Letter Report to U.S. Environmental Protection Agency
October 10, 2008

Andrew Persily
Building and Fire Research Laboratory
National Institute of Standards and Technology

ABSTRACT
In 2004, the National Institute of Standards and Technology (NIST) published an analysis of the ventilation data collected as part of the U.S. Environmental Protection Agency (EPA) Building Assessment Survey and Evaluation (BASE) study [1]. That analysis provided a unique dataset of office building ventilation rates, both design and measured, along with many insights into building ventilation. The analysis also raised questions regarding the use of the difference between peak indoor carbon dioxide (CO_2) concentrations and the corresponding outdoor CO_2 concentrations to estimate building ventilation rates, as there was a systematic difference between the ventilation rates based on this method and those based on duct traverse measurements. The current study examined the discrepancies between the peak indoor CO_2-based and traverse-based ventilation rates in more detail. In addition, the overall ventilation rate dataset was re-examined for consistency and, as a result, some errors were corrected.

SUMMARY OF ANALYSIS AND REPORT CONTENT

The BASE ventilation data reanalysis effort focused on two primary areas: 1) general corrections and adjustments to the original data; and 2) the disagreement between the outdoor air ventilation rates based on peak indoor CO_2 concentrations and those based on traverse measurements at the air handlers (sometimes referred to as volumetric rates). The corrections involved a detailed review of the data files generated by National Institute of Standards and Technology (NIST) and provided to U.S. Environmental Protection Agency (EPA) for the BASE (Building Assessment Survey and Evaluation) CD distributed by EPA [2]. In addition, outliers (primarily those with high measured ventilation rates) were examined in more detail. Regarding the second issue, a number of potential explanations were examined for the differences between the ventilation rates estimated from peak indoor CO_2 concentrations and the traverse-based or volumetric rates.

DATABASE CORRECTIONS

As part of the data review, the various files used in the ventilation data analysis were studied and compared with the files on the CD distributed by EPA [2]. As a result, a number of changes were made to the dataset, which are identified below. However, none of the changes modify the overall conclusions of the study, only some of the summary statistics. An updated version of the original NIST report on the dataset [1] will be published with these corrections.

This data review effort involved a detailed examination of the data analysis files generated by the original analysis, including the following design parameters:

Supply capacity of each air handling unit (AHU)
AHU return capacity
Floor area served by each AHU
AHU design minimum outdoor air intake
Number of occupants served by each AHU
AHU supply capacity divided by floor area served
AHU design minimum outdoor air per person
AHU ratio of minimum outdoor air to supply capacity
Number of occupants per unit floor area (for each AHU)
Ratio of supply to return airflow (for each AHU)

In addition, the following measured parameters were also reviewed:

AHU supply airflow and associated uncertainty
AHU outdoor airflow and associated uncertainty
AHU recirculation airflow and associated uncertainty
AHU outdoor air intake fraction and associated uncertainty
Study space supply airflow per unit floor area and associated uncertainty
Study space outdoor airflow (per person, per unit floor area and per unit volume) and associated uncertainty

The changes made to the data files as a result of this effort are documented in Table 1.

Building	Parameter	Modification	Comment
CAJS01	Peak CO_2 value and outdoor airflow calculated from peak	All values deleted.	All indoor CO_2 concentrations are very erratic; two locations are consistently below outdoors at night.
CAJW20	% of AHU capacity serving test space (C1TS1PCT*)	Changed from 100 % to 14 %, based on floor area and number of occupants served.	Field notes indicate AHU serves 7 floors, not 1 as indicated by original value of C1TS1PCT. Results in 86 % reduction in supply and outdoor airflows, and associated reduction in uncertainty.
CAJW24	Uncertainty in CO_2 ratio outdoor airflow per person.	Fixed small error in uncertainty in L/s•person and cfm/person	Roughly 10 % reduction in these two uncertainty values; no impact on airflow results.
MOCS01	Floor area served by system (C7AAREA*)	Increased by roughly a factor of 8 (# of building floors) as listed value is only for a single floor.	Reduces design value of supply airflow per unit floor area and occupant density by factor of 8.
NCDW02	% of AHU capacity serving test space (C1TS1PCT)	Change from 50 % to 20 % for AHU #1 and to 30 % for AHU #2, based on floor area and number of occupants served.	Results in roughly 50 % reduction in reported supply and outdoor airflows, and associated reduction in uncertainties.
PABS04	Design # of occupants (C7AOCCU)	Replaced value of 0 with blank cell for AHU #2	AHU serves perimeter; occupants accounted for by other systems.
TNDS05	Design # of occupants (C7AOCCU)	Replaced value of 0 with blank cell for AHU #2.	AHU serves corridor; occupants accounted for by other systems.

TXFS02	Uncertainty in CO_2 ratio outdoor airflow per floor area.	Fixed error in uncertainty in L/s•m^2 and cfm/ft^2.	Corrected uncertainty values ten times uncorrected; no impact on airflow results.

* Variable name from BASE data dictionary.

Table 1 Modifications to BASE ventilation data parameters

As a result of these modifications, some of the summary statistics in the original NIST report to EPA (NISTIR 7145) also change. The affected tables and figures are presented below, with the table and figure number from the original report in parentheses. In the tables, the revised values are highlighted in bold font.

	Floor area served m^2 (ft^2)	**Design supply airflow capacity** L/s•m^2 (cfm/ft^2)			**Supply/ Return**
		All systems	CV	VAV	
# of values	141	134	47	87	41
Mean	**3100 (33 300)**	**5.86 (1.15)**	7.01 (1.38)	**5.25 (1.03)**	1.14
Std. Dev.	**4230 (45 600)**	**3.57 (0.70)**	5.33 (1.05)	**1.85 (0.36)**	0.22
Minimum	**110 (1200)**	1.13 (0.22)	1.13 (0.22)	1.67 (0.33)	0.20
10th percentile	540 (5800)	2.90 (0.57)	2.74 (0.54)	**3.26 (0.64)**	1.00
25th percentile	990 (10 700)	4.15 (0.82)	4.19 (0.83)	4.15 (0.82)	1.07
Median	**1640 (17 600)**	**5.21** (1.03)	5.63 (1.11)	**4.99 (0.98)**	1.11
75th percentile	**3440 (37 000)**	**6.78 (1.33)**	7.83 (1.54)	**6.17 (1.22)**	1.25
90th percentile	**7620 (82 100)**	**8.45 (1.66)**	11.21 (2.21)	**7.56 (1.49)**	1.28
Maximum	33 780 (363 600)	30.18 (5.94)	30.18 (5.94)	**12.47 (2.45)**	1.85

	Design minimum outdoor air intake		**Minimum OA/ Supply**	**Occupant density** #/100 m^2 (1000 ft^2)
	L/s (cfm) per person	L/s•m^2 (cfm/ft^2)		
# of values	74	76	76	137
Mean	18.4 (39.0)	0.94 (0.18)	0.19	**5.3 (4.9)**
Std. Dev.	13.7 (29.0)	1.06 (0.21)	0.22	**6.5 (6.1)**
Minimum	1.3 (2.9)	0.17 (0.03)	0.06	0.9 (0.8)
10th percentile	7.5 (16.0)	0.31 (0.06)	0.08	2.2 (2.0)
25th percentile	10.6 (22.4)	0.42 (0.08)	0.10	2.9 (2.7)
Median	15.2 (32.1)	0.60 (0.12)	0.12	**3.9** (3.7)
75th percentile	23.6 (50.0)	0.92 (0.18)	0.15	5.9 (**5.4**)
90th percentile	29.7 (63.0)	**1.82** (0.36)	0.31	**8.0 (7.4)**
Maximum	98.3 (208.2)	6.67 (1.31)	1.00	65.1 (60.5)

Table 2 System Design Values (Table 6 in NISTIR 7145)

System *	Issue	Comments
AZHW10 (2 of 2)	High supply capacity, 24 L/s•m^2 (4.7 cfm/ft^2)	System (1) at 8 L/s•m^2 (1.5 cfm/ft^2)
LAGW05 (1 of 2)	High supply capacity, 18 L/s•m^2 (3.6 cfm/ft^2)	System (2) at 4 L/s•m^2 (0.7 cfm/ft^2); occupant density 5 times that of system (2); floor area could be low
~~MOCS01 (1 of 1)~~	~~High supply capacity, 27 L/s•m^2 (5.3 cfm/ft^2)~~	
PABS04 (2 of 2)	High supply capacity, 25 L/s•m^2 (5.9 cfm/ft^2)	System (1) at 4 L/s•m^2 (0.8 cfm/ft^2)
CAEW09 (1 of 1)	High minimum outdoor air 53 L/s (113 cfm) per person,	Minimum outdoor air based on supply and return capacities
CAJS21 (2 of 2)	High minimum outdoor air, 98 L/s (208 cfm) per person	100 % outdoor air system; System (1) at 29 L/s (61 cfm) per person
MDDS01 (1 of 1)	High minimum outdoor air, 51 L/s (109 cfm) per person	
NCDW03 (2 of 5)	High minimum outdoor air, 38 L/s (80 cfm) per person	Other 4 systems from 9 L/s (20 cfm) per person to 16 L/s (33 cfm) per person; system (2) occupant density about 25 % of other 4 systems.
NECW02 (1 of 1)	High minimum outdoor air, 38 L/s (80 cfm) per person	High occupant density, 16 occupants per 100 m^2 (1000 ft^2)
TNFS10 (1 of 1)	High minimum outdoor air, 34 L/s (72 cfm) per person	Low occupant density, 1.1 occupants per 100 m^2 (1000 ft^2)
CAJW25 (1 of 1)	High occupant density, 61 occupants per 100 m^2 (1000 ft^2)	Supply airflow 24 L/s•m^2 (2.5 cfm/ft^2); floor area could be low
~~MOCS01 (1 of 1)~~	~~High occupant density, 24 occupants per 100 m^2 (1000 ft^2)~~	
NECW02 (1 of 1)	High occupant density, 16 occupants per 100 m^2 (1000 ft^2)	
SDBW02 (1 of 1)	High occupant density, 38 occupants per 100 m^2 (1000 ft^2)	Low minimum outdoor air 1 L/s (3 cfm) per person, consistent with high occupant density value
TNDS05 (1 of 2)	High occupant density, just over 12 occupants per 100 m^2 (1000 ft^2)	System (2) lists no occupants

* Values in parentheses refers to air handler number relative to total number of air handlers, e.g. (2 of 2) means second of two air handlers serving the study space.

Table 3 System design outliers*
(Table 7 in NISTIR 7145)

* The text in the table noted with a strikethrough corresponds to two occurrences that are no longer outliers given the modifications to the data described earlier.

	Study space outdoor air requirement L/s (cfm) per person
Mean	**9.0 (19.1)**
Std. Dev.	**3.3 (6.9)**
Minimum	4.8 (10.2)
10th percentile	**6.5 (13.7)**
25th percentile	7.2 (15.3)
Median	8.7 (18.3)
75th percentile	10.0 (21.1)
90th percentile	**12.1 (25.7)**
Maximum	33.5 (71.0)

Table 4 Study space outdoor air requirements based on Standard 62 addendum n (Table 8 in NISTIR 7145)

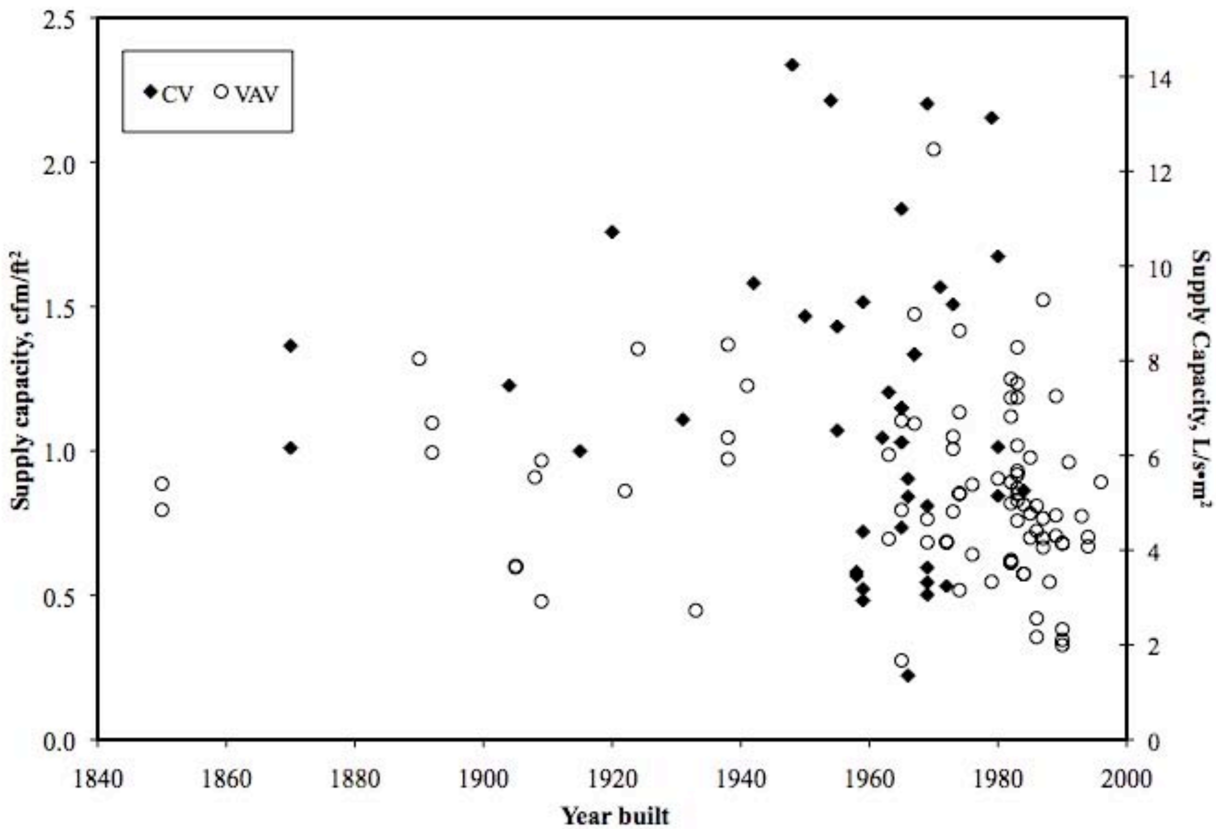

Figure 1 Design supply airflow capacity versus year built (Figure 3 in NISTIR 7145)

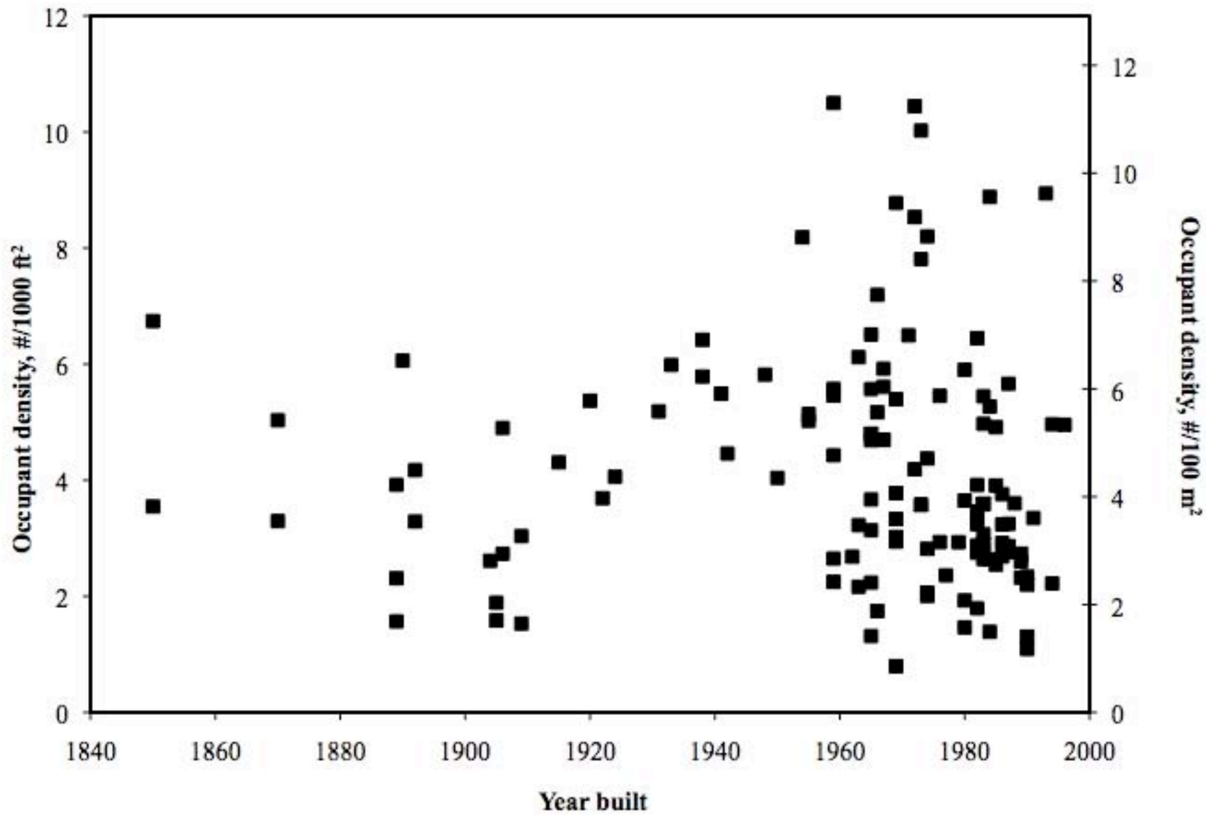

Figure 2 Design occupant density versus year built (Figure 5 in NISTIR 7145)

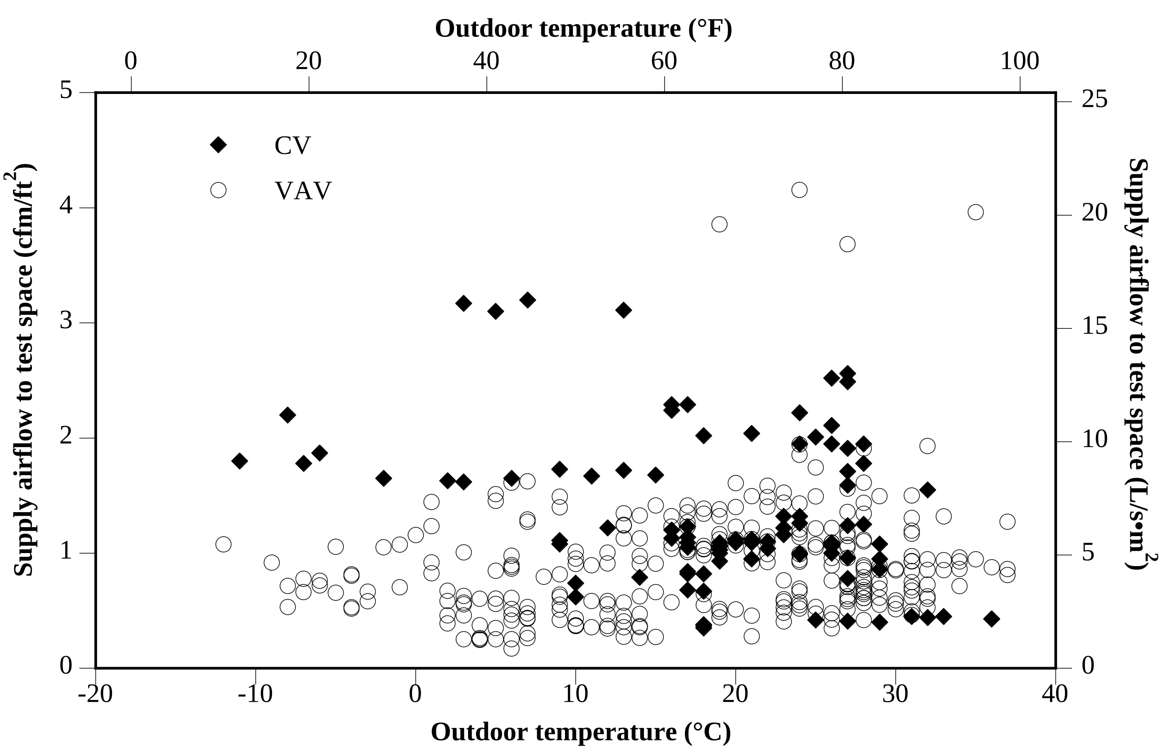

Figure 3 Measured study space supply airflow vs. outdoor temperature (Figure 7 in NISTIR 7145)

	Supply airflow/Floor area L/s•m^2 (cfm/ft^2)		
	All systems	VAV	CV
# of values	384	289	95
Mean	**5.12 (1.01)**	**4.55 (0.90)**	6.86 (1.35)
Std. Dev.	**3.02 (0.59)**	**2.62 (0.52)**	3.46 (0.68)
Minimum	0.88 (0.17)	0.88 (0.17)	1.80 (0.35)
10th percentile	**2.16 (0.43)**	**2.12 (0.42)**	2.25 (0.44)
25th percentile	**2.99 (0.59)**	**2.89 (0.57)**	4.82 (0.95)
Median	**4.69 (0.92)**	**4.30 (0.85)**	5.72 (1.13)
75th percentile	**6.25 (1.23)**	**5.69 (1.12)**	9.04 (1.78)
90th percentile	**8.47 (1.67)**	**7.19 (1.41)**	11.34 (2.23)
Maximum	21.11 (4.15)	21.11 (4.15)	16.24 (3.20)

Table 5 Summary of measured supply airflows (Table 13 in NISTIR 7145)

	Best volumetric	**Carbon dioxide**
# of values	**509**	520
Mean	**0.38**	0.31
Standard deviation	0.35	0.27
Minimum	0.00	0.00
10th percentile	0.04	0.03
25th percentile	0.10	0.11
Median	0.22	0.23
75th percentile	0.59	0.44
90th percentile	1.00	0.75
Maximum	**1.52**	1.20

Table 6 Summary of measured outdoor air fraction
(Table 14 in NISTIR 7145)

	Per person L/s (cfm) per person	**Per unit floor area** L/s•m^2 (cfm/ft^2)	**Air changes per hour,** h^{-1}
# of values	367	369	369
Mean	**49 (105)**	**1.87 (0.37)**	**1.83**
Std. Dev.	**54 (114)**	**2.08 (0.41)**	**2.07**
Minimum	0 (0)	0 (0)	0.00
10th percentile	6 (13)	0.24 (0.05)	0.22
25th percentile	13 (27)	0.50 (0.10)	0.47
Median	30 (63)	1.03 (0.20)	0.98
75th percentile	**66 (140)**	**2.30 (0.45)**	**2.46**
90th percentile	**116 (245)**	**4.64 (0.91)**	**4.46**
Maximum	**310 (657)**	**12.31 (2.42)**	**13.23**

Table 7 Summary of Measured Outdoor Air Ventilation – Volumetric
(Table 15 in NISTIR 7145)

	Outdoor air per person, L/s (cfm)
# of values	356
Mean	**44 (94)**
Std. Dev.	**47 (101)**
Minimum	0 (0)
10th percentile	5 (11)
25th percentile	12 (26)
Median	31 (65)
75th percentile	**59 (125)**
90th percentile	**96 (203)**
Maximum	**339 (717)**

Table 8 Summary of Measured Outdoor Air Ventilation – CO_2 Ratio
(Table 16 in NISTIR 7145)

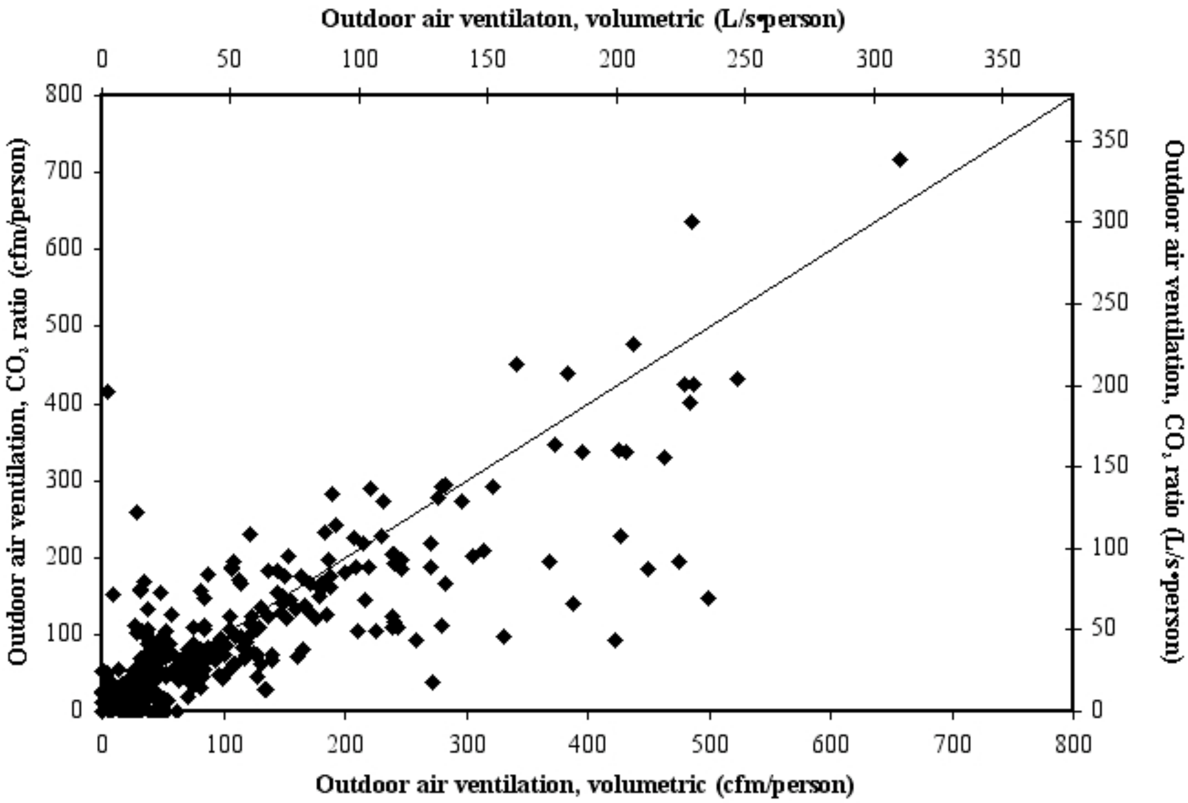

Figure 4 Outdoor air ventilation, CO_2-ratio vs. volumetric
(Figure 14 in NISTIR 7145)

	Measured (Table 15*)	Adjusted to # of workstations	Adjusted to 15 % outdoor air	
			# of workstations	Standard 62 default occupant density**
	L/s (cfm) per person			
Mean	**49 (105)**	**36 (76)**	**12 (26)**	**8 (18)**
Std. Dev.	**54 (114)**	**37 (79)**	**8 (17)**	**6 (13)**
Minimum	0 (0)	0 (0)	0 (0)	0 (0)
10th percentile	6 (13)	5 (10)	4 (9)	3 (5)
25th percentile	13 (27)	10 (22)	**7 (14)**	5 (10)
Median	30 (63)	21 (45)	**11 (23)**	7 (15)
75th percentile	**66 (140)**	**52 (110)**	**16 (34)**	11 **(23)**
90th percentile	**116 (245)**	**87 (184)**	**21 (44)**	16 **(34)**
Maximum	**310 (657)**	**210 (444)**	**47 (100)**	42 (89)

* Refers to Table 15 in the original report.
** Adjustment based on default occupant density in Standard 62.1 2001 (same as 1989) and not in 2004 and 2007 versions.

Table 9 Outdoor air ventilation adjusted for occupancy and outdoor air fraction
(Table 17 in NISTIR 7145)

	Outdoor air ventilation, L/s (cfm) per person		
	All peak CO_2 data	**Peak CO_2 data on "test days"**	**Volumetric results from Table 15***
# of values	**548**	**353**	367
Mean	**20 (43)**	**21 (45)**	**49 (105)**
Std. Dev.	**14 (31)**	**17 (35)**	**54 (114)**
Minimum	6 (13)	6 (13)	0 (0)
10^{th} percentile	10 (20)	10 (21)	6 (13)
25^{th} percentile	12 (26)	13 (27)	13 (27)
Median	18 **(37)**	18 (**38**)	30 (63)
75^{th} percentile	24 (**50**)	25 (**53**)	**66 (140)**
90^{th} percentile	**32 (68)**	**33 (71)**	**116 (245)**
Maximum	213 (452)	213 (452)	**310 (657)**

* Refers to Table 15 in the original report.

Table 10 Summary of Measured Outdoor Air Ventilation – Peak CO_2
(Table 18 in NISTIR 7145)

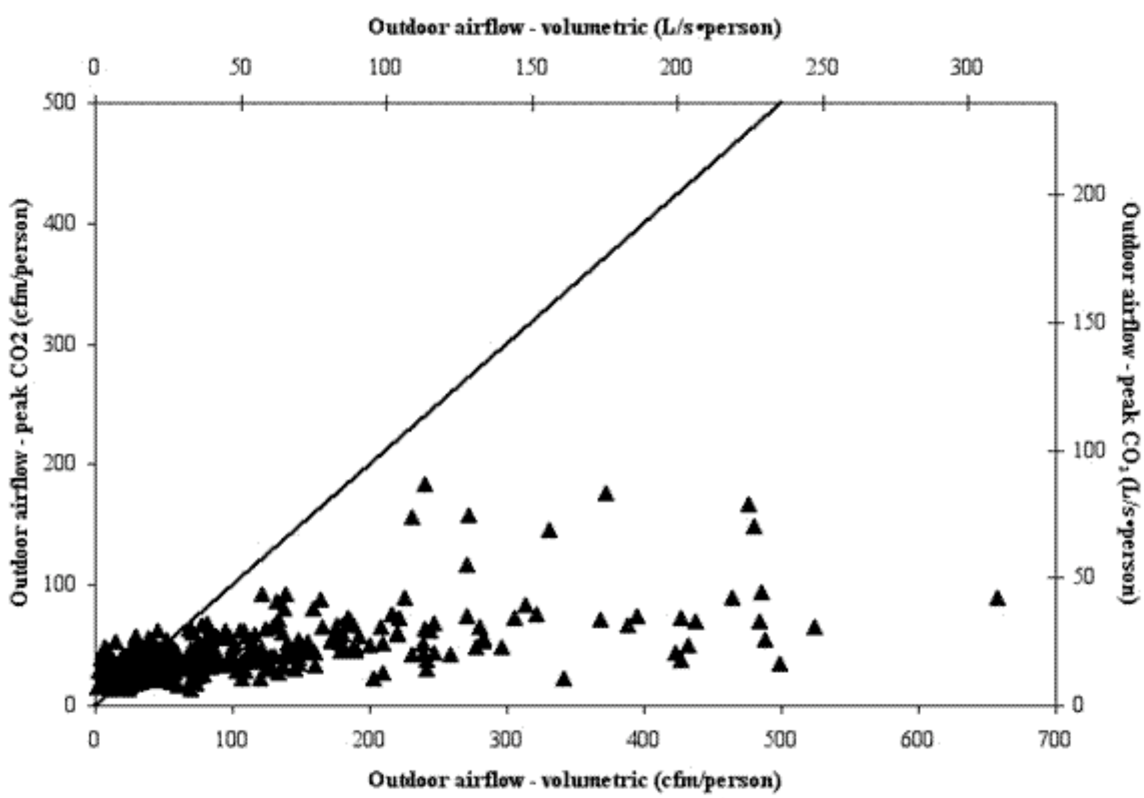

Figure 5 Outdoor air ventilation, CO_2 peak vs. volumetric
(Figure 15 in NISTIR 7145)

In reviewing the data, the issue of low values of traverse measurements of airflow was examined but no changes were made to the dataset as a result. For the airflow traverses, the concern is the accuracy of the anemometer or pitot tube measurements at lower air speeds. While a small number of traverse measurements of airflow are in the range of 50 L/s (100 cfm), it is actually the air speed measured in the duct that is most relevant to its accuracy. For the supply duct traverses, the mean measured air speed is 5.3 m/s (1000 ft/min), which is within the range at which such measurements are expected to be accurate. A small number of the air speeds are low enough to be of potential concern, but less than 1 % are below 0.3 m/s (60 ft/min). The mean air speed for the outdoor air intake traverses is 3.1 m/s (600 ft/min), again in a reliable range, with only about 3 % below about 0.3 m/s (60 ft/min). No modifications were made to the dataset to eliminate the low readings, but given the small number of such values, their removal would not have a major effect on the overall conclusions of the study.

OUTDOOR AIRFLOW: COMPARISON OF PEAK INDOOR CO_2-BASED AND DUCT TRAVERSE-BASED VALUES

A key finding of the original study, and a primary motivation for this reanalysis, is the consistent difference between the outdoor airflow rates based on the duct traverse measurements and the estimates based on peak CO_2 concentrations in the study spaces. The latter estimates were based on indoor CO_2 concentrations measured continuously during several days of the study period using 3 to 4 fixed monitors distributed randomly in the study space. The concentrations were then averaged and peak values of those averages were determined for each morning and afternoon. This approach to ventilation rate estimation has been used for a number of years though often without a complete understanding of the assumptions inherent in the method [3]. The peak indoor CO_2 method for estimating outdoor air ventilation rates is essentially a single-zone, constant injection tracer gas technique. Therefore, it is based on the assumption that the indoor CO_2 concentration is uniform throughout the study space and that the test space is isolated from the rest of the building or that the rest of the building is at the same CO_2 concentration as the study space. In addition, the approach as typically applied assumes that the indoor CO_2 concentration is at steady-state and that the following quantities are constant: outdoor concentration, ventilation airflow rate, and building occupancy. The validity of these assumptions was not assessed as part of the BASE study and most of them cannot be assessed based on the available data.

As seen in Figure 5 above (corrected Figure 15 from the original report), for volumetric (traverse-based) outdoor airflow rates above about 20 L/s•person (40 cfm/person), the values based on peak CO_2 concentrations are consistently lower than the volumetric values. This issue was discussed in the original report as follows:

> “The reason that the peak CO_2 values tend to be lower than expected has been investigated, but no explanation has yet been verified. Considering the methodology behind the peak CO_2 analysis, one might suspect the lack of steady-state CO_2 concentrations could be impacting the agreement between the two values. However, steady state is more likely to occur at the higher ventilation rates due to the shorter system time constants, resulting in better agreement at higher rates, which is contrary to what is seen in Figure 15. Another potential explanation is the existence of significant CO_2 concentration gradients within the study spaces, as well as between them and adjoining spaces, given that the single-zone analysis method assumes a uniform concentration within the zone and neglects interzone transfer of CO_2. While it is

certainly possible that the CO_2 concentrations were different in adjoining zones, one would expect the impact to be positive in some cases and negative in others. However, the differences in the data tend to all be in one direction. The level of agreement was examined in those study spaces that corresponded to an entire building, for which concentration differences in adjoining spaces are not an issue, and the peak CO_2 and volumetric ventilation rates were not observed to agree any better. Note that the fixed CO_2 monitors in the study spaces were placed at a height of 1.1 m (43 in.) above the floor and at locations representative of workstation layout and work activities, i.e., locations in hallways and passageways were intentionally avoided (EPA 2003)[1]. Given these guidelines on location, it is possible that the measured CO_2 concentrations are higher than the study-space average. If the measured CO_2 concentration is indeed higher than the true space average, then the calculated ventilation rates would be low relative to their actual value. Also, it is reasonable to expect that the lack of uniformity would be more pronounced at higher outdoor air ventilation with less recirculation of return air, leading to the observed increase in errors. However, it is not possible to verify the magnitude of the concentration nonuniformity in these spaces based on the available data, and therefore it cannot be confirmed whether this is necessarily a valid explanation for the observed differences. The peak CO_2 concentrations were examined with the issue of nonuniformity in mind, and it was determined that the actual average concentration in the study space would have to be 360 mg/m^3 to 720 mg/m^3 (200 ppm(v) to 400 ppm(v)) lower than that measured by the fixed monitors to explain the observed differences."

Figure 15 in the original report actually included only a subset of the values, i.e., those with volumetric outdoor air ventilation rates less than 200 L/s•person (400 cfm/person). The corrected version above in Figure 5 contains all the points in the corrected dataset. The corrected dataset includes many outdoor airflow values with high uncertainties. These uncertainties were calculated using standard approaches to the propagation of error in which the estimated uncertainties in the values used to calculate the airflows were propagated through the mathematical operations used to determine the airflow rates. Note that these uncertainty estimates do not account for biases in the measurement methods or the impact of the assumptions behind the peak CO_2 method not being valid. For the volumetric values, the mean value of the ratio of the uncertainty in the outdoor airflow per person to the corresponding measured value is close to 1.1; the median ratio is about 0.3. The mean ratio of the uncertainty to the measured value for the peak indoor CO_2-based values is much smaller, about 0.3, and there are values over 1.0. The relative uncertainties for the volumetric flows tend to be larger due in part to the existence of a small number of measurement events with very low outdoor airflow rates but very high uncertainties. These high uncertainty cases occur when the outdoor airflow is determined by subtracting the recirculation airflow from the supply.

Figure 6 is a plot of the same data shown in Figure 5, but with only those values for which the ratio of the uncertainty to the measured value is less than one. These data exhibit less scatter than that seen in Figure 5. Figure 7 restricts the data plotted even further to values for which the ratio is less than 0.5. This plot is particularly striking in the very flat distribution of the data in which the volumetric values range from 0 L/s-person to about 250 L/s-person (500 cfm/person) while the peak indoor CO_2-based values cover a much more narrow range from about 7 L/s-person (15 cfm/person) to 35 L/s•person (74 cfm/person). The ratio of the standard deviation to the

[1] This is reference number 4 in the list of references for this report.

mean for the values in Figure 7 is 1.0 for the volumetric rates but only 0.4 for the peak CO_2 values. The lack of variability in the peak CO_2 values relative to the volumetric rates is notable and is discussed further below.

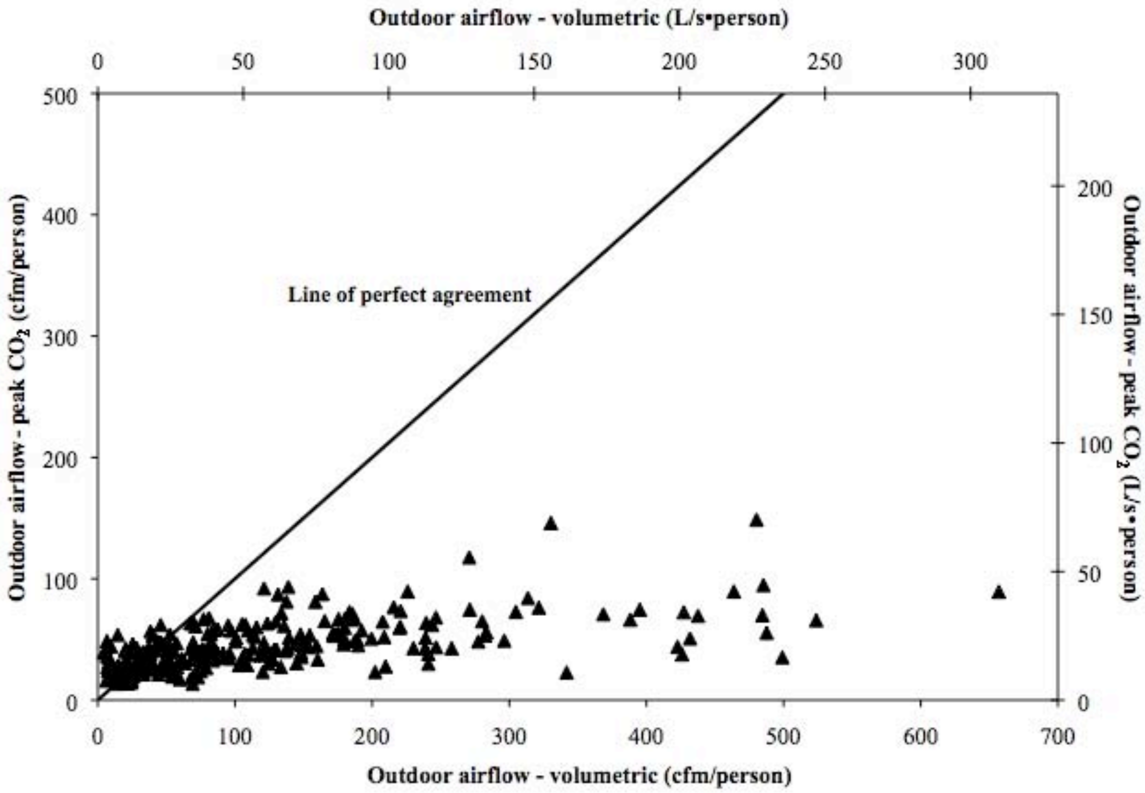

Figure 6 Updated - Outdoor air ventilation, CO_2 peak vs. volumetric (relative uncertainty < 1)

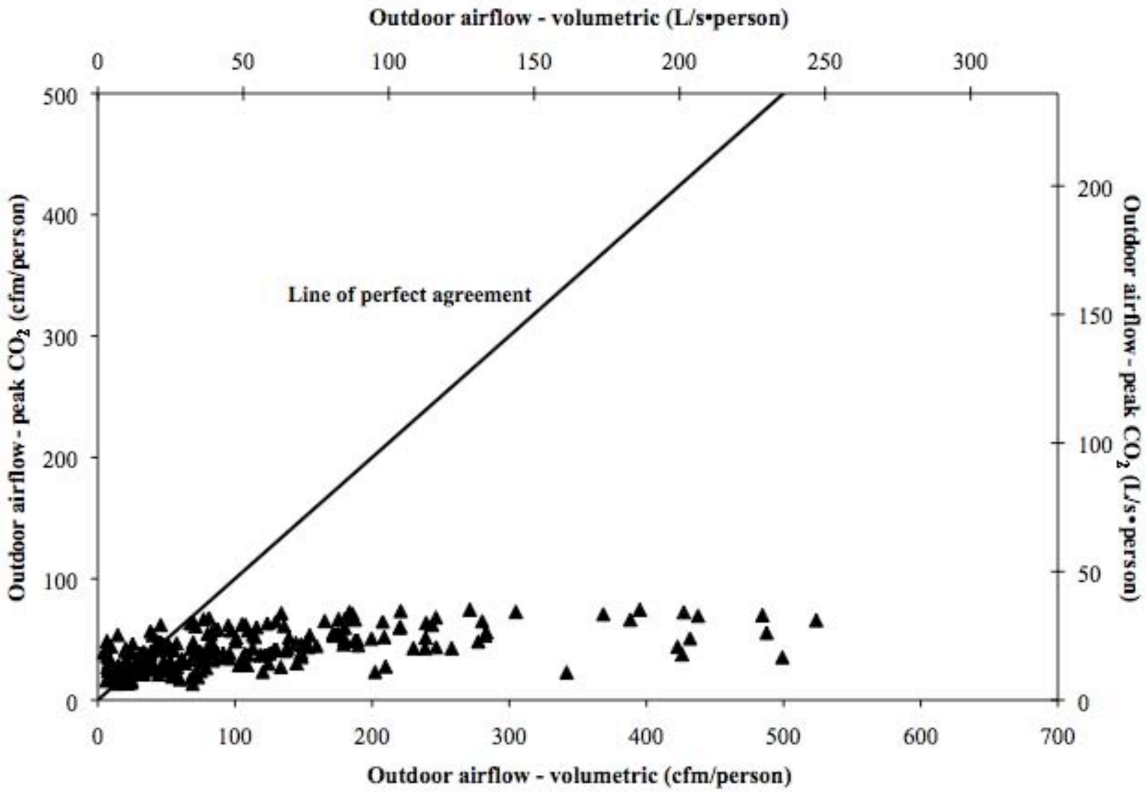

Figure 7 Updated - Outdoor air ventilation, CO_2 peak vs. volumetric (rel. uncertainty < 0.5)

Nonuniform CO_2 concentrations

As noted in the original report, one potential explanation for the discrepancy between the traverse and peak CO_2 rates is nonuniformity in the CO_2 concentrations in the space. Specifically, the fact that the CO_2 concentrations were sampled "at a height of 1.1 m (43 in.) above the floor and at locations representative of workstation layout and work activities" raises the question of whether the readings were impacted by the occupants' local exhalations. In addition, the BASE protocol requires that these monitoring locations be selected among 5 m by 5 m grids of which more than 50 % of the area is occupied full time [4]. CO_2 concentrations in the exhaled breath from people are in the range of 72 000 mg/m^3 (40 000 ppm(v)) [3], which is well above the concentrations measured in the study spaces. Therefore the proximity of occupants to the indoor monitoring locations does lead to the potential for the measured concentrations being elevated relative to the space average.

The issue of nonuniform concentration was evaluated in two ways, by comparing the space concentrations to those measured in the air handler returns and by examining the uniformity among the various sample locations in each study space.

As part of the ventilation evaluations, CO_2 concentrations were measured on four occasions during the test week (typically on Wednesday and Thursday of the study week in the morning and afternoon) in the air handler return, supply, and outdoor airstreams to calculate the outdoor air intake fraction based on a mass balance of CO_2 in the air handler. These discrete measurements of CO_2 in the return were compared with the average of the concentrations in the study space taken at the same time, which is generally not the same time as peak in the study space concentration. Note that the return airstreams sometimes contained air drawn from other spaces in addition to the study space, therefore the comparisons were only made for study spaces served by a dedicated air handler, i.e., an air handler that doesn't serve any other spaces. Figure 8 is a plot of the space concentration versus the corresponding concentration in the air handler return (open squares) as well as the difference between the space and return concentrations again plotted against the return concentration (open circles). The space concentrations do tend to exceed the return concentrations, though there are a small number of cases for which the space concentration is lower. The average difference for the 183 cases where both values exist equals 108 mg/m^3 (60 ppm(v)). The differences tend be higher for lower return concentrations, which correspond to higher ventilation rates. These higher ventilation rates are associated with higher outdoor air intake fractions, which result in less mixing of the indoor air and are consistent with the greater differences between space and return concentrations.

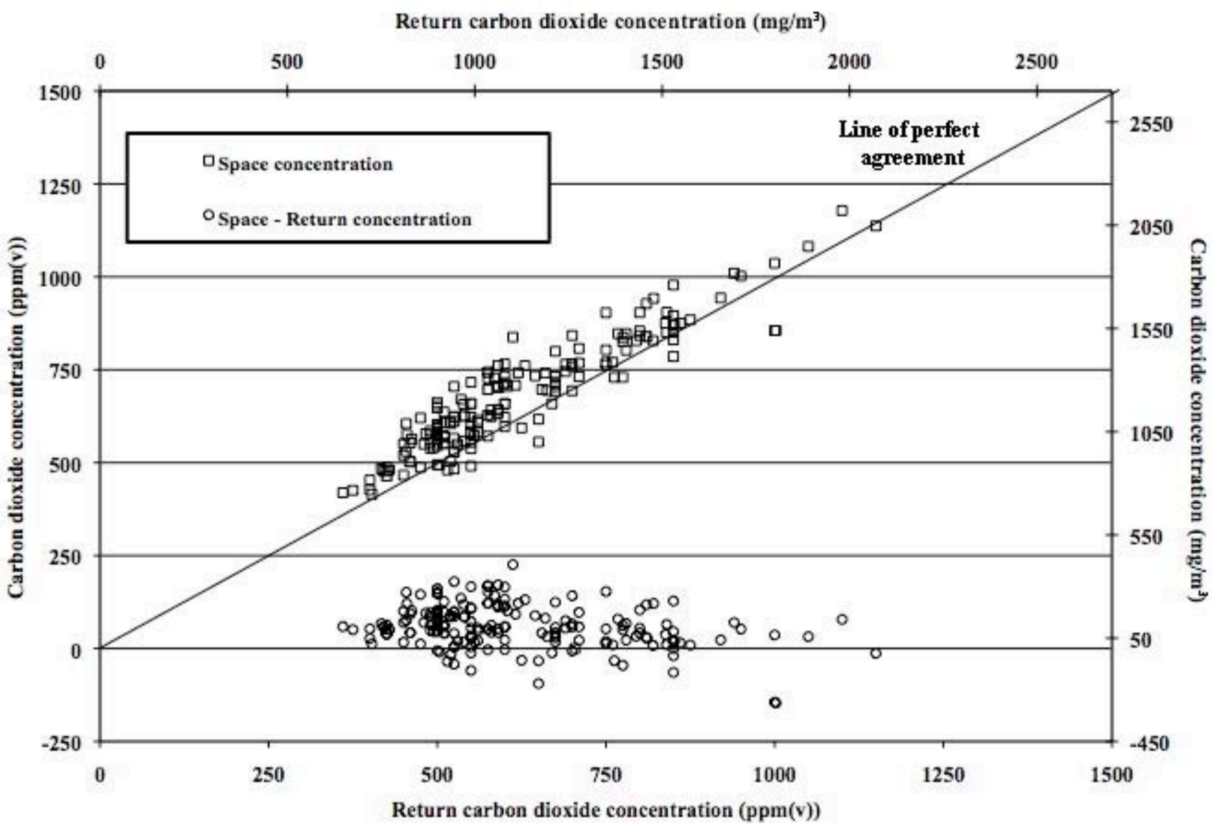

Figure 8 Space and space-minus-return CO_2 concentrations vs. return concentration

The return versus space concentration differences were also examined for study spaces that correspond to an entire building. One might expect the concentration differences to be more clearly defined in such situations because there is no interzone airflow and CO_2 transport to confound the return-versus-space relationship. However, those study spaces revealed no significant differences relative to other spaces.

Some of the buildings tested later in the BASE project were also subject to continuous measurements of CO_2 in the air handler returns. Several of these datasets were examined for systematic differences between the study space and air handler return peak CO_2 concentrations.

The results were largely consistent with those seen between the space and spot measurements in the return.

While the observed differences between the return and space concentrations indicate that the space concentrations may be elevated due to the presence of occupants, the magnitude of the impact is not sufficient to explain the observed differences between the volumetric and peak CO_2 based ventilation rates. Figure 9 is a plot of the peak CO_2 rates adjusted using the average space-return difference of 108 mg/m^3 (60 ppm(v)), i.e., with the peak space concentration reduced by that average difference. In this figure, the adjusted rates are superimposed on the unadjusted data from Figure 6.

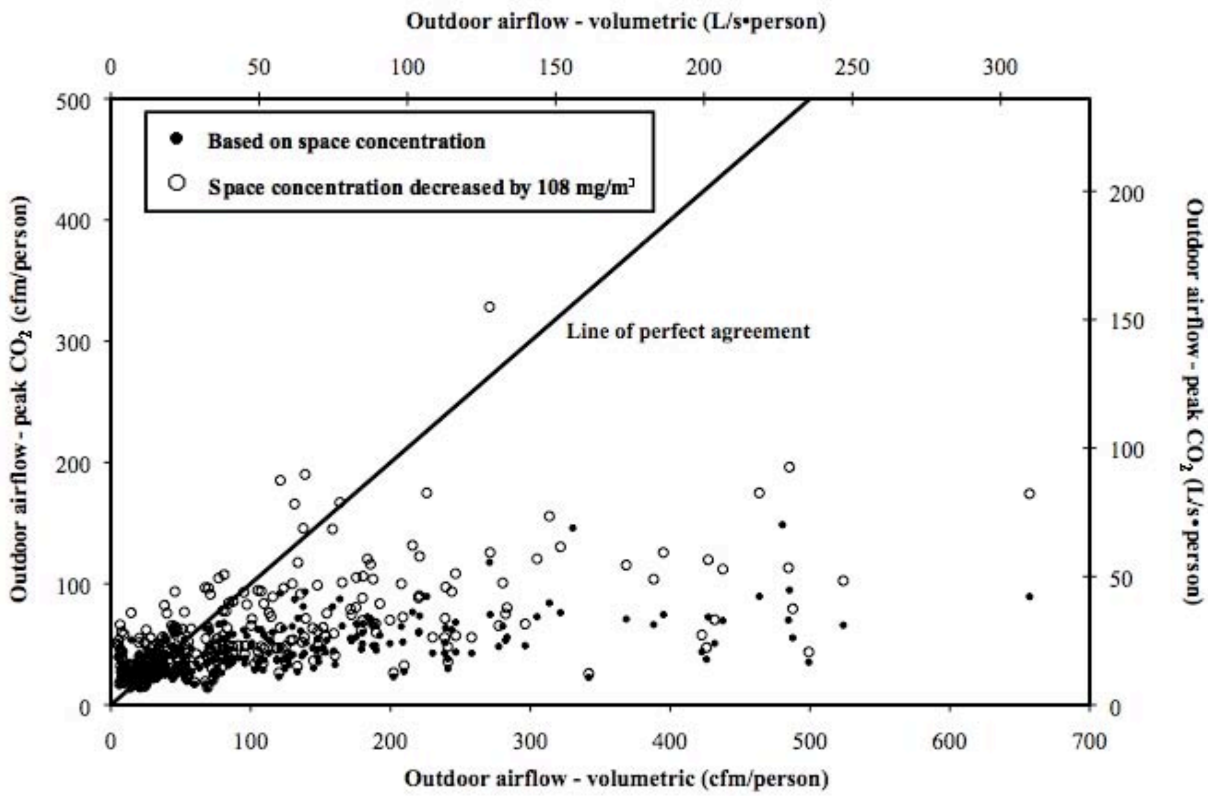

Figure 9 CO_2 peak vs. volumetric ventilation rate adjusted for space-return concentration

The second approach used to examine the issue of nonuniform CO_2 concentrations in the study spaces was to consider the concentration variations within the space. As noted earlier, the CO_2 concentrations were measured at multiple locations in each study space, and the concentrations among these locations varied. In an attempt to examine the impact of those nonuniformities, the ventilation rates were recalculated using the CO_2 sampling location that yielded the lowest peak value. Figure 10 is a plot of the measured CO_2 concentrations for study space MIBW03, including the outdoor and three indoor locations. The difference between the indoor locations is evident in this plot. Note that ASTM D6245 [3] requires that CO_2 concentrations within the study space not vary from the space average by more than 10 % when estimating ventilation rates based on peak CO_2 concentrations. This requirement is not met for this study space and for many of the other BASE study spaces.

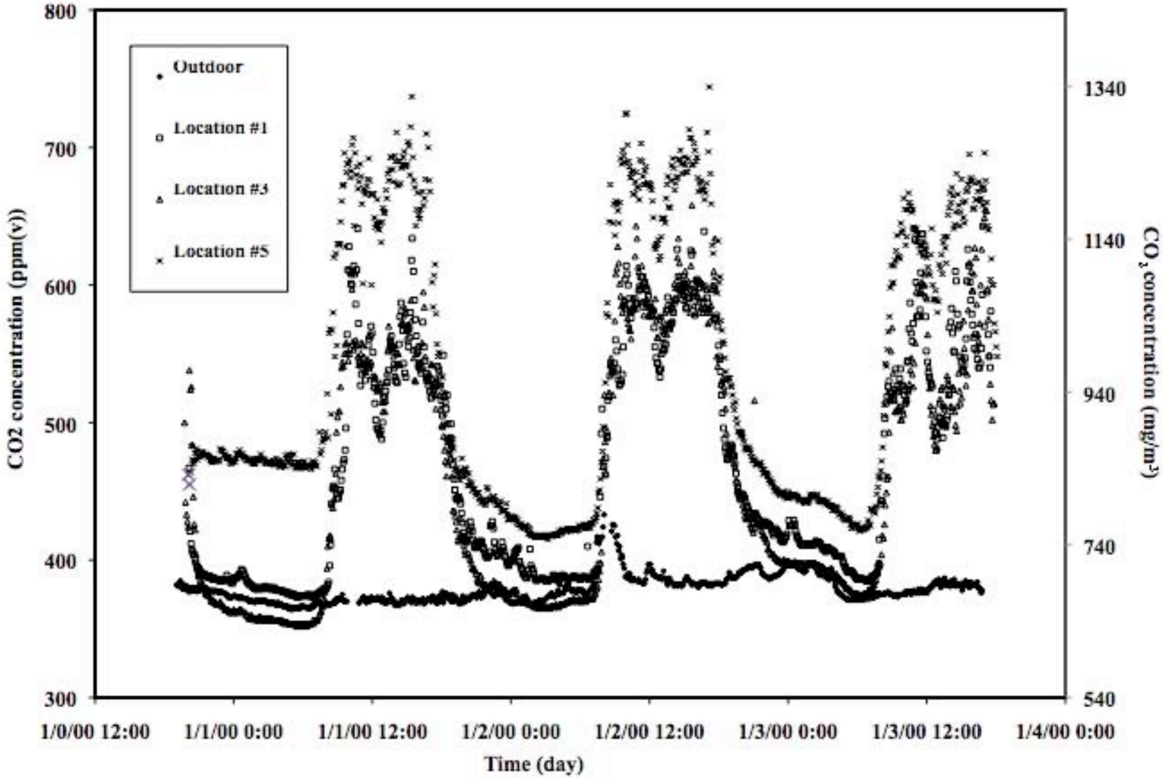

Figure 10 Variation in CO_2 concentrations among indoor locations (study space MIBW03)

For each study space, the indoor location with the lowest peak CO_2 value was used to estimate the outdoor air ventilation values. Figure 11 is a plot of the outdoor airflows estimated using the monitoring location with the minimum peak CO_2 value against the volumetric rates, with the airflows based on the peak average CO_2 concentration from Figure 6 included as well. Using the minimum peak CO_2 concentrations does increase the outdoor airflow values, but not enough to result in good agreement with the volumetric values. The improvement is more pronounced than that seen for the adjustment based on the average return-space concentration difference seen in Figure 9.

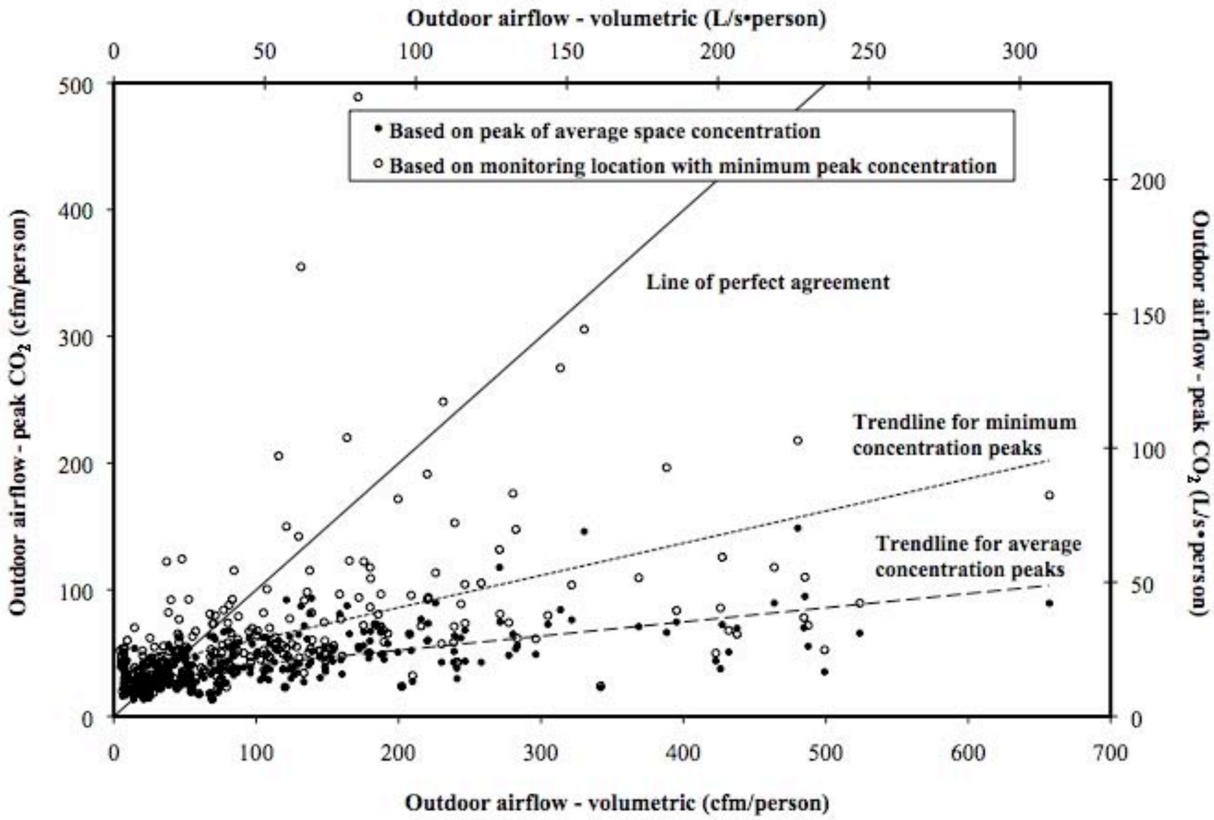

Figure 11 CO_2 peak vs. volumetric ventilation rate, using monitoring location with minimum peak concentration

While using the return concentrations and the minimum peak CO_2 concentrations instead of the study space concentrations is not sufficient to explain the difference between the peak CO_2 and the volumetric values, these two explanations are consistent with the existence of nonuniform concentrations in the study spaces.

If CO_2 concentration variations between the study space and the rest of the building is an issue, then study spaces that are a whole building or are served by dedicated air handlers might be expected to exhibit better agreement between the peak indoor CO_2-based and volumetric airflow values. The level of agreement between the two airflow rates was examined for test spaces corresponding to a whole building (only 6 cases) or which were served by dedicated air handlers (43 cases), but no obvious difference in the agreement was evident. Note that within-space nonuniformity may have been an issue in these spaces as well.

Association of peak-volumetric difference with various factors

In investigating the differences between the peak indoor CO_2-based estimates and volumetric measurements of the outdoor airflows in the BASE buildings, a number of parameters were considered to see if they were associated with the magnitudes of the differences and therefore might offer some explanation.

Given the hypothesis that nonuniform indoor CO_2 concentrations might be important, the standard deviation of the peak concentrations for the various indoor locations was computed for each study space. This standard deviation was then divided by the mean peak to determine the coefficient of variation (COV). Figure 12 is a plot of the relative difference between the volumetric and peak indoor CO_2-based airflows (volumetric minus peak indoor CO_2-based, divided by peak value) against the COV. The data in this figure do not show a strong dependence of the flow discrepancy on the COV.

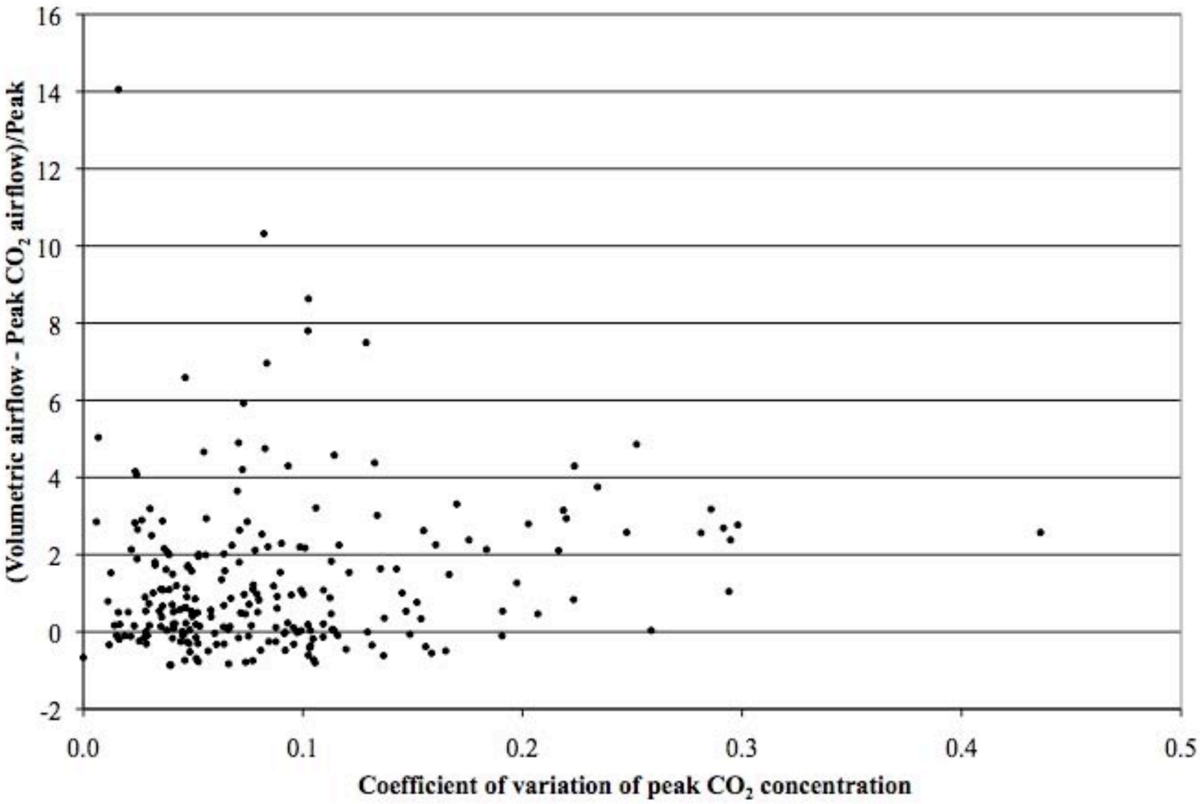

Figure 12 Relative difference between airflows vs. coefficient of variation

Given that the indoor concentrations are expected to be more uniform with more mixing, i.e., lower outdoor air fractions (%OA), the differences between the peak indoor CO_2-based and volumetric airflows were also examined relative to %OA for the study space. The results are plotted in Figure 13. The volumetric airflows are below the peak indoor CO_2-based values at the lowest values of %OA and become increasingly larger than the peak values as the %OA increases. Note that the low %OA values are consistent with more air mixing in the building, while higher values correspond to less. The trend seen here does support poor mixing as a potential explanation of the observed discrepancy.

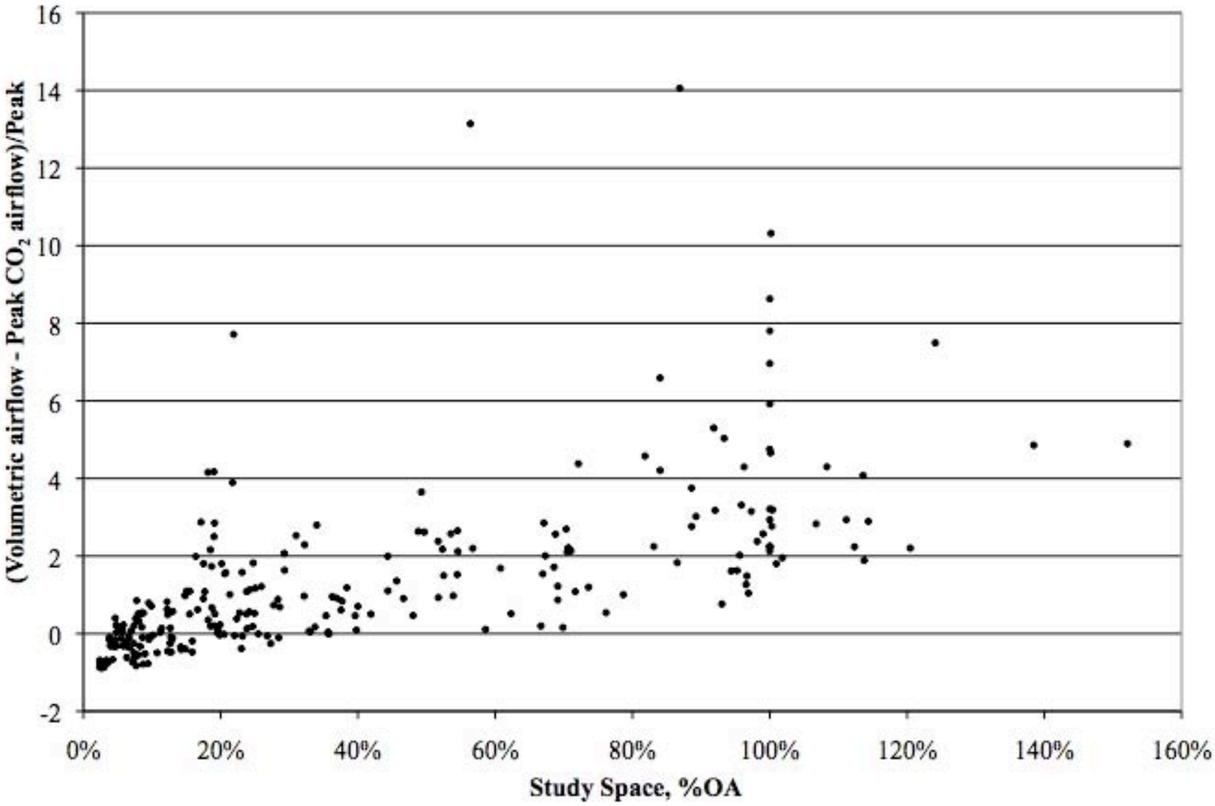

Figure 13 Relative difference between airflows vs. study space outdoor air fraction

However, low %OA values also correspond to low outdoor airflow rates, and as seen in Figures 5 through 7, the discrepancy is largest as the volumetric outdoor airflow rate increases. Therefore the trend in Figure 13 may be simply a manifestation of the dependency already noted.

The discrepancy between the volumetric and peak indoor CO_2-based airflow values were also examined for any dependence on a number of other factors, including the measured occupant density in the study space (number of people per unit floor area) and the estimated uncertainty of the peak indoor CO_2-based airflow rate, but no dependence was observed.

Accuracy of volumetric airflows

While questions have been raised above regarding the precision and bias of the peak indoor CO_2-based airflow rates, it is also reasonable to consider the accuracy of the traverse measurements. Industry guidance generally cites a measurement uncertainty of about 10 % for duct traverses under good field conditions [5-7], but the basis for this estimate is not well defined. The key question in the current study is whether there is a reason to suspect that the traverse measurements are biased high, particularly for the higher values of outdoor airflow per person. These higher values are associated with higher duct velocities. In general, traverse errors are more of a concern for low velocities, and therefore there is no particular reason to suspect the higher airflow rates to be inaccurate. While duct leakage would cause the delivered outdoor airflow to the space to be lower than that measured at the air handler, the amount of leakage required to account for the observed differences would have to be extremely high, as much as 90 % of the supply air leaking out of the ductwork. This is much larger than the commercial building duct leakage values that have been measured in the field to date, which are more in the 10 % to 20 % range [8].

One indication of the reliability of the duct traverse measurements is the comparison of the outdoor air fraction determined from the measured supply and outdoor airflow rates with the outdoor air fraction estimated from the CO_2 concentrations in the return, outdoor, and supply airstreams. As discussed in the original report, these two independent measurements of the outdoor air fraction are on average consistent. These data are replotted in Figure 14, and while there is some scatter in the data, no strong bias is evident.

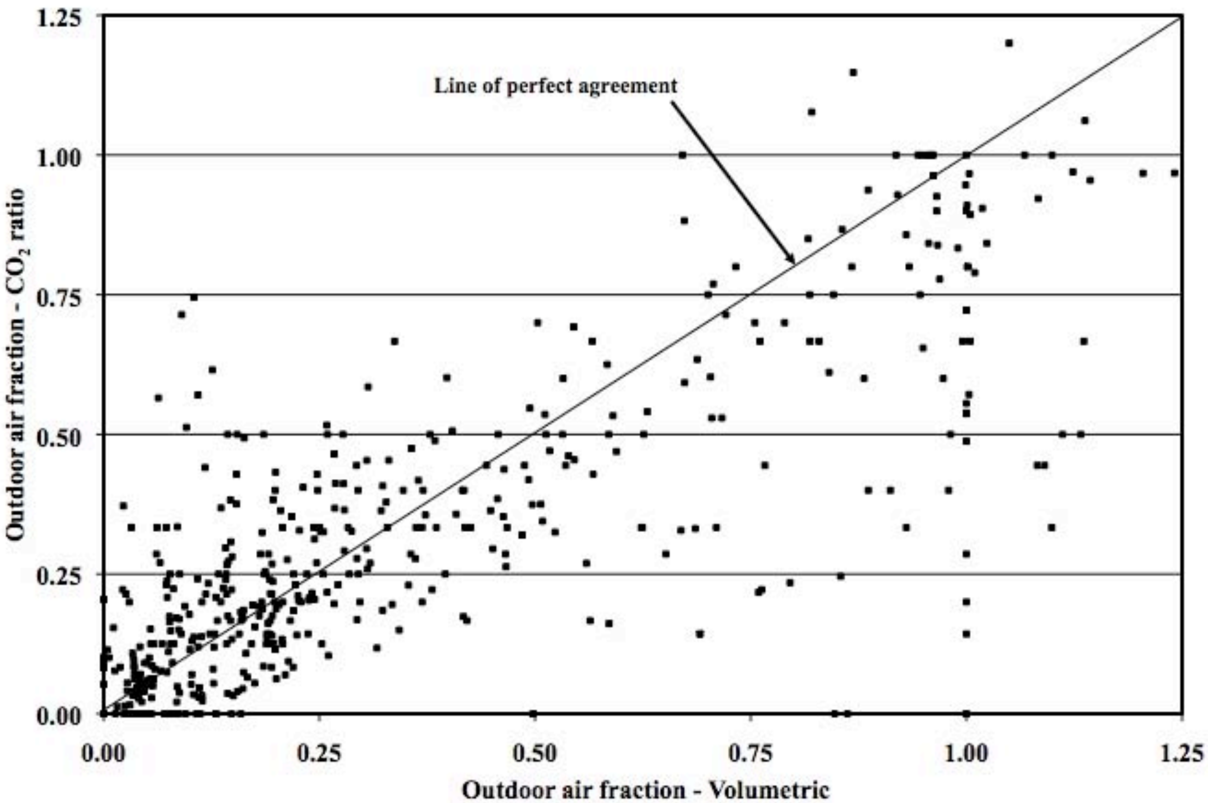

Figure 14 Outdoor air fraction based on CO_2 ratio vs. based on volumetric flows

A similar comparison can be made by comparing the outdoor airflow intake of the air handlers calculated from the supply traverse value times the outdoor air fraction determined from the airstream CO_2 concentrations with the outdoor airflow measured by the traverse measurements. These data are plotted in Figure 15, and while there is significant scatter in the plot the two methods of determining this quantity are on average consistent. The mean value of the former (Q_{supply} x %OA) is about 4800 L/s (10 200 cfm), while the mean of the latter is about 5600 L/s (11 900 cfm). Therefore, the traverse measurements of outdoor airflow are somewhat higher on average, but not enough to account for the differences noted related to the peak indoor CO_2-based airflows.

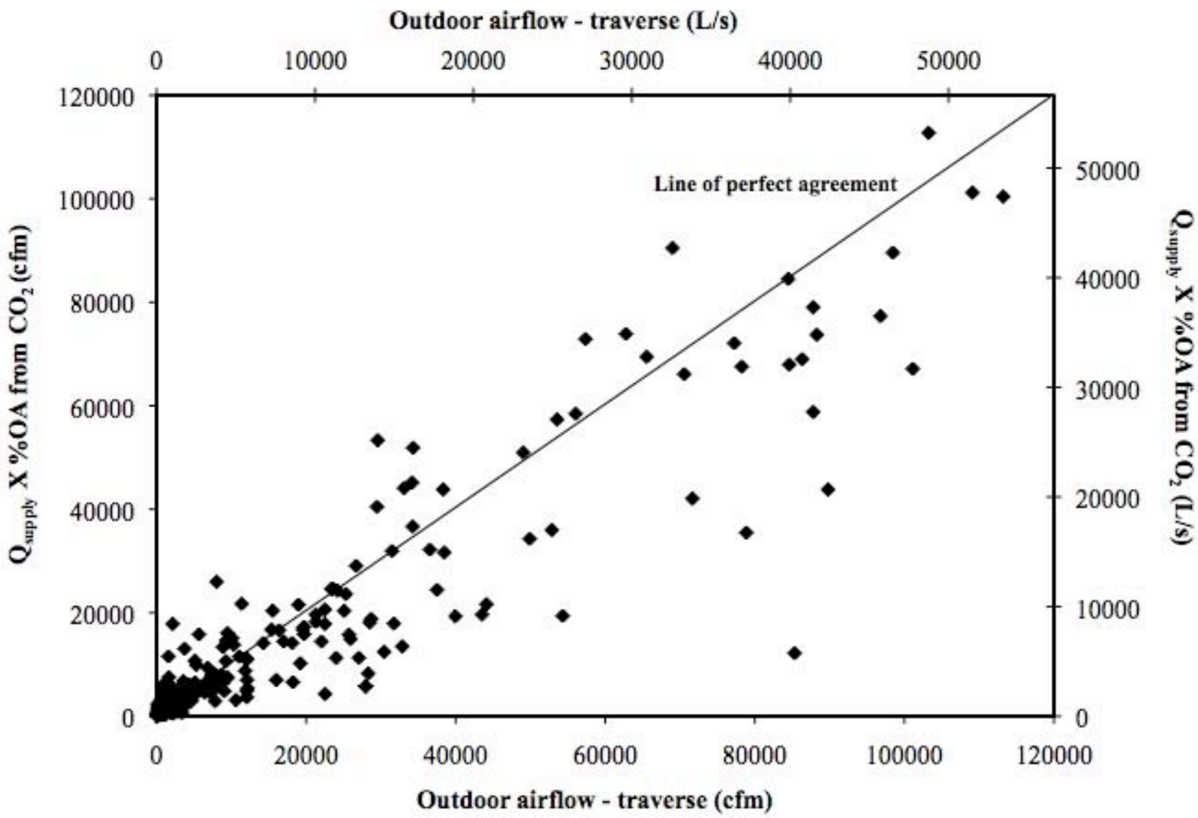

Figure 15 Outdoor airflow from CO_2 ratio times supply airflow vs. volumetric outdoor airflow

Another check on the internal consistency of traverses was performed by calculating the ratio of the measured supply airflow to the sum of the outdoor and recirculation airflows. Only twelve events exist in which all three airflows were measured by duct traverses. Four of them are in one building where the supply and recirculation airflows are very close to each other, i.e., the outdoor air intake rate is quite low. The mean value of this ratio for all twelve events is 1.3; without the first building the mean is 1.1. This comparison does not prove that the traverse measurements are accurate but it does demonstrate their internal consistency. However, if a large and consistent systematic error existed, it might have been evident in these ratios.

Another confirmation of the validity of the traverses is the comparison of the supply airflow traverse measurements with the design values. While there is much variation expected in this comparison, the mean measured supply airflow rate is 5.12 L/s•m^2 (1.01 cfm/ft^2), while the mean of the corresponding design value is 4.98 L/s•m^2 (0.98 cfm/ft^2). This comparison does not prove that the traverse values are accurate, but if there were a large systematic error, it should be evident in comparing the mean measured to the mean design value.

Limited range of peak CO_2 ventilation rates

As noted earlier, the ventilation rates based on the indoor peak CO_2 concentrations do not exhibit the range of rates seen for the volumetric rates. Considering the data in Figure 7, the peak CO_2 ventilation rates never exceed about 35 L/s (74 cfm) per person, which corresponds to an indoor-outdoor concentration difference of about 270 mg/m^3 (150 ppm(v)). In other words, the peak indoor CO_2 concentrations are seldom less than 270 mg/m^3 (150 ppm(v)) above the outdoors.

This lower limit on the peak values is a very curious result, for which no explanation has been identified.

Conclusion on Peak CO_2 versus Traverse Issue

The final comparison worth noting is a “reality-check” on the air change rates calculated from the traverse measurements and from the peak CO_2 estimates. The mean test space outdoor air change rate based on traverse measurements is 1.83 h^{-1}, or 1.87 L/s•m^2 (0.37 cfm/ft^2). Dividing this value by the mean outdoor air fraction of 0.31 (based on CO_2 concentrations in the supply, return, and outdoor airstreams) yields 5.9 h^{-1} or 6.03 L/s•m^2 (1.19 cfm/ft^2), which is a very reasonable value for the supply airflow rate in an office building. The mean outdoor air change rate based on peak indoor CO_2 levels equals 0.83 h^{-1}, or 0.85 L/s•m^2 (0.17 cfm/ft^2), which when divided by the average outdoor air fraction is 2.7 h^{-1} or 2.74 L/s•m^2 (0.55 cfm/ft^2). These supply airflow rates based on the peak CO_2 values are well below, about half of, typical supply airflow rates for an office building.

In conclusion, the discrepancy between the peak indoor CO_2-based and traverse-based outdoor airflow rates has not been fully explained. However, there is good reason to suspect that the peak indoor CO_2-based values may not provide reliable estimates of the BASE study space outdoor air ventilation rates. In particular, the measured test space CO_2 concentrations may be elevated relative to the actual space concentrations based on the observed differences between the space concentrations and return concentrations, the concentration variation among the test space locations, and the fact that the study space concentration is seldom less than 270 mg/m^3 (150 ppm(v)) above the outdoor concentration.

CONCLUSIONS

This reanalysis of the BASE ventilation data has uncovered a small number of corrections, none of which impact the conclusions of the study. However, the updated dataset is now more reliable and should be used instead of the original version released in 2004 [1]. The attempt to explain the difference between the outdoor air ventilation rates determined by the duct traverses and those based on the peak CO_2 concentrations in the study spaces revealed some potential explanations related to concentration nonuniformities but they were not able to fully explain the magnitude of the differences. It is unlikely that these differences will be explained through additional analyses of the BASE data. However, future efforts to understand these differences are warranted through experimental efforts specifically designed to investigate the problem. Other potential explanations could also be studied in the future, such as those related to assumed values for the CO_2 generation rates by the occupants.

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