



P.O. Box 1962, Paso Robles, CA 93447
805.712.6359, sarah.palt@paltandassociates.com

Santa Barbara City College Supply Airflow Testing Report

Presented to:

SBCC
721 Cliff Drive
Santa Barbara, CA 93109

Testing Date: Feb./ March 2021

Presented by:

Palt & Associates, Inc.
Sarah Palt

This is to certify that Palt and Associates, Inc., a California Corporation, has inspected and tested the systems described herein as to the state of performance, conditions and capabilities. The testing has been performed in accordance with ISO Norm 14644-1:2015 and the standard requirements and procedures of the Associated Air Balance Council. Palt and Associates is a California State Licensed air and water balance contractor and a carries a D-62 license. We certify the results of this testing to be true and accurate.

Certification Number: **P21-012.1**

A handwritten signature in blue ink, appearing to read 'Sarah Palt', is written over a faint, light blue circular stamp.

Sarah Palt, CEO

Final report 04/15/2021

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1. Overview

The following is the report for the airflow test study conducted at the Santa Barbara City College beginning of 2021. The scope of work was to test supply airflows for all indicated classrooms, lecture halls and offices to determine Air Change Rates for each room / area. Outside airflows were calculated for each room using building DDC information.

The current report contains only a small number of rooms that were tested during this study. The rooms listed in this report are the main focus as part of the early re-opening of the College to Students beginning of May 2021. A complete report including all buildings and tested rooms will be submitted as soon as the on-site testing of airflows is completed.

1.1. Definitions

SA = Supply Airflow

OSA = Outside Airflow = fresh air

Air Change Rate: How many times the air in a defined space is changed out per hour; ACR is calculated as follows: $ACR = \text{Total SA (CFM)} * 60 / \text{Room Volume (CFT)}$

ASHRAE Standard 62.1-2019: Standard listing supply and OSA amounts to calculated new design buildings. The Standard also includes a table (Table L-1) providing check values for ventilation rates for existing buildings. This table and calculated outside airflows are check values ONLY and based on assumed and standardized default settings. In no way can these values determine a PASS/FAIL criteria for any rooms. It is only to provide check values, assuming default values for occupancy and a multi-zone HVAC system to simplify calculations.

2. Preliminaries

Each tested HVAC system was set to maximum airflow capacity at the time of testing. The numbers listed in this report give the maximum possible supply airflow for each area with the current HVAC system (exceptions are noted in the attached data sheets).

Room areas (in square feet) were given to Palt and Associates by SBCC and were NOT measured or verified on site. Room height of each individual room was measured by Palt and Associates on site.

All data taken are listed in the attached data sheets, organized by building and floor. Each data sheet lists room area, room height, calculated room volume, testes Supply Airflow and Supply Air Change Rates.

Outside Air amounts (OSA) were NOT tested. OSA was calculated by using the DDC systems information (provided by SBCC) for each individual system and are noted in the data sheets. These numbers are used to calculate the Outside Air Change Rate, which differs from the Supply Air Change Rate (less), unless the system provides 100% outside air.

The subject of this report is to report tested airflows only. Assumptions based on these data in regard to health and safety of occupants are in no way the responsibility of Palt and Associates Inc. This airflow study can only report test data at one point in time (at the time of testing) and help evaluate the condition and performance of the mechanical HVAC system tested.

Note: HVAC design calculations in California are based on minimum energy consumption. Conditioning of outside air requires a lot of energy in most cases and is therefore set to the minimum amount.

3. Supply Airflow Testing

Airflow measurements were obtained using a Shortridge Instruments ADM860 Air Data Multimeter with a Flowhood adapter (tent) wherever possible. If the use of the Flowhood was not feasible due to ceiling height (lecture halls, theatres, gym) the main supply air duct for the specific area was traversed using a Shortridge Multimeter with Airfoil adapter. Small holes were drilled into the ductwork and velocity readings were taken across the entire opening of the duct. The average velocity was multiplied by the open area of the duct to calculate the supply airflow.

4. Data Analysis

Required air change rates (ACR) and outside airflow depends on multiple factors: Size and volume of room, usage of room, and occupancy. A minimum Outside Air Amount of ACR = 4-6 for classrooms can be used as a guideline ONLY. Correct requirements per ASHREA Standard have to be calculated for each room specifically.

To verify and check ventilation rates, ASHRAE Standard 62.1-2019 includes a table listing “Combined Outdoor Air Rate” in CFM/SQFT for different Occupancy Categories. This list is NOT intended for design purpose and is used to provide check values ONLY, with assumed default values to simplify calculations.

Using this table, outdoor airflow rates were calculated for each room and compared to the current, tested outdoor airflow rates.

5. Test Data Summary

The following table shows a summary of the main tested data compiled during the airflow study. More detailed information for each area tested are arranged at the end of this report.

Building	Room	Tested		ASHRAE STANDARD 62.1- 2019 Table L-1 Ventilation Check Table		Recommendation
		Total SA Airflow	Calculated OSA Airflow	Min. required OSA Airflow	Within ASHRAE Requirements	
		CFM	CFM	CFM	Yes / No	
ADM-01	160	3,845	3,076	2,165	YES	See section 5.1, 1 thru 3
ADM-01	161	1,378	1,102	552	YES	See section 5.1, 1 thru 3
ADM-02	211	3,688	3,688	4,415	NO	See section 5.1, 1 thru 4
ADM-02	236	95	76	246	NO	See section 5.1, 1 thru 4
ADM-02	242	137	110	355	NO	See section 5.1, 1 thru 4
ADM-02	243	150	120	342	NO	See section 5.1, 1 thru 4
ADM-02	273	1,168	934	605	YES	See section 5.1, 1 thru 3
BCM-01	102	1,048	210	1,114	NO	See section 5.1, 1 thru 4
DM-01	105	2,404	1,202	1,077	YES	See section 5.1, 1 thru 3
DM-01	110	1,054	211	489	NO	See section 5.1, 1 thru 4
DM-01	126	747	149	389	NO	See section 5.1, 1 thru 4
DM-01	130	262	52	235	NO	See section 5.1, 1 thru 4
DM-01	139	6,825	1,365	1,158	YES	See section 5.1, 1 thru 3
DM-01	150	15,788	3,158	3,548	NO	See section 5.1, 1 thru 4
DM-01	155	518	259	371	NO	See section 5.1, 1 thru 4

		Tested		ASHRAE STANDARD 62.1- 2019 Table L-1 Ventilation Check Table		
Building	Room	Total SA Airflow	Calculated OSA Airflow	Min. required OSA Airflow	Within ASHRAE Requirements	Recommendation
		CFM	CFM	CFM	Yes / No	
EBS	123	1,222	611	2,152	NO	See section 5.1, 1 thru 4
EBS	312	1,018	1,018	1,785	NO	See section 5.1, 1 thru 4
HUM-01	111	1,654	827	1,375	NO	See section 5.1, 1 thru 4
HUM-02	220	1,860	1,488	626	YES	See section 5.1, 1 thru 3
HUM-03	300	1,085	217	236	NO	See section 5.1, 1 thru 4
HUM-03	301	498	100	337	NO	See section 5.1, 1 thru 4
HUM-03	302	201	40	337	NO	See section 5.1, 1 thru 4
PE	101	21,525	10,762	6,473	YES	See section 5.1, 1 thru 3
PE	218	1,222	244	536	NO	See section 5.1, 1 thru 4
PS	208	838	838	1,839	NO	See section 5.1, 1 thru 4
WCC	117	1,113	223	214	YES	See section 5.1, 1 thru 3

5.1. Recommendations:

The following list are recommendations applicable for all areas (1 to 3) but especially for the areas with outside airflows below minimum ASHRAE recommendations:

1. Increase mechanical outside airflow from current minimum setting to maximum setting wherever possible; re-calculate calculated outside airflows for new OSA settings and reevaluate outside airflows.
2. Open windows to increase outside air amount and fresh air circulation throughout the room; this method cannot be “tested”, as airflow testing can only be performed for mechanical systems (airflow amount through an open window will change depending on outside air conditions, wind, temperature etc.); however, it will increase the outside airflow in the classroom. Strategically placed fans in front of windows will help outside air circulation throughout the room. If necessary, smoke studies can be performed to help visualize airflow pattern and currents throughout the classroom.

3. Minimize class density; above listed recommended outside airflows per ASHRAE Table L-1 assume standard occupancy
4. Place portable HEPA filter air purifiers in classrooms of concern. These units recirculate room air at a specified rate (can be tested) through a system of pre- and HEPA filters and help provide clean filtrated air to the area.

6. Conclusion and Discussion:

All tested airflows listed in this report can only be used to evaluate the condition of the HVAC system. The original design parameters for rooms and buildings are unknown at this time. All comparison values are recommendations only, using comparison tables and current mechanical standards as references. These standards are meant to evaluate the HVAC systems only and cannot in any way be used in regard to health and safety recommendations. Recommendations listed in this report are based on current CDC, NEBB and similar organizations knowledge, recommendations and suggestions.

Common best practice recommendations for all areas:

- Run HVAC system continuously; at a minimum perform building flush-outs by running mechanical airflows two hour prior and two hours past building occupancy
- Continue to use MERV 13 Filters in all HVAC Systems with monthly check up on filter loading / change out
- Continue to clean and sanitize all areas in use
- Continue to request face covering to be worn at all times
- Continue to minimize close contact and maintain a safe distance
- Increase total Supply Airflow if Supply Airflow Rate is low
- Increase OSA airflow to maximum possible amount
- Open windows in all areas possible and whenever spaces are occupied
- Place portable HEPA filter units in areas of concern

Further options of upgrading the mechanical systems are currently available, for example installation of UV lights inside HVAC units or Ionization units in supply air ducts. However, these methods are costly and are not short term / fast options as they require major changes to the mechanical systems. Their effectiveness has to be evaluated in regard to their costs (installation and maintenance) and installation duration.

7. APPENDIX

7.1. Detailed building summary

7.1.1.ADM Building

Building	Room #	Room Volume	Total SA Airflow	Total SA Air Change Rate	Calculated OSA	Calculated OSA Air Change Rate
		CFT	CFM	AC/hr	CFM	AC/hr
ADM-01	160	15,640.8	3,844.9	14.7	3,076.0	11.8
ADM-01	161	7,497.0	1,378.0	11.0	1,102.4	8.8
ADM-02	211	46,566.7	3,687.5	4.8	3,687.5	4.8
ADM-02	236	4,274.1	95.0	1.3	76	1.1
ADM-02	242	4,576.5	137.0	1.8	109.6	1.4
ADM-02	243	4,641.0	150.0	1.9	120.0	1.6
ADM-02	273	8,290.0	1,168.0	8.5	934.4	6.8

ASHREA STANDARD 62.1-2019 Table L-1 Ventilation Check Table				
Room Area	Occupancy Category	Combined Outdoor Air Rate	Required	% Difference
SQFT		CFM/SQFT	CFM	
1,370	Lecture Hall (fixed seating)	1.58	2,165	42%
756	Lecture Class Room	0.73	552	100%
2,794	Lecture Hall (fixed seating)	1.58	4,415	-16%
431	Science Laboratory	0.57	246	-100%
486	Lecture Class Room	0.73	355	-69%
468	Lecture Class Room	0.73	342	-65%
829	Lecture Class Room	0.73	605	54%

Example Room 160:

Room 160 has a calculated total room volume of 15,640 cubic feet (room area * room height). The total supply airflow was tested with 3,845 CFM, which calculates a Supply Airflow Rate (ACR) of 14.7. This means, the entire air volume of Room 160 is changed out 14.7 times per hour. According to SBCC the HVAC system for Room 160 is set to 80% outside air, 80% of the total supply airflow is fresh, outside air and only 20% (100%-80%) is recirculated return airflow. Therefore, the Outside airflow can be calculated by multiplying the supply airflow of 3,845 CFM by 0.8 = 3,076 CFM. The Outside Air Change Rate comes to 11.8 AC/hr = the entire room volume is change out with fresh OUTSIDE AIR 11.8 times per hour.

Using ASHRAE Ventilation Check list and the room seating data provided by SBCC, Room 160 is defined as a Lecture Hall with fixed seating and an “Combined Outdoor Air Rate” of 1.58. Multiplied by the area of the room (sqft), a required or recommended outside airflow of 2,165 CFM can be calculated, which is 42% ABOVE what is currently available in this classroom.

7.1.2. BC Building

Building	Room #	Room Volume	Total SA Airflow	Total SA Air Change Rate	Calculated OSA	Calculated OSA Air Change Rate
		CFT	CFM	AC/hr	CFM	AC/hr
BCM-01	102	15,132.8	1,048.0	4.2	209.6	0.8

ASHREA STANDARD 62.1-2019 Table L-1 Ventilation Check Table				
Room Area	Occupancy Category	Combined Outdoor Air Rate	Required	% Difference
SQFT		CFM/SQFT	CFM	
1,526	Lecture Class Room	0.73	1,114	-81%

7.1.3. DM Building

Building	Room #	Room Volume	Total SA Airflow	Total SA Air Change Rate	Calculated OSA	Calculated OSA Air Change Rate
		CFT	CFM	AC/hr	CFM	AC/hr
DM-01	105	43,261.3	2,404.4	3.3	1,202.2	1.7
DM-01	110	7,926.9	1,054.0	8.0	210.8	1.6
DM-01	126	6,304.1	747.0	7.1	149.4	1.4
DM-01	130	3,816.3	262.0	4.1	52.4	0.8
DM-01	139	46,485.4	6,824.7	8.8	1,364.9	1.8
DM-01	150	149,962.5	15,788.4	6.3	3,157.7	1.3
DM-01	155	6,122.2	518.0	5.1	259.0	2.5

ASHREA STANDARD 62.1-2019 Table L-1 Ventilation Check Table				
Room Area	Occupancy Category	Combined Outdoor Air Rate	Required	% Difference
SQFT		CFM/SQFT	CFM	
1,959	Music / Theatre/Dance	0.55	1,077	12%
889	Music / Theatre/Dance	0.55	489	-57%
707	Music / Theatre/Dance	0.55	389	-62%
428	Music / Theatre/Dance	0.55	235	-100%
2,105	Music / Theatre/Dance	0.55	1,158	18%
6,450	Music / Theatre/Dance	0.55	3,548	-11%
674	Music / Theatre/Dance	0.55	371	-30%

7.1.4. EBS Building

Building	Room #	Room Volume	Total SA Airflow	Total SA Air Change Rate	Calculated OSA	Calculated OSA Air Change Rate
		CFT	CFM	AC/hr	CFM	AC/hr
EBS	123	13,052.5	1,222.0	5.6	611.0	2.8
EBS	312	11,111.7	1,018.0	5.5	1,018.0	5.5

ASHREA STANDARD 62.1-2019 Table L-1 Ventilation Check Table				
Room Area	Occupancy Category	Combined Outdoor Air Rate	Required	% Difference
SQFT		CFM/SQFT	CFM	
1,362	Lecture Hall (fixed seats)	1.58	2,152	-72%
1,130	Lecture Hall (fixed seats)	1.58	1,785	-43%

7.1.5.HUM Building

Building	Room #	Room Volume	Total SA Airflow	Total SA Air Change Rate	Calculated OSA	Calculated OSA Air Change Rate
		CFT	CFM	AC/hr	CFM	AC/hr
HUM-01	111	10,730.0	1,654.0	9.2	827.0	4.6
HUM-02	220	15,452.3	1,860.0	7.2	1,488.0	5.8
HUM-03	300	3,343.8	1,085.0	19.5	217.0	3.9
HUM-03	301	5,037.9	498.0	5.9	99.6	1.2
HUM-03	302	5,037.9	201.0	2.4	40.2	0.5

ASHREA STANDARD 62.1-2019 Table L-1 Ventilation Check Table				
Room Area	Occupancy Category	Combined Outdoor Air Rate	Required	% Difference
SQFT		CFM/SQFT	CFM	
870	Lecture Hall (fixed seating)	1.58	1,375	-40%
1,228	Art Class Room	0.51	626	138%
375	Class Room	0.63	236	-8%
535	Class Room	0.63	337	-100%
535	Class Room	0.63	337	-88%

7.1.6. PE Building

Building	Room #	Room Volume	Total SA Airflow	Total SA Air Change Rate	Calculated OSA	Calculated OSA Air Change Rate
		CFT	CFM	AC/hr	CFM	AC/hr
PE	101	673,666.5	21,524.5	1.9	10,762.3	1.0
PE	218	8,155.4	1,222.0	9.0	244.4	1.8

ASHREA STANDARD 62.1-2019 Table L-1 Ventilation Check Table				
Room Area	Occupancy Category	Combined Outdoor Air Rate	Required	% Difference
SQFT		CFM/SQFT	CFM	
15,054	Gym, sports arena	0.43	6,473	66%
851	Class Room	0.63	536	-54%

7.1.7. PS Building

Building	Room #	Room Volume	Total SA Airflow	Total SA Air Change Rate	Calculated OSA	Calculated OSA Air Change Rate
		CFT	CFM	AC/hr	CFM	AC/hr
PS	208	13,580.0	838.0	3.7	838.0	3.7

ASHREA STANDARD 62.1-2019 Table L-1 Ventilation Check Table				
Room Area	Occupancy Category	Combined Outdoor Air Rate	Required	% Difference
SQFT		CFM/SQFT	CFM	
1,164	Lecture Hall (fixed seating)	1.58	1,839	-54%

7.1.8. WCC Building

Building	Room #	Room Volume	Total SA Airflow	Total SA Air Change Rate	Calculated OSA	Calculated OSA Air Change Rate
		CFT	CFM	AC/hr	CFM	AC/hr
WCC	117	3,371.7	1,113.0	19.8	222.6	4.0

ASHREA STANDARD 62.1-2019 Table L-1 Ventilation Check Table				
Room Area	Occupancy Category	Combined Outdoor Air Rate	Required	% Difference
SQFT		CFM/SQFT	CFM	
340	Class Room	0.63	214	4%

7.2. Equipment Calibration Certificates



Calibration Certificate

001102024

Customer: PALT AND ASSOC INC
6110 WILD HORSE PL

Serial Number: M95752RFS

Test Result: **PASS**

Asset ID: M95752RFS

Cal Date: 8/17/2020

Manufacturer: SHORTRIDGE INSTRUMENTS

Next Cal Date: 08/17/2021

PASO ROBLES, CA, 93446-8408

Model Number: ADM-860

Date of Issue: 08/17/2020

Work Order: 00121424

Location:

Performed At: ALLOMETRICS LABORATORY

Performed By: TFIREBAUGH

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TEST ENVIRONMENT

Temperature: 20.58 C

Humidity: 45.8 %

UUT CONFORMITY TEST DATA

#	Description	Test Point	Unit	Minimum	Maximum	As Found	P/F	As Left	P/F
1	Absolute Pressure	30.01	inHg	29.31	30.71	30.02	P	30.02	P
2	Differential Pressure	0.0500	in.wc	0.0480	0.0520	0.0508	P	0.0508	P
3		0.1250	in.wc	0.1215	0.1285	0.1228	P	0.1228	P
4		0.2250	in.wc	0.2195	0.2305	0.2274	P	0.2274	P
5		1.000	in.wc	0.979	1.021	0.992	P	0.992	P
6		2.000	in.wc	1.959	2.041	2.001	P	2.001	P
7		3.600	in.wc	3.527	3.673	3.571	P	3.571	P
8		27.00	in.wc	26.46	27.54	26.73	P	26.73	P
9	Low Velocity Confirmation	100	fpm	90	110	101	P	101	P
10	w/ pitot tube	500	fpm	478	522	498	P	498	P

TEST EQUIPMENT

Description	Asset ID	Cal. Due Date
ADDITEL/ADT760-LLP-DL/PRESSURE CALIBRATOR	1516	2/8/2021
ADDITEL/ADT155-DP30-760/Pressure Module	1516A	2/8/2021
OMEGA/WT4401-D/WIND TUNNEL SYSTEM	1904	11/26/2021

PROCEDURE

Procedure Name	Revision	Description	Date
QWI 19-45	C.	CALIBRATION PROCEDURE FOR PRESSURE DEVICES	11/4/2019

COMMENTS

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Calibration Certificate

001102026

Customer: PALT AND ASSOC INC 6110 WILD HORSE PL PASO ROBLES, CA, 93446-8408 Work Order: 00121424	Serial Number: M891011RFS Asset ID: M891011RFS Manufacturer: SHORTRIDGE INSTRUMENTS Model Number: ADM-860 Location:	Test Result: PASS Cal Date: 8/17/2020 Next Cal Date: 08/17/2021 Date of Issue: 08/17/2020 Performed At: ALLOMETRICS LABORATORY Performed By: TFIREBAUGH
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The standards listed under the Test Equipment section and used in this calibration are traceable through NIST (National Institute for Standards and Technology) to the SI (International System of Units).

ACCEPTANCE OF THIS CERTIFICATION OR CALIBRATION DOCUMENT OR THE CONTINUED USE OF THE EQUIPMENT LISTED ON THIS DOCUMENT INDICATES AGREEMENT WITH ALLOMETRICS INC. TERMS AND CONDITIONS AS FOUND AT <https://www.allometrics.com/terms-and-conditions/> AND AGREEMENT THAT THOSE CONDITIONS GOVERN ANY TRANSACTION RELATED TO THE CERTIFICATION, CALIBRATION, REPAIR OR USE OF ANY EQUIPMENT LISTED ON OR ASSOCIATED WITH THIS DOCUMENT.

TEST ENVIRONMENT

Temperature: 20.58 C

Humidity: 45.8 %

UUT CONFORMITY TEST DATA

#	Description	Test Point	Unit	Minimum	Maximum	As Found	P/F	As Left	P/F
1	Absolute Pressure	30.02	inHg	29.32	30.72	30.30	P	30.30	P
2	Differential Pressure	0.0500	in.wc	0.0480	0.0520	0.0487	P	0.0487	P
3		0.1250	in.wc	0.1215	0.1285	0.1273	P	0.1273	P
4		0.2250	in.wc	0.2195	0.2305	0.2234	P	0.2234	P
5		1.000	in.wc	0.979	1.021	1.010	P	1.010	P
6		2.000	in.wc	1.959	2.041	2.007	P	2.007	P
7		3.600	in.wc	3.527	3.673	3.603	P	3.603	P
8		27.00	in.wc	26.46	27.54	26.84	P	26.84	P
9	Low Velocity Confirmation	100	fpm	90	110	101	P	101	P
10	w/ pitot tube	500	fpm	478	522	497	P	497	P

TEST EQUIPMENT

Description	Asset ID	Cal. Due Date
ADDITEL/ADT760-LLP-DL/PRESSURE CALIBRATOR	1516	2/8/2021
ADDITEL/ADT155-DP30-760/Pressure Module	1516A	2/8/2021
OMEGA/WT4401-D/WIND TUNNEL SYSTEM	1904	11/26/2021

PROCEDURE

Procedure Name	Revision	Description	Date
QWI 19-45	C.	CALIBRATION PROCEDURE FOR PRESSURE DEVICES	11/4/2019

COMMENTS

----- end report -----

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7.3. Detailed room data sheets

P21-012 SBCC Air Flow Testing

Building: ADM-01
Room: 160

Room Area: 1,370 SQFT
 Room Height: 11.4 FT
 Room Volume: 15,640.8 CFT

Tested Supply Airflow = 3,844.9 CFM
Tested SA Air Change Rate = 14.7 AC/hr

OSA % (DDC): 0.8 80%
 OSA calculated = 3,076.0 CFM

Calc. OSA Air Change Rate = 11.8 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Normal operations 70% speed (tested @ 100%)

Calc. OSA Air Change Rate = 8.3 AC/hr

Testing Method: Duct Traverse / Airfoil

Duct Diameter: 16" x 24"
 Duct Area = 2.7 SQFT

1,365	1,568	1,535	1,538	1,566	1,589	1,573	1,493	1,453
1,542	1,585	1,592	1,457	1,306	1,322	1,274	1,264	1,151
1,469	1,581	1,646	1,643	1,516	1,368	1,230	1,026	1,278

Average Velocity = 1,442 FPM
 Supply Airflow = 3,844.9 CFM

Air Handler: AH-1
 Comment: 100% max airflow; 80% OSA
 AH-1 set to 70% of max airflow (normal operations)
 No cooling capacity

P21-012 SBCC Air Flow Testing

Building: ADM-01
Room: 161

Room Area: 756 SQFT
Room Height: 9.9 FT
Room Volume: 7,497.0 CFT

Tested Supply Airflow = 1,378.0 CFM
Tested SA Air Change Rate = 11.0 AC/hr

OSA % (DDC): 0.8 80%
OSA calculated = 1,102.4 CFM

Calc. OSA Air Change Rate = 8.8 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Flow Hood

Register	CFM
SA#1	347
SA#2	319
SA#3	375
SA#4	337
Total	1,378

Supply Airflow = 1,378.0 CFM

P21-012 SBCC Air Flow Testing

Building: ADM-02
Room: 211

Room Area: 2,794 SQFT
 Room Height: 16.7 FT
 Room Volume: 46,566.7 CFT

Tested Supply Airflow = 3,687.5 CFM
Tested SA Air Change Rate = 4.8 AC/hr

OSA % (DDC): 1 100%
 OSA calculated = 3,687.5 CFM

Calc. OSA Air Change Rate = 4.8 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Duct Traverse / Airfoil

Ins. Duct Diameter: 22" x 34"
 Duct Area = 5.2 SQFT

0	567	930	1,036	1,028	1,027	994	1,055	1,053	956
446	611	643	594	604	666	739	790	775	867
530	576	566	524	477	630	651	810	715	859
611	662	647	329	482	663	707	741	898	937

Average Velocity = 710 FPM
 Supply Airflow = 3,687.5 CFM

Air Handler: AH-3
 Comment: 100% OSA

P21-012 SBCC Air Flow Testing

Building: ADM-02
Room: 236

Room Area: 431 SQFT
 Room Height: 9.9 FT
 Room Volume: 4,274.1 CFT

Tested Supply Airflow = 95.0 CFM
 Tested SA Air Change Rate = 1.3 AC/hr

OSA % (DDC): 0.8 80%
 OSA calculated = 76.0 CFM

Calc. OSA Air Change Rate = 1.1 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Flow Hood

Register	CFM
SA#1	42
SA#2	53
Total	95

Supply Airflow = 95.0 CFM

Building: ADM-01
Room: 236-A

Room Area: 322 SQFT
 Room Height: 9.9 FT
 Room Volume: 3,193.2 CFT

Tested Supply Airflow = 28.0 CFM
 Tested SA Air Change Rate = 0.5 AC/hr

OSA % (DDC): 0.8 80%
 OSA calculated = 22.4 CFM

Calc. OSA Air Change Rate = 0.4 AC/hr

Recommendation: 4-6 OSA Air Change Rate

P21-012 SBCC Air Flow Testing

Testing Method: Flow Hood

Register	CFM
SA#1	28
Total	28

Supply Airflow = 28.0 CFM

Building: ADM-01

Room: 236-B

Room Area: 299 SQFT

Room Height: 9.9 FT

Room Volume: 2,965.1 CFT

Tested Supply Airflow = 41.0 CFM

Tested SA Air Change Rate = 0.8 AC/hr

OSA % (DDC): 0.8 80%

OSA calculated = 32.8 CFM

Calc. OSA Air Change Rate = 0.7 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Flow Hood

Register	CFM
SA#1	41
Total	41

Supply Airflow = 41.0 CFM

P21-012 SBCC Air Flow Testing

Building: ADM-02
Room: 242

Room Area: 486 SQFT
Room Height: 9.4 FT
Room Volume: 4,576.5 CFT

Tested Supply Airflow = 137.0 CFM
Tested SA Air Change Rate = 1.8 AC/hr

OSA % (DDC): 0.8 80%
OSA calculated = 109.6 CFM

Calc. OSA Air Change Rate = 1.4 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Flow Hood

Register	CFM
SA#1	0
SA#2	45
SA#3	43
SA#4	49
Total	137

Supply Airflow = 137.0 CFM

P21-012 SBCC Air Flow Testing

Building: ADM-02
Room: 243

Room Area: 468 SQFT
Room Height: 9.9 FT
Room Volume: 4,641.0 CFT

Tested Supply Airflow = 150.0 CFM
Tested SA Air Change Rate = 1.9 AC/hr

OSA % (DDC): 0.8 80%
OSA calculated = 120.0 CFM

Calc. OSA Air Change Rate = 1.6 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Flow Hood

Register	CFM
SA#1	46
SA#2	34
SA#3	30
SA#4	40
Total	150

Supply Airflow = 150.0 CFM

P21-012 SBCC Air Flow Testing

Building: ADM-02
Room: 273

Room Area: 829 SQFT
Room Height: 10.0 FT
Room Volume: 8,290.0 CFT

Tested Supply Airflow = 1,168.0 CFM
Tested SA Air Change Rate = 8.5 AC/hr

OSA % (DDC): 0.8 80%
OSA calculated = 934.4 CFM

Calc. OSA Air Change Rate = 6.8 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Flow Hood

Register	CFM
SA#1	305
SA#2	275
SA#3	293
SA#4	295
Total	1,168

Supply Airflow = 1,168.0 CFM

P21-012 SBCC Air Flow Testing

Building: BCM-01

Room: 102

Room Area: 1,526 SQFT

Room Height: 9.9 FT

Room Volume: 15,132.8 CFT

Tested Supply Airflow = 1,048.0 CFM

Tested SA Air Change Rate = 4.2 AC/hr

OSA % (DDC): 0.2 20%

OSA calculated = 209.6 CFM

Calc. OSA Air Change Rate = 0.8 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Flow Hood

Register	CFM
SA#1	139
SA#2	166
SA#3	132
SA#4	138
SA#5	313
SA#6	75
SA#7	85
Total	1,048

Supply Airflow = 1,048.0 CFM

P21-012 SBCC Air Flow Testing

Building: DM-01
Room: 105 Instrumental Rehearsal Room

Room Area: 1,959 SQFT
 Room Height: 22.1 FT
 Room Volume: 43,261.3 CFT

Tested Supply Airflow = 2,404.4 CFM
Tested SA Air Change Rate = 3.3 AC/hr

OSA % (DDC): 0.5 50%
 OSA calculated = 1,202.2 CFM

Calc. OSA Air Change Rate = 1.7 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Duct Traverse / Airfoil

Ins. Duct Diameter: 15" x 32"
 Duct Area = 3.3 SQFT

807	977	898	851	745	621	504	870	946	856
1,155	976	630	500	582	520	643	650	420	649
888	862	632	532	598	632	589	646	657	804

Average Velocity = 721 FPM
 Supply Airflow = 2,404.4 CFM

Air Handler: HP-5
 Comment: 50% OSA Fixed
 Static Pressure 0.244"WC

P21-012 SBCC Air Flow Testing

Building: DM-01
Room: 110 Music Appreciation Lab

Room Area: 889 SQFT
Room Height: 8.9 FT
Room Volume: 7,926.9 CFT

Tested Supply Airflow = 1,054.0 CFM
Tested SA Air Change Rate = 8.0 AC/hr

OSA % (DDC): 0.2 20% FIXED
OSA calculated = 210.8 CFM

Calc. OSA Air Change Rate = 1.6 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Flow Hood

Register	CFM
SA#1	559
SA#2	495
Total	1,054

Supply Airflow = 1,054.0 CFM

P21-012 SBCC Air Flow Testing

Building: DM-01
Room: 126 Costume Lab

Room Area: 707 SQFT
 Room Height: 8.9 FT
 Room Volume: 6,304.1 CFT

Tested Supply Airflow = 747.0 CFM
Tested SA Air Change Rate = 7.1 AC/hr

OSA % (DDC): 0.2 20%
 OSA calculated = 149.4 CFM

Calc. OSA Air Change Rate = 1.4 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Flow Hood

Register	CFM
SA#1	177
SA#2	37
SA#3	268
SA#4	265
Total	747

Supply Airflow = 747.0 CFM

Building: DM-01
Room: 126-A Dye Room

Room Area: 88 SQFT
 Room Height: 8.9 FT
 Room Volume: 784.7 CFT

Tested Supply Airflow = 397.0 CFM
Tested SA Air Change Rate = 30.4 AC/hr

OSA % (DDC): 0.2 20%
 OSA calculated = 79.4 CFM

Calc. OSA Air Change Rate = 6.1 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Flow Hood

P21-012 SBCC Air Flow Testing

Building: DM-01
Room: 130 Make-Up Lab

Room Area: 428 SQFT
Room Height: 8.9 FT
Room Volume: 3,816.3 CFT

Tested Supply Airflow = 262.0 CFM
Tested SA Air Change Rate = 4.1 AC/hr

OSA % (DDC): 0.2 20%
OSA calculated = 52.4 CFM

Calc. OSA Air Change Rate = 0.8 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Flow Hood

Register	CFM
SA#1	56
SA#2	45
SA#3	55
SA#4	61
SA#5	45
Total	262

Supply Airflow = 262.0 CFM

P21-012 SBCC Air Flow Testing

Building: DM-01
Room: 139 Jurkowitz Theatre

Room Area: 2,105 SQFT
 Room Height: 22.1 FT
 Room Volume: 46,485.4 CFT

Tested Supply Airflow = 6,824.7 CFM
Tested SA Air Change Rate = 8.8 AC/hr

OSA % (DDC): 0.2 20%
 OSA calculated = 1,364.9 CFM

Calc. OSA Air Change Rate = 1.8 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Duct Traverse / Airfoil

Ins. Duct Diameter: 31" x 32"
 Duct Area = 6.9 SQFT

1,157	1,354	1,293	1,057	1,500	1,476	1,312	1,184	1,133	859
1,338	1,183	1,344	1,285	1,222	1,019	946	888	736	770
1,290	1,126	1,186	1,025	948	945	882	718	815	666
1,128	946	877	721	949	987	1,076	1,003	872	816
1,018	693	685	838	801	691	712	819	763	482

Average Velocity = 991 FPM
 Supply Airflow = 6,824.7 CFM

Air Handler: AH-2
 Comment: 20% OSA Fixed
 Static Pressure 0.35"WC

P21-012 SBCC Air Flow Testing

Building: DM-01
Room: 150 Garvin Theatre

Room Area: 6,450 SQFT
 Room Height: 23.3 FT
 Room Volume: 149,962.5 CFT

Tested Supply Airflow = 15,788.4 CFM
Tested SA Air Change Rate = 6.3 AC/hr

OSA % (DDC): 0.2 20%
 OSA calculated = 3,157.7 CFM

Calc. OSA Air Change Rate = 1.3 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Duct Traverse / Airfoil

Duct #1:
 Ins. Duct Diameter: 10" x 38"
 Duct Area = 2.6 SQFT

801	921	946	871	899	694	658	624	655	531	502
861	844	722	924	741	670	665	664	507	586	550
725	551	802	738	587	564	467	507	374	435	567

Average Velocity = 684 FPM
 Supply Airflow #1 = 1,806.2 CFM

Static Pressure: 0.87"WC

P21-012 SBCC Air Flow Testing

Duct #2:

Ins. Duct Diameter: 29" x 52"

Duct Area = 10.5 SQFT

2,184	1,978	1,152	1,663	1,507
2,226	1,611	1,551	1,657	1,564
1,956	1,969	1,302	1,178	1,564
1,870	1,279	880	1,375	1,316
1,745	1,158	957	1,548	1,215
1,383	1,855	1,175	1,576	1,207
999	1,679	1,236	1,181	1,256
1,341	1,484	748	1,012	1,148
1,135	1,319	898	1,413	1,017
1,061	1,315	1,282	1,513	1,097
899	1,073	1,038	1,184	534
1,251	954	1,385	1,170	887

Average Velocity = 1,335 FPM

Supply Airflow #2 = 13,982.2 CFM

Static Pressure: 0.65"WC

P21-012 SBCC Air Flow Testing

Building: DM-01
Room: 155 Class Room

Room Area: 674 SQFT
Room Height: 9.1 FT
Room Volume: 6,122.2 CFT

Tested Supply Airflow = 518.0 CFM
Tested SA Air Change Rate = 5.1 AC/hr

OSA % (DDC): 0.5 50%
OSA calculated = 259.0 CFM

Calc. OSA Air Change Rate = 2.5 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Flow Hood

Register	CFM
SA#1	166
SA#2	352
Total	518

Supply Airflow = 518.0 CFM

P21-012 SBCC Air Flow Testing

Building: EBS
Room: 123 Earth & Planetary Science Lab "B"

Room Area: 1,362 SQFT
Room Height: 9.6 FT
Room Volume: 13,052.5 CFT

Tested Supply Airflow = 1,222.0 CFM
Tested SA Air Change Rate = 5.6 AC/hr

OSA % (DDC): 0.5 50% adjustable
OSA calculated = 611.0 CFM

Calc. OSA Air Change Rate = 2.8 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Flow Hood

Register	CFM
SA#1	149
SA#2	236
SA#3	211
SA#4	185
SA#5	238
SA#6	203
Total	1,222

Supply Airflow = 1,222.0 CFM

P21-012 SBCC Air Flow Testing

Building: EBS
Room: 312 Earth & Planetary Science Lab "B"

Room Area: 1,130 SQFT
Room Height: 9.8 FT
Room Volume: 11,111.7 CFT

Tested Supply Airflow = 1,018.0 CFM
Tested SA Air Change Rate = 5.5 AC/hr

OSA % (DDC): 1 100%
OSA calculated = 1,018.0 CFM

Calc. OSA Air Change Rate = 5.5 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Flow Hood

Register	CFM
SA#1	179
SA#2	172
SA#3	199
SA#4	179
SA#5	103
SA#6	186
Total	1,018

Supply Airflow = 1,018.0 CFM

P21-012 SBCC Air Flow Testing

Building: HUM-01
Room: 111 Auditorium

Room Area: 870 SQFT
Room Height: 12.3 FT
Room Volume: 10,730.0 CFT

Tested Supply Airflow = 1,654.0 CFM
Tested SA Air Change Rate = 9.2 AC/hr

OSA % (DDC): 0.5 50%
OSA calculated = 827.0 CFM

Calc. OSA Air Change Rate = 4.6 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Flow Hood

Register	CFM
SA#1	394
SA#2	259
SA#3	306
SA#4	236
SA#5	221
SA#6	238
Total	1,654

Supply Airflow = 1,654.0 CFM

P21-012 SBCC Air Flow Testing

Building: HUM-02
Room: 220 Drawing Studio

Room Area: 1,228 SQFT
Room Height: 12.6 FT
Room Volume: 15,452.3 CFT

Tested Supply Airflow = 1,860.0 CFM
Tested SA Air Change Rate = 7.2 AC/hr

OSA % (DDC): 0.8 80%
OSA calculated = 1,488.0 CFM

Calc. OSA Air Change Rate = 5.8 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Flow Hood

Register	CFM
SA#1	296
SA#2	668
SA#3	446
SA#4	450
Total	1,860

Supply Airflow = 1,860.0 CFM

P21-012 SBCC Air Flow Testing

Building: HUM-03
Room: 300 Class Room

Room Area: 375 SQFT
Room Height: 8.9 FT
Room Volume: 3,343.8 CFT

Tested Supply Airflow = 1,085.0 CFM
Tested SA Air Change Rate = 19.5 AC/hr

OSA % (DDC): 0.2 20% FIXED
OSA calculated = 217.0 CFM

Calc. OSA Air Change Rate = 3.9 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Flow Hood

Register	CFM
SA#1	282
SA#2	249
SA#3	285
SA#4	269
Total	1,085

Supply Airflow = 1,085.0 CFM

Comments: Fan Coil @ Full Speed

P21-012 SBCC Air Flow Testing

Building: HUM-03
Room: 301 Class Room

Room Area: 535 SQFT
Room Height: 9.4 FT
Room Volume: 5,037.9 CFT

Tested Supply Airflow = 498.0 CFM
Tested SA Air Change Rate = 5.9 AC/hr

OSA % (DDC): 0.2 20% FIXED
OSA calculated = 99.6 CFM

Calc. OSA Air Change Rate = 1.2 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Flow Hood

Register	CFM
SA#1	149
SA#2	149
SA#3	130
SA#4	70
Total	498

Supply Airflow = 498.0 CFM

Comments: Fan Coil @ Full Speed
FC-20

P21-012 SBCC Air Flow Testing

Building: HUM-03
Room: 302 Class Room

Room Area: 535 SQFT
Room Height: 9.4 FT
Room Volume: 5,037.9 CFT

Tested Supply Airflow = 201.0 CFM
Tested SA Air Change Rate = 2.4 AC/hr

OSA % (DDC): 0.2 20% FIXED
OSA calculated = 40.2 CFM

Calc. OSA Air Change Rate = 0.5 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Flow Hood

Register	CFM
SA#1	82
SA#2	119
Total	201

Supply Airflow = 201.0 CFM

Comments: Fan Coil @ Full Speed
FC-19

P21-012 SBCC Air Flow Testing

Building: PE
Room: 101 Gym

Room Area: 15,054 SQFT
 Room Height: 44.8 FT
 Room Volume: 673,666.5 CFT

Tested Supply Airflow = 21,524.5 CFM
Tested SA Air Change Rate = 1.9 AC/hr

OSA % (DDC): 0.5 50% adjustable
 OSA calculated = 10,762.3 CFM

Calc. OSA Air Change Rate = 1.0 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Duct Traverse / Airfoil

Ins. Duct Diameter: 44" x 86"
 Duct Area = 26.3 SQFT

359	783	261	398	418	1,129
357	714	464	380	553	1,034
1,056	608	286	326	387	1,047
883	521	727	265	742	1,173
772	385	244	444	762	1,229
747	425	451	197	459	956
713	528	174	255	416	1,054
600	576	449	415	404	858
1,085	555	706	402	1,367	1,181
978	899	716	1,239	1,639	1,810
945	946	1,114	1,350	1,379	1,307
833	964	1,171	1,416	1,391	1,524
825	823	951	1,485	1,420	1,433
666	1,023	763	1,153	1,519	1,111
679	601	752	1,084	1,211	1,088
467	760	375	1,034	1,085	1,026

Average Velocity = 819 FPM
 Supply Airflow = 21,524.5 CFM

Air Handler: AH-1 set to 75% speed (normal = 67.3%)
 Comment: 50% OSA
 Static Pressure 0.81"WC

P21-012 SBCC Air Flow Testing

Building: PE
Room: 218 Class Room

Room Area: 851 SQFT
Room Height: 9.6 FT
Room Volume: 8,155.4 CFT

Tested Supply Airflow = 1,222.0 CFM
Tested SA Air Change Rate = 9.0 AC/hr

OSA % (DDC): 0.2 20%
OSA calculated = 244.4 CFM

Calc. OSA Air Change Rate = 1.8 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Flow Hood

Register	CFM
SA#1	303
SA#2	318
SA#3	336
SA#4	265
Total	1,222

Supply Airflow = 1,222.0 CFM

P21-012 SBCC Air Flow Testing

Building: PS
Room: 208 Class Lab

Room Area: 1,164 SQFT
 Room Height: 11.7 FT
 Room Volume: 13,580.0 CFT

Tested Supply Airflow = 838.0 CFM
Tested SA Air Change Rate = 3.7 AC/hr

OSA % (DDC): 1 100% adjustable
 OSA calculated = 838.0 CFM

Calc. OSA Air Change Rate = 3.7 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Flow Hood

Register	CFM
SA#1	107
SA#2	229
SA#3	243
SA#4	259
Total	838

ASHREA Standard 62.1-2019: Ventilation Rate Check table (Table L-1):

Occupancy Category: Lecture Hall (fixed seats)
 Combined Outdoor Air Rate: 1.58 CFM/SQFT

Required OSA per ASHREA: 1839.12 CFM
 Currently available: 838.0 CFM
 Difference: -1,001.1 CFM -54%

P21-012 SBCC Air Flow Testing

Building: WCC
Room: 117 Class Room

Room Area: 340 SQFT
Room Height: 9.9 FT
Room Volume: 3,371.7 CFT

Tested Supply Airflow = 1,113.0 CFM
Tested SA Air Change Rate = 19.8 AC/hr

OSA % (DDC): 0.2 20%
OSA calculated = 222.6 CFM

Calc. OSA Air Change Rate = 4.0 AC/hr

Recommendation: 4-6 OSA Air Change Rate

Testing Method: Flow Hood

Register	CFM
SA#1	417
SA#2	364
SA#3	332
Total	1,113

Supply Airflow = 1,113.0 CFM

Comments: Fan Coil Unit
OSA assumed set to 20%