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PNNL-31230, Rev 1
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Hanford Waste Treatment Plant LAB Facility Stack Effluent Monitoring

Sampling Probe Location Qualification Evaluation

February 2022

Julia E Flaherty
Ernest J Antonio

U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

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Revision History

Revision Number	Effective Date	Description of Change
1	2/28/22	Incorporated corrections to velocity, flow, and diameter × velocity (DV) values in the tables in the report body, and all flow angle and velocity data sheets in the appendix. Corrections to the velocity conversions included the addition of the pitot tube factor and use of total stack pressure as well as conversions from actual to standard velocity and flow units.
0	07/07/21	Initial Issue

Summary

The Waste Treatment Plant laboratory (LAB) facility stack monitor locations were qualified using scale model stacks to mitigate the risk of identifying that sampling locations do not meet the qualification criteria on the full-scale stack. As required by the American National Standards Institute/Health Physics Society (ANSI/HPS) N13.1-1999 standard, the scale model and its sampling location were geometrically similar to the actual stack and the Reynolds numbers for both the actual and model stacks were >10,000. An additional criterion is that the product of the hydraulic diameter and mean velocity (DV) of the full-scale stack must be between 1/6 DV and 6 DV of the scale model stack tests. Verification tests of the LAB stacks were performed at normal operating conditions. The minimum 1/6 DV value, along with the maximum 6 DV value from the scale model testing determines the range of conditions for which the full-scale stack may be operated and remain in compliance with the stack verification criterion. Based on these DV values, the corresponding stack flow rates for each of the LAB stacks are 609 to 48,044 scfm for LB-C2, 1,704 to 103,131 scfm for LB-S1, and 467 to 18,088 scfm for LB-S2.

The remaining criteria for the stack verification to be considered valid involve the flow angle and velocity uniformity results. First, the flow angle at the full-scale stack must be ≤20°. Second, the velocity uniformity at the full-scale stack must be ≤20% coefficient of variance (COV). Finally, the velocity uniformity results for the actual and scale model stack tests must agree within 5% COV. These criteria were met through the full-scale stack tests at the LAB facility. Flow angle results were primarily less than 10 degrees, except for the LB-C2 Fan A results, which were an average of 17.6 degrees; all flow angle results were within the ≤20° criterion. The velocity uniformity results for each test condition averaged between 1.5 and 3.5% COV, which were all within the range of the target %COV values from the scale model tests.

Based on these stack verification test results, the three LAB filtered exhaust stack sampling locations meet the qualification criteria provided in the ANSI/HPS N13.1-1999 standard for all fan operating configurations. This includes single-fan as well as dual-fan operations for LB-C2, each of the dual-fan operating conditions for LB-S1, and each single-fan operating condition for LB-S2. Further changes to the system configuration or operating conditions that are outside the bounds described in this report may require additional tests or analyses to determine compliance with the standard.

Acknowledgments

This effort was performed under the project management of Mike Wentink of Waste Treatment Completion Company (WTCC). We acknowledge support from Ryan Cioli, Bill Jackson, and Clarke Respess from WTCC in facilitating Pacific Northwest National Laboratory staff in observing the stack tests at the LAB facility. We also acknowledge Zach Harding, Connor Everly and Kelly Dorsi from Bison Engineering, Inc., who were accommodating to our staff looking over their shoulders, asking questions, and providing feedback.

The quality assurance measures employed to produce this document include oversight and guidance from our quality engineer, David MacPherson as well as reviews and data entry from Jennifer Yao and retired staff member Carmen Arimescu. Chrissy Charron provided administrative support for this effort. Finally, Cary Counts served as the technical editor for this document.

Acronyms and Abbreviations

% COV	percent coefficient of variation
acfm	actual cubic feet per minute, an air volume flow unit at actual conditions
ANSI	American National Standards Institute
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
DV	product of the hydraulic diameter and the mean velocity
EPA	Environmental Protection Agency
HPS	Health Physics Society
LAB	WTP Laboratory
LB-C2	WTP laboratory zone C2V ventilation system exhaust stack
LB-S1	WTP laboratory zone C3V ventilation system exhaust stack
LB-S2	WTP laboratory zone C5V ventilation system exhaust stack
M&TE	measuring and test equipment
PNNL	Pacific Northwest National Laboratory
scfm	standard cubic feet per minute, an air volume flow unit at standard air density (standard conditions used here are 68°F and 14.7 psia)
sfpm	standard feet per minute, an air velocity unit at standard air density (standard conditions used here are 68°F and 14.7 psia)
WTCC	Waste Treatment Closure Company LLC
WTP	Hanford Tank Waste Treatment and Immobilization Plant
WTPSP	Waste Treatment Plant Support Project

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1.0 Introduction

Stack verification tests were performed by a Waste Treatment Completion Company (WTCC) contractor at the exhaust stack monitoring locations of each of the Hanford Tank Waste Treatment and Immobilization Plant (WTP) laboratory facility (LAB) stacks to evaluate whether they meet the applicable regulatory criteria (i.e., Washington Administrative Code, Chapter 246-247) governing effluent monitoring systems.

Emissions from the LAB facility air exhaust stacks are expected to remain below the 0.1-millirem per year threshold limit given in Title 40 of the Code of Federal Regulations (CFR), Part 61, National Emissions Standards for Hazardous Air Pollutants, Subpart H, National Emissions Standard for Emissions of Radionuclides Other than Radon from Department of Energy Facilities. during the first year of stack operations. The rule requires that a sampling probe be located in the exhaust stack according to criteria established by the American National Standards Institute/Health Physics Society (ANSI/HPS) N13.1-1999, Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stack and Ducts of Nuclear Facilities. Compliance with the standard is demonstrated through a series of tests as described in the standard. This standard allows, under certain conditions, for results from previously tested stacks to be used instead of a full series of tests. For the LAB stacks, existing scale model test results were used, and verification tests were performed on the full-scale stack.

While a contractor to WTCC performed the verification tests, Pacific Northwest National Laboratory (PNNL) provided guidance for these tests, performed data reduction following the tests, and produced this report to provide an assessment of the compliance of the stack sampling locations. PNNL had performed the scale model tests that served as the basis for these full-scale stack verification tests. This prior involvement put PNNL in a unique position to provide the data reduction rigor and process insight to evaluate these stack verification results. This document provides stack flow information, details of the stack qualification criteria, and a review of the scale model tests. Section 2 describes the verification test methods, while Section 3 describes the results of these tests.

The three LAB facility stacks exhaust air from general building ventilation and laboratory spaces. Stack LB-C2 ventilates non-process (C2) areas; LB-S1 ventilates hoods, shops, and maintenance (C3) areas; and LB-S2 ventilates hot cells and glovebox (C5) areas. Table 1 provides information about each of the LAB facility stack operations. The ventilation system for LB-S1 and LB-S2 have an extra fan available on standby for back-up or maintenance needs. LB-C2 uses both fans under normal operations. The most current data sheets for these stacks were used for the flow rates listed in Table 1. These values have changed relative to the PNNL Test Input Document (Peterson 2019) and the scale model stack test reports (Glissmeyer, Flaherty, and Piepel 2011, Glissmeyer and Geeting 2013). The impacts of these changes will be described in subsequent sections of this document. Velocity and flow values presented in this document use standard units, and standard conditions used is 68 °F and 14.7 psia.

Table 1. LAB Facility Stack Design Parameters as of February 2018

Stack Parameter	LB-C2[a]	LB-S1[b]	LB-S2[c]
Discharge diameter (in.)	48	60	28
Duct diameter at sampling probes (in.)	48	60	28
Number of duct diameters from sampling probes to upstream disturbance	13.3	10.3	25.0
Total available fans	2	3	2
Number of operating fans	2[d]	2	1
Maximum flow rates (scfm)	44,500	79,200	15,700
Normal operating flow rates (scfm)	40,400	68,880	14,100

a. DS No: 24590-LAB-JFD-SDJ-00001, Rev 5
b. DS No: 24590-LAB-JFD-SDJ-00002, Rev 5
c. DS No: 24590-LAB-JFD-SDJ-00003, Rev 4
d. Prior stack configurations indicated that one fan will be operating, while one would be in standby for the LB-C2 stack. WTCC states that normal operation now uses both fans.

1.1 Qualification Criteria

The qualification criteria for an air monitoring probe location are taken from ANSI/HPS N13.1-1999 and are paraphrased as follows:

1. *Angular Flow* – Sampling nozzles usually are aligned with the axis of the stack. If the air travels up the stack in cyclonic fashion, the air velocity vector approaching a sampling nozzle could be sufficiently misaligned with the nozzle to impair extraction of particles. The average of the flow angle measurements, made at the several discrete points in the duct cross section at the position of the sampling nozzle, should not exceed 20° relative to the sampling nozzle axis.
2. *Velocity Uniformity* – The air velocity must be uniform across the stack cross section where the sample is extracted. The air velocity is measured at the same grid of points as the flow angle measurements. Uniformity is expressed as the variability of the measurements about the mean. This is expressed using the percent coefficient of variation (% COV),[1] which is the standard deviation divided by the mean and expressed as a percentage. The lower the % COV value, the more uniform the velocity. The acceptance criterion is that the air velocity must be ≤20% COV in the center two-thirds of the duct cross section at the sampling probe location.
3. *Gaseous Tracer Uniformity* – A uniform contaminant concentration in the sampling plane enables the extraction of samples that represent the true concentration within the duct. The uniformity of the concentration is first tested using a tracer gas to represent gaseous effluents. The fan is a good mixer, so injecting the tracer downstream of the fan provides worst-case results. The qualification criteria are that 1) the measured tracer gas concentration is ≤20% COV across the center two-thirds of the duct cross section at the sampling location and 2) the concentrations at any of the measurement points cannot deviate from the mean by >30%.

[1] *Coefficient of variation* is also known as *percent relative standard deviation*. The standard uses the term *coefficient of variation*, so it will likewise be used here.

4. *Particulate Tracer Uniformity* – The second set of tests addressing contaminant concentration uniformity at the sampling position uses tracer particles large enough to exhibit inertial effects. Tracer particles of 10-µm aerodynamic diameter are used by default unless it is known that larger contaminant particles will be present in the airstream. The acceptance criterion is that the particle concentration is ≤20% COV across the center two-thirds of the duct at the sampling location.

Tests to determine if Criteria 1 through 4 are met have been conducted on scale models of the exhaust ductwork and stacks, from the fans to the planned position of the sampling probes. Scale model test results are documented in Glissmeyer, Flaherty, and Piepel (2011) and Glissmeyer and Geeting (2013). The ANSI/HPS N13.1-1999 standard sets additional acceptance criteria for the use of a scale model (or another, similar stack) as a substitute for the actual stack. The criteria for the use of substitute stacks are:

- The scale model and its sampling location must be geometrically similar to the actual stack.
- The product of the hydraulic diameter and the mean velocity (DV) for the candidate stack is within a factor of six of that of the tested stack, and the hydraulic diameters of the stack is at least 250 mm at the sampling location.
  - For clarity, the DV requirement can be expressed as follows:

    1/6 DV of scale model stack ≤DV of full scale stack ≤6 DV of scale model stack
- The Reynolds number for the actual and model stacks must be >10,000.

Finally, the scale model results are considered valid if measurements on the full-scale stack show:

- The flow angle criterion (with a mean value ≤20°) is met.
- The velocity uniformity criterion (with ≤20% COV) is met.
- The velocity uniformity results for the actual and model stacks agree within 5% COV.

1.2 Scale Model Tests

Scale model tests have been performed at PNNL using primarily 12-in. diameter ducting to represent each of the LAB stacks. Glissmeyer, Flaherty, and Piepel (2011) and Glissmeyer and Geeting (2013) report on the complete set of tests that were performed with the scale model stacks. This includes tests of flow angle, velocity uniformity, gaseous tracer uniformity, and particulate tracer uniformity. Tests were performed for a range of conditions, including different combinations of fans and flow rates to account for the range of operating conditions that were reported by WTCC at the time of the scale model tests. The test matrices for the scale model tests were designed to provide information concerning the well-mixed nature of the sampling location for each stack. That is, different stack operating condition attributes were varied with different fixed operating conditions so that, in total, the full range of conditions were considered. For example, while three port locations may have been tested, each port location may not have been tested with every fan condition or operating flow rate. The resultant data were therefore used to confirm that the stack location is qualified for well-mixed sampling and monitoring.

Table 2 presents a summary of the duct diameter and range of velocity values measured during the velocity uniformity tests performed with the LAB scale model stacks. For consistency with the stack data sheets for these stacks, as well as with the verification test results, the velocity values are presented in standard units, where the standard temperature is 68°F.

Table 2. Summary of the Acceptable Ranges of Diameter x Velocity Products from LAB Scale Model Stacks

Stack	Diameter (in.)	Velocity Range[a] (sfpm)	1/6 DV (ft^2/min)	6 DV (ft^2/min)
LB-C2	12	1,165-2,549	194	15,293
LB-S1	12	2,602–4,377	434	26,262
LB-S2	12	1,531–1,645	255	9,870

a. Range of velocities from velocity uniformity tests on the scale model stack. Because the stack diameter is 1 ft, this column is equivalent to the DV.

1.3 Quality Assurance

Work performed by PNNL staff documented in this report was performed in accordance with the Waste Treatment Plant Support Program (WTPSP) Quality Assurance Plan and associated procedures. The WTPSP implements the requirements of ASME NQA-1-2000, Quality Assurance Requirements for Nuclear Facility Applications, graded on the approach presented in NQA-1-2000, Subpart 4.2, Guidance on Graded Application of Quality Assurance (QA) for Nuclear-Related Research and Development.

The WTPSP works in conjunction with PNNL's laboratory-level Quality Management Program, which is based upon the requirements as defined in the United States Department of Energy (DOE) Order 414.1D, Quality Assurance, and 10 CFR 830, Nuclear Safety Management, Subpart A, Quality Assurance Requirements. PNNL implements these requirements with a graded approach using the consensus standard ASME NQA-1-2000, Quality Assurance Requirements for Nuclear Facility Applications, graded on the approach presented in NQA-1-2000, Subpart 4.2, Guidance on Graded Application of Quality Assurance (QA) for Nuclear-Related Research and Development.

The WTPSP QA Plan describes the technology life cycle stages, which include the progression of technology development, commercialization, and retirement in process phases of basic and applied research and development, engineering and production, and operation until process completion. The work described in this report has been completed under the QA Technology Level of Development Work.

2.0 Verification Test Methods

Bison Engineering, Inc. (Bison), performed tests of the three LAB facility stacks during the week-long period of October 15–19, 2019. The Test Plan (Bison Engineering Inc. 2019) provided the test matrix of stack fan configurations to be used for the tests (see Table 3). Tests in support of 40 CFR 52, Appendix E, were also performed during this test period, which dictated that 14 stack flow tests be performed as an independent measurement for comparison with the stack flow monitor for each of the three stacks.

Table 3. LAB Stack Test Matrix. All tests performed at normal operating flow conditions. The same number of tests were performed for flow angle and velocity uniformity.

Stack	Fan Configuration	Number of Flow Angle, Velocity Uniformity Tests
LB-C2	Fan A Only	5
	Fan B Only	5
	Fans A and B	4
LB-S1	Fans A and B	5
	Fans B and C	5
	Fans A and C	4
LB-S2	Fan A Only	7
	Fan B Only	7

Bison followed test measurement practices as guided by Environmental Protection Agency (EPA) Methods 1 and 2 (40 CFR 60, Appendix A) and did not follow a separate Test Instruction or Test Procedure. Flow angle tests were performed with an s-type pitot tube, a digital level, and an oil-filled slant-tube manometer. Velocity uniformity tests were performed with a standard pitot tube and an electronic manometer, along with a desktop weather station for ambient temperature and pressure measurements and a thermocouple for in-stack temperature measurements. Each stack traverse comprised eight discrete measurement points across the diameter of the duct, plus the center point. Two traverses, positioned 90° apart, were used to complete each measurement set. Figure 1 shows one of the three LAB stacks with the two ports for the two traverse measurements.

Figure 1. LAB LB-C2 Stack. Each port is covered in this photo with a large plate secured by eight bolts. The stack flow meter is visible as the large collection of equipment located slightly left of stack center in this photograph.

For each traverse, the probe (s-type or standard pitot tube) was inserted completely into the stack such that the tip contacted the far wall, and then backed away from that wall the necessary distance to measure point 1. Triplicate measurements were made at each point before moving to the next point. Method 1 does not specify how measurements should be made and making three measurements at the traverse point is adequate but perhaps not as comprehensive in its coverage of uncertainty as some alternatives. For example, PNNL practice is to perform three separate traverses with one measurement at each point. This allows three opportunities to position the probe tip at the measurement location and captures the variability associated with the measurement position itself. Because of obstructions in the test area (e.g., railings, ports on neighboring stacks), the pitot tube may not have been longitudinally level during all portions of the test. As a result, measurements in the stack may not have been completely co-planar, but this is not expected to have any substantive impact on the measurement results. The port cover plate was rotated out of the way of the port opening during each traverse, and a burlap sack, folded several times to be slightly larger than the port opening, was used to cover the opening during measurements. With this configuration, the pitot tube rested along the bottom edge of the port opening, rather than at the centerline of the opening.

While Bison performed the tests under a subcontract from WTCC, PNNL staff observed most tests to understand how they were executed. In addition to comments about the test process described above, PNNL also noted that test staff did not appear to consistently record the sign (positive or negative) associated with the flow angle value. This does not impact the results because the absolute value is used but is listed here to indicate that this may be why many of the flow angle test results presented in the appendices often change in sign across the center of the traverse. Figure 2 shows a Bison Engineering, Inc. staff member and WTCC crafts support staff member performing a flow angle test in the LB-C2 stack.

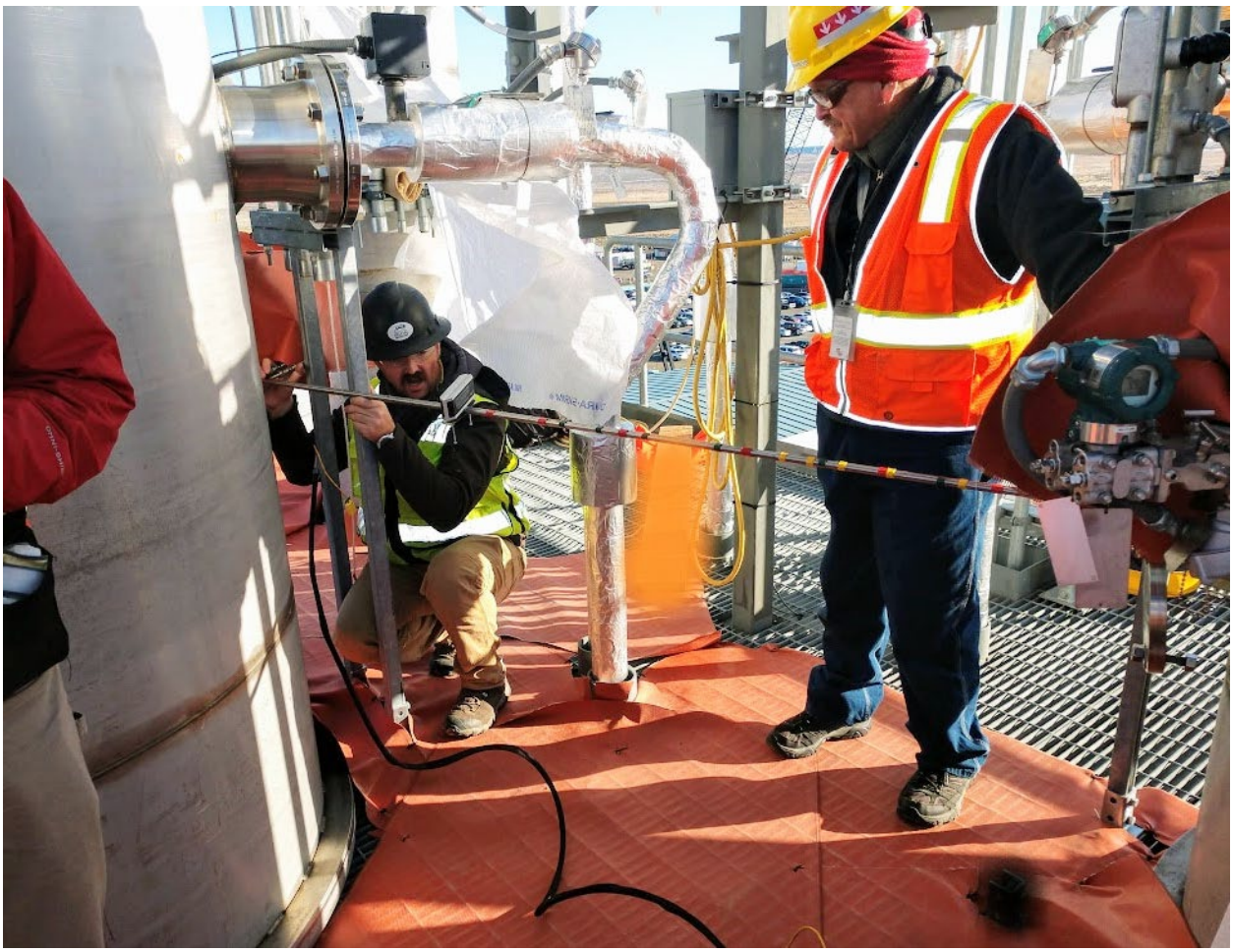

Figure 2. Flow Angle Testing on the LB-C2 Stack, with Probe Maneuvered around the LB-S1 Pitot Support

Finally, we note that equipment used for these tests generally were marked with calibration information. The exception to this is that Bison determined that the slant-tube manometer is calibrated on site, and therefore did not need separate calibration information.

3.0 Verification Test Results

PNNL was directed by WTCC to use data collected by Bison to perform the LAB verification testing data reduction. PNNL staff were observers during most of the testing so that the equipment used, the measurement techniques, and data recording process could be evaluated. PNNL staff also recorded a subset of measurements from each test when observation was performed to provide secondary quality assurance for the data. The quality assurance process at PNNL included following the procedure for qualification of existing data through data corroboration and sponsor-directed use of data. Test Data Packages were developed to document the observation forms completed by PNNL staff, data sheets provided through the Bison report, and data sheets developed through PNNL data entry into controlled Excel worksheets.

Velocity-uniformity measurements collected by Bison were the delta-pressure values, which were then converted to velocity values by Bison to complete the velocity uniformity data sheets. PNNL performed a spot-check of the conversions from delta-pressure to velocity for these velocity uniformity tests. Data in the Bison report then were used as input to PNNL-controlled Excel spreadsheets to eliminate the possibility that unexpected calculation modifications were made in the spreadsheets transmitted to Bison. These spreadsheets then were subject to calculation reviews to document the accuracy of the calculations from both a theoretical and numerical perspective.

As a result, there are some minor differences between the values calculated in the Bison report and the values calculated by PNNL. In one instance, there was a typo in one Bison-produced flow angle sheet, which meant that value was not included in their calculation. Additionally, Bison also provided velocity values to one decimal point in the data sheets, but the value in the cells appear to have more digits (from the conversion from in. H_2O). The PNNL data sheets used the single decimal point values in the subsequent calculations. Appendix A, Appendix B, and Appendix C contain the flow angle and velocity data sheets that were produced by PNNL to support this analysis. Due to errors discovered after the initial issue of this PNNL report, the use of the original velocity data as the starting point for corrections to the velocity values, and the small differences that exist due to the rounding that results from those velocity data, there are instances where new average velocities or average flow rates differ by less than 0.1% between the Bison and PNNL velocity data sheets.

Appendix D contains a table that summarizes the quality assurance documents that have been produced by PNNL as part of this LAB verification effort.

3.1 LB-C2 (LAB C2V) Verification Tests

Table 4 summarizes the flow angle and velocity uniformity test results from the LB-C2 stack verification tests. The DV values, calculated from the stack nominal diameter and the velocity computed from the EPA Method 1 measurement points is included in Table 4 for reference. Note that the flow angle and velocity uniformity tests for each numbered test were performed in sequence so the velocity uniformity test flow and DV value is expected to be representative of the flow during the flow angle test as well. All test results meet the criterion of flow angle values ≤20°and velocity uniformity values ≤20% COV.

Table 4. LB-C2 Verification Test Results

Fan Configuration	Test Number	Flow Angle (°)	Velocity Uniformity Test Flow (scfm)	Velocity Uniformity (% COV)	DV (ft^2/min)
Fan A Only	1	17.1	34,576	2.6	11,007
	2	18.0	34,074	3.0	10,846
	3	16.6	33,082	3.9	10,529
	4	19.0	33,210	1.9	10,570
	14	17.3	35,850	2.4	11,411
Fan B Only	5	5.8	32,342	2.4	10,295
	6	4.0	32,391	3.5	10,310
	7	5.2	33,211	2.0	10,570
	8	5.6	33,279	2.0	10,595
	9	5.4	32,819	1.7	10,447
Fans A and B	10	3.1	35,573	1.9	11,324
	11	2.8	35,729	1.8	11,372
	12	3.6	36,389	1.6	11,585
	13	2.8	36,244	1.2	11,539

3.2 LB-S1 (LAB C3V) Verification Tests

Table 5 summarizes the flow angle and velocity uniformity test results from the LB-S1 stack verification tests, along with the DV values. Note that the flow angle and velocity uniformity tests for each numbered test were performed in sequence so the velocity uniformity test flow and DV is expected to be representative of the flow during the flow angle test as well. All test results meet the criterion of flow angle values ≤20° and velocity uniformity values ≤20% COV.

Table 5. LB-S1 Verification Test Results

Fan Configuration	Test Number	Flow Angle (°)	Velocity Uniformity Test Flow (scfm)	Velocity Uniformity (% COV)	DV (ft^2/min)
Fans A and B	1	10.4	75,239	2.1	19,160
	2	9.6	75,716	2.0	19,283
	3	9.3	75,030	2.2	19,109
	4	9.4	73,682	2.8	18,761
	14	9.5	77,324	1.8	19,690
Fans B and C	5	5.4	72,968	2.7	18,582
	6	4.4	72,712	2.4	18,514
	7	4.9	73,355	1.5	18,682
	8	5.4	73,670	1.8	18,761
	9	4.8	72,878	1.8	18,556
Fans A and C	10	2.1	75,014	2.0	19,104
	11	3.6	74,751	1.3	19,035
	12	3.3	76,657	1.6	19,520
	13	1.3	75,796	1.5	19,301

3.3 LB-S2 (LAB C5V) Verification Tests

Table 6 summarizes the flow angle and velocity uniformity test results from the LB-S2 stack verification tests, along with the DV values. Note that the flow angle and velocity uniformity tests for each numbered test were performed in sequence so the velocity uniformity test flow and DV is expected to be representative of the flow during the flow angle test as well. All test results meet the criterion of flow angle values ≤20° and velocity uniformity values ≤20% COV.

Table 6. LB-S2 Verification Test Results

Fan Configuration	Test Number	Flow Angle (°)	Velocity Uniformity Test Flow (scfm)	Velocity Uniformity (% COV)	DV (ft^2/min)
Fan A	1	2.2	16,815	3.8	9,175
	2	2.6	16,909	3.4	9,227
	3	2.9	16,742	3.9	9,136
	4	2.7	16,775	3.5	9,154
	5	3.3	16,595	3.4	9,056
	6	2.8	16,539	3.3	9,024
	7	2.6	16,643	3.4	9,083
Fan B	8	4.2	17,330	3.3	9,457
	9	3.5	17,399	3.2	9,493
	10	3.7	17,100	2.7	9,330
	11	3.3	17,206	4.0	9,390
	12	3.7	17,436	3.0	9,515
	13	3.7	17,448	3.0	9,520
	14	3.9	17,157	3.4	9,361

4.0 Comparisons of Verification Test and Scale Model Test Results

While the stack verification test results demonstrate that both the flow angle and velocity uniformity values are acceptable compared with the qualification criteria, the velocity uniformity values must be compared with the scale model test results to accept the full suite of stack qualification test results from the scale model tests. Table 7 presents a summary of the normal operating velocities for each stack, along with the corresponding DV values. Additionally, Table 7 includes the scale model DVs and 6 DV range, which provides the upper limit of the full-scale stack DV values for which the surrogate stack may be used to represent the full-scale stack.

Note that there were some differences between the Bison test conditions and the stack design conditions presented on the data sheets. The Bison test conditions were performed under normal operating flow conditions according to the operators at the time of the tests. The Bison test velocity was nearly the velocity of the LB-S1 design maximum condition (4030 sfpm) and exceeded the LB-S2 design maximum condition (3670 sfpm). These differences between the expected normal operating conditions based on the latest version of the data sheets and the test conditions warrants comparisons with the scale model stack conditions against both sets of conditions. Note that the verification of each scale model data point is not required to qualify the sampling location for specific operating configurations or conditions. As noted in Section 1.2, the scale model tests are used to confirm the overall range of conditions for which the stack location is qualified.

Table 7. Calculation of Acceptable DV Ranges

Stack	Diameter (in.)	Stack Data Sheet		Bison Test Condition		Scale Model	
		Operating Velocity[a] (sfpm)	DV (ft^2/min)	Operating Velocity[b] (sfpm)	DV (ft^2/min)	DV (ft^2/min)	6 DV (ft^2/min)
LB-C2	48	3,210	12,840	2,721	10,886	1165–2549	6,990–15,293
LB-S1	60	3,510	17,550	3,801	19,004	2602–4377	15,612–26,262
LB-S2	28	3,300	7,700	3,977	9,280	1531–1645	9,186–9,870

a. Velocity based on normal operating flow velocity from stack data sheets.
- LB-C2: 24590-LAB-JFD-SDJ-00001, Rev 5
- LB-S1: 24590-LAB-JFD-SDJ-00002, Rev 5
- LB-S2: 24590-LAB-JFD-SDJ-00003, Rev 4

b. Velocity based on average velocity measured during velocity uniformity tests performed by Bison.

4.1 LB-C2 (LAB C2V) Qualification

The LB-C2 stack qualification tests were performed on a scale model of the stack constructed at a PNNL outdoor facility, and the results were reported in Glissmeyer, Flaherty, and Piepel (2011) (document number PNNL-20154, WTP-RPT-209). At the time of these tests, the design flow rate for the stack was 35,450 scfm, with a maximum flow of 40,400 scfm. However, the latest version of the data sheet for this stack (24590-LAB-JFD-SDJ-00001, Rev 5) now reflects that the normal stack flow is 40,400 scfm and maximum flow is 44,500 scfm. As a result, many of the scale model stack conditions are not within the range of DV values that represent the normal flow conditions. Scale model tests with this stack were performed with each fan individually, as well as with both fans operating.

The single fan cases shown in Table 8 were only performed for minimum flow conditions and therefore the 6 DV values from the scale model tests were below both the stack data sheet and Bison test condition DV values shown in Table 7. The velocity uniformity results from the verification tests were less than 4% COV during Fan A operations, and less than or equal to 3.5% COV during Fan B operations, which are both within the range of the target values for these conditions.

Table 8 also lists the scale model stack tests with both fans operating together, which were performed with the then-maximum flow condition, and as a result, the DV values from both the stack data sheet and Bison test conditions were within the range of 1/6 to 6 DV of the scale model stack tests. The average velocity uniformity from the scale model tests with both fans in operation was 3.5% COV, which means that full-scale verification test results with a velocity uniformity value of less than or equal to 8.5% COV are acceptable. Tests performed by Bison ranged from 1.2 to 1.9% COV, which meets the criterion.

Scale model tests of gaseous and particulate tracer uniformity were performed at conditions like the velocity uniformity tests. Single fan operations were at minimum conditions, while dual-fan operations were at maximum conditions.

Table 8. Summary of LB-C2 Scale Model Velocity Uniformity Tests. Adapted from Table 4.2 of Glissmeyer, Flaherty, and Piepel (2011).

Operating Fan(s)	Test Port	Flow Condition[a]	Test Number	Velocity (sfpm)[b]	6 DV[c] (ft^2/min)	% COV	Average % COV	Target % COV
A	1	Min	VT-11	1245	7470^{N}	4.6	4.3	≤9.3
		Min	VT-7	1262	7569^{N}	4.2		
		Min	VT-9	1273	7638^{N}	4.1		
	2	Min	VT-8	1286	7713^{N}	3.6	3.6	≤8.6
	3	Min	VT-10	1280	7678^{N}	1.3	1.3	≤6.3
B	1	Min	VT-12	1210	7258^{N}	1.9	1.9	≤6.9
	2	Min	VT-13	1249	7494^{N}	2.4	2.4	≤7.4
	3	Min	VT-16	1165	6990^{N}	1.9	2.0	≤7.0
		Min	VT-15	1219	7315^{N}	2.5		
		Min	VT-14	1257	7539^{N}	1.6		
A and B	1	Max	VT-2	2449	$14694^{D/B}$	3.4	3.4	≤8.4
	2	Max	VT-3	2274	$13641^{D/B}$	3.1	3.5	≤8.5
		Max	VT-17	2293	$13756^{D/B}$	4.2		
		Max	VT-5	2410	$14461^{D/B}$	3.3		
		Max	VT-6	2427	$14559^{D/B}$	3.2		
	3	Max	VT-4	2430	$14578^{D/B}$	2.0	2.0	≤7.0

a. Minimum or Maximum flow condition labeling is based on the data provided at the time of the scale model tests and may not reflect current minimum or maximum design flow rates.
b. Velocity values previously reported in units of afpm (i.e., actual feet per minute) were converted to sfpm using 68°F as the standard temperature.
c. DV values result in the latest data sheet values (D), the Bison test conditions (B), or neither (N) fell within the range for the use of scale model stack qualification data.

4.2 LB-S1 (LAB C3V) Qualification

The LB-S1 stack qualification tests were performed on a scale model of the stack constructed at a PNNL outdoor facility, and the results were reported in Glissmeyer and Geeting (2013) (document number PNNL-22167, WTP-RPT-227). At the time of these tests, the design flow rate for the stack was 74,150 acfm, with a maximum flow of 88,800 acfm. However, the latest version of the data sheet for this stack (24590-LAB-JFD-SDJ-00002, Rev 5) now reflects that the normal stack flow is 68,880 scfm and maximum flow is 79,200 scfm. Scale model stack tests meant to represent the then-minimum flow conditions results in a 6 DV value that is less than the DV values that represent current normal flow conditions. Scale model tests with this stack were performed with three combinations of two-fan operations.

Table 9 presents the results of tests performed with all three fan combinations of two-fan operations: A and B, A and C, and B and C. Fans A and B were tested for then-minimum, then-normal, and then-maximum flow conditions, while Fans A and C and Fans B and C were tested at only then-minimum and then-maximum flow conditions.

The minimum flow conditions that were tested with the scale model results in a 6 DV value that is below the DV value of the current normal operating flow rate. However, these test runs are not necessary for the stack verification test comparison. Each fan combination included at least one maximum flow condition, which results in a 6 DV value that is greater than the DV value for the current operating flow rate. The average velocity uniformity from the scale model tests for the various fan combinations was nominally between 3.7 and 7.3% COV. This means that full-scale verification test results with a velocity uniformity value of less than or equal to 8.7% COV are acceptable. Tests performed by Bison ranged from 1.3 to 2.8% COV, which meets the criterion.

Table 9. Summary of LB-S1 Scale Model Velocity Uniformity Tests

Operating Fan(s)	Test Port	Flow Condition[a]	Test Number	Velocity (sfpm)	6 DV[b] (ft^2/min)	% COV	Average % COV	Target % COV
A and B	1	Max	VT-1	4,331	25,986[D/B]	5.9	5.4	0.4 ≤ x ≤ 10.4
		Max	VT-2	4,377	26,262[D/B]	7.6		
		Max	VT-3	4,202	25,212[D/B]	5.2		
		Max	VT-4	4,260	25,560[D/B]	5.6		
		Max	VT-19	4,320	25,920[D/B]	4.0		
		Max	VT-20	4,297	25,782[D/B]	4.3		
A and B	1	Norm	VT-5	3,623	21,738[D/B]	3.9	3.9	≤8.9
		Norm	VT-6	3,633	21,798[D/B]	3.4		
		Norm	VT-7	3,605	21,630[D/B]	4.2		
		Norm	VT-8	3,573	21,438[D/B]	4.2		
A and B	1	Min	VT-9	2,602	15,612[N]	3.5	3.3	≤8.3
		Min	VT-10	2,624	15,744[N]	3.3		
		Min	VT-11	2,619	15,714[N]	3.3		
		Min	VT-12	2,616	15,696[N]	3.1		
A and C	1	Max	VT-13	4,178	25,068[D/B]	7.2	7.3	2.3 ≤ x ≤ 12.3
		Max	VT-14	4,115	24,690[D/B]	7.4		
		Min	VT-15	2,928	17,568[D]	6.4	6.4	1.4 ≤ x ≤ 11.4
B and C	1	Max	VT-16	4,222	25,332[D/B]	3.4	3.7	≤8.7
		Max	VT-17	4,361	26,166[D/B]	4.0		
		Min	VT-18	3,008	18,048[D]	3.4	3.4	≤8.4

a. Minimum, Normal, or Maximum flow condition labeling is based on 83%, 100%, or 115%, respectively, of the normal stack flow data provided at the time of the scale model tests, which may not reflect current design flow rates.
b. DV values result in the latest data sheet values (D), the Bison test conditions (B), or neither (N) fell within the range for the use of scale model stack qualification data.

4.3 LB-S2 (LAB C5V) Qualification

The LB-S2 stack qualification tests were performed on a scale model of the stack constructed at a PNNL outdoor facility, and the results were reported in Glissmeyer, Flaherty, and Piepel (2011) (document number PNNL-20154, WTP-RPT-209). At the time of these tests, the design flow rate for the stack was 14,800 scfm, with a maximum flow of 17,020 scfm, which was an assumed value based on 115% of the normal flow rate. However, the latest version of the data sheet for this stack (24590-LAB-JFD-SDJ-00003, Rev 4) now reflects that the normal stack flow is 14,100 scfm and maximum flow is 15,700 scfm. The differences between the scale model stack conditions and the new data sheet conditions are small and the DV value from the latest version of the data sheet and the average DV value from the Bison test conditions are generally within the DV range from the scale model stack tests.

Table 10 presents the results of tests performed with each fan at the then-maximum flow conditions. The average velocity uniformity from the scale model tests with either Fan A or Fan B in operation was nominally 5% COV. This means that full-scale verification test results with a velocity uniformity value of less than or equal to approximately 10% COV are acceptable. Tests performed by Bison ranged from 2.7 to 4.0% COV, which meets the criterion.

Table 10. Summary of LB-S2 Scale Model Velocity Uniformity Tests

Operating Fan(s)	Test Port	Flow Condition[a]	Test Number	Velocity (sfpm)	6 DV[b] (ft^2/min)	% COV	Average % COV	Target % COV
A	2	Max	VT-2	1,539	9,234[D/B]	5.2	4.8	≤9.8
		Max	VT-8	1,531	9,186[D/B]	4.3		
B	2	Max	VT-3	1,642	9,852[D/B]	5.4	5.4	0.4 ≤ x ≤ 10.4
		Max	VT-4	1,645	9,870[D/B]	5.3		
		Max	VT-5	1,629	9,774[D/B]	5.6		

a. Maximum flow condition labeling is based on 115% of the normal stack flow data provided at the time of the scale model tests, which may not reflect current design flow rates.
b. DV values result in the latest data sheet values (D), the Bison test conditions (B), or neither (N) fell within the range for the use of scale model stack qualification data.

5.0 Summary/Discussion

The WTP LAB exhaust stack sampling and monitoring locations were qualified using scale model stacks to mitigate the risk of identifying that sampling locations do not meet the qualification criteria on the full-scale stack. As required by the ANSI/HPS N13.1-1999 standard, the scale model and its sampling location were geometrically similar to the actual stack and the Reynolds numbers for both the actual and model stacks were >10,000. Table 11 summarizes the stack design conditions, including the duct diameter, the distance to the nearest upstream disturbance, and operating fans.

An additional criterion for the use of the scale model test results is that the DV of the full-scale stack must be between 1/6 DV and 6 DV of the scale model stack tests. Table 12 summarizes the stack flow conditions from the verification tests along with the range of DV values from the qualification tests and the corresponding velocity and flow rates for the full-scale stacks. Verification tests were performed at normal operating conditions and did not specifically address maximum or minimum flows. As a result, the average flow rate represents the typical flow rate from those tests. The minimum and maximum qualified stack flow values are based on the DV values from the scale model tests and does not address other constraints, such as the rated velocity range of the shrouded probe or deposition on the probe. Based on the range of DV values and the corresponding stack flow rate range, the average verification test flow rate was within the acceptable range and the design flow rates (from Table 11) are also within the acceptable range.

Table 11. LAB Stack Design Summary

Stack Parameter	LB-C2	LB-S1	LB-S2
Duct diameter at sampling probe (in)	48[a]	60[b]	28[c]
No. of duct diameters from sampling probe to upstream disturbance	13.3	10.3	25.0
Total available fans	2	3	2
No. of operating fans	2[d]	2	1
Current Design Maximum flow rate (scfm)	44,500[a]	79,200[b]	15,700[c]
Current Design Normal operating flow rate (scfm)	40,400[a]	68,880[b]	14,100[c]
Current Design Minimum flow rate (scfm)	35,450[a]	62,000[b]	12,700[c]

a. DS No: 24590-LAB-JFD-SDJ-00001, Rev 5
b. DS No: 24590-LAB-JFD-SDJ-00002, Rev 5
c. DS No: 24590-LAB-JFD-SDJ-00003, Rev 4
d. Prior stack configurations indicated that one fan will be operating, while one would be in standby for the LB-C2 stack. WTCC states that normal operation now uses both fans; however, single fan operation is allowable based on the stack qualification criteria.

Table 12. LAB Stack Sampling/Monitoring Location Qualification Summary

Stack Parameter	LB-C2	LB-S1	LB-S2
Verification Test Average flow rate (scfm)	34,198	74,628	17,007
Verification Test Average DV (ft^2/min)	10,886	19,004	9,280
Minimum Allowable DV (1/6DV, ft^2/min)[a]	194	434	255
Maximum Allowable DV (6DV, ft^2/min)[b]	15,293	26,262	9,870
Minimum Qualified Stack Velocity (sfpm)	49	87	109
Maximum Qualified Stack Velocity (sfpm)	3823	5252	4,230
Minimum Qualified Stack Flow (scfm)	609	1,704	467
Maximum Qualified Stack Flow (scfm)	48,044	103,131	18,088

a. Minimum DV values at the LAB stacks based on 1/6 DV from scale model tests, also found in Table 2
b. Maximum DV values at the LAB stacks based on 6 DV from scale model tests, also found in Table 2 and Table 7

The remaining criteria for the stack verification to be considered valid involve the flow angle and velocity uniformity results. First, the flow angle at the full-scale stack must be ≤20°. Second, the velocity uniformity at the full-scale stack must be ≤20% COV. Finally, the velocity uniformity results for the actual and scale model stack tests must agree within 5% COV. In general, these criteria were met through the full-scale stack tests at the LAB facility, as shown in Table 13.

Table 13. LAB Stack Sampling/Monitoring Location Qualification Test Result Summary

Stack	Operating Fan(s)	Average Flow Angle (deg)	Average Velocity Uniformity (%COV)	Target %COV[a]
LB-C2	A	17.6	2.8	≤8.6
	B	5.2	2.3	≤7.4
	A and B	3.1	1.6	≤8.5
LB-S1	A and B	9.6	2.2	0.4 ≤ x ≤ 10.4
	B and C	5.0	2.0	≤8.7
	A and C	2.6	1.6	1.4 ≤ x ≤ 12.3
LB-S2	A	2.7	3.5	≤9.8
	B	3.7	3.2	0.4 ≤ x ≤ 10.4

a. The %COV values are based on the most comparable scale model test conditions when available, or the most conservative bounds when multiple, similarly comparable conditions exist.

Based on these stack verification test results, the three LAB filtered exhaust stack sampling locations meet the qualification criteria provided in the ANSI/HPS N13.1-1999 standard for all fan operating configurations. This includes single-fan as well as dual-fan operations for LB-C2, each of the dual-fan operating conditions for LB-S1, and each single-fan operating condition for LB-S2. Further changes to the system configuration or operating conditions that are outside the bounds described in this report may require additional tests or analyses to determine compliance with the standard.

6.0 References

10 CFR 830, Subpart A. "Quality Assurance Requirements." *Code of Federal Regulations*, U.S. Department of Energy.

40 CFR 60, Appendix A, Method 1. "Method 1—Sample and Velocity Traverses for Stationary Sources." *Code of Federal Regulations,* U.S. Environmental Protection Agency.

40 CFR 61, Subpart H. "National Emission Standard for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities." *Code of Federal Regulations,* U.S. Environmental Protection Agency.

ANSI/HPS N13.1-1999. *Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and ducts of Nuclear Facilities*. American National Standards Institute and the Health Physics Society, McLean, VA (reaffirmed in 2011 as ANSI/HPS N13.1-2011).

Antonio E and JE Flaherty. 2017. *Test Plan: Verification Testing Activities for the Waste Treatment Plant LAB Facility Exhaust Stack Air Monitor Locations*. TP-WTPSP-149, Pacific Northwest National Laboratory, Richland, Washington.

Bison Engineering, Inc. 2020. Laboratory Facility Flow Verification. 24590-CM-HC4-HX00-00007-01-00003 Rev 00B, Helena, Montana.

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Flaherty JE. 2019. *Verification Testing Activities for the Waste Treatment Plant LAB, LAW and EMF Facility Exhaust Stack Air Monitor Locations*. RP-WTPSP-162 Rev 0, Pacific Northwest National Laboratory, Richland, Washington.

Glissmeyer JA, JE Flaherty, and GF Piepel. 2011. *Assessment of the Group 5-6 (LB-C2, LB-S2, LV-S1) Stack Sampling Probe Locations for Compliance with ANSI/HPS N13.1-1999*. PNNL-20154, WTP-RPT-209 Rev 0., Pacific Northwest National Laboratory, Richland Washington.

Glissmeyer JA and JGH Geeting. 2013. *Assessment of Waste Treatment Plant LAB C3V (LB-S1) Stack Sampling Probe Location for Compliance with ANSI/HPS N13.1-1999*. PNNL-22167, WTP-RPT-227 Rev 0, Pacific Northwest National Laboratory, Richland, Washington.

Peterson R. to C Luchi. September 13, 2017. *Subcontract No. 24590-QL-HC9-WA49-00001, Project No. 53024 (WA#09) Transmittal of Revised LAB Verification Test Input Document*. [Memorandum] WTP/RPP-MOA-PNNL-00970, Rev 0.0, Pacific Northwest National Laboratory, Richland, Washington.

Washington Administrative Code, Chapter 246-247, Radiation Protection – Air Emissions.

Appendix A – LB-C2 Stack Verification Data Sheets

A.1 Flow Angle Data Forms

FLOW ANGLE DATA FORM

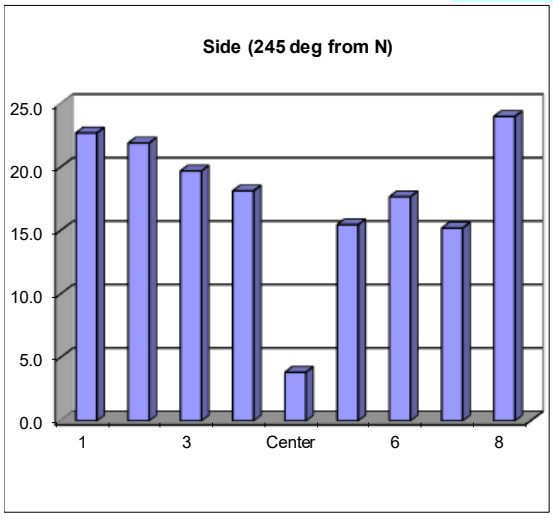
Stack	LB-C2	Run No.	FA-1
Date	10/15/2019	Fan Setting	N/A Hz
Start/End Time	11:20 11:50	Fan Configuration	Fan A only
Testers	ZDH/LCE	Stack Temp	61 deg F
Stack Dia.	48 in		
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

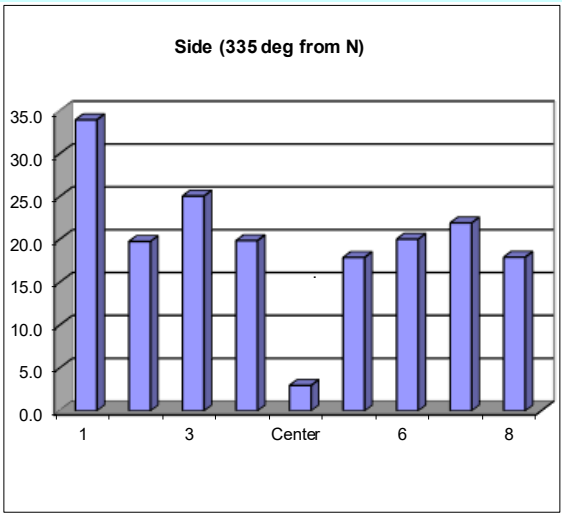
Order -->		First				Second			
Traverse-->		Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	46.46	24.7	20.1	23.3	22.7	33.3	34.4	34.2	34.0
2	42.96	29.3	18.5	17.9	21.9	20.8	21.6	16.9	19.8
3	38.69	19.7	19.9	19.5	19.7	27.3	23.9	24.0	25.1
4	32.50	22.7	15.6	16.1	18.1	21.7	19.5	18.4	19.9
Center	24.00	5.5	4.3	1.7	3.8	6.6	1.0	1.3	3.0
5	15.50	13.8	16.1	16.5	15.5	16.1	17.7	19.9	17.9
6	9.31	17.3	18.9	16.8	17.7	21.9	22.6	15.6	20.0
7	5.04	14.5	15.3	15.8	15.2	23.8	22.0	20.0	21.9
8	1.54	21.0	25.7	25.3	24.0	17.5	17.8	18.5	17.9
Mean of absolute values:					17.6				19.9
" " w/o points by wall:					16.0				18.2
								Grand mean ABS	18.8
								Grand mean ABS w/o wall pts	17.1

Instuments Used:		Cal. Due
S-type pitot (ID: 7A, 7ft)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuracy check prior to each use; field recalibration as necessar
Fluid Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point.
Did not record the sign of angles for the first run, Starded doing that for run 2.
Approx. air velocity was derived from all points on the Velocity Traverse Forms.





FLOW ANGLE DATA FORM

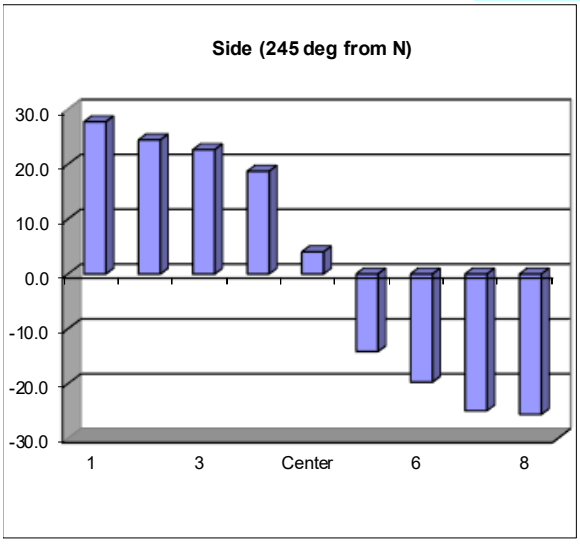
Stack	LB-C2	Run No.	FA-2
Date	10/15/2019	Fan Setting	N/A Hz
Start/End Time	14:57 15:10	Fan Configuration	Fan A only
Testers	ZDH/LCE	Stack Temp	66.6 deg F
Stack Dia.	48 in		
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

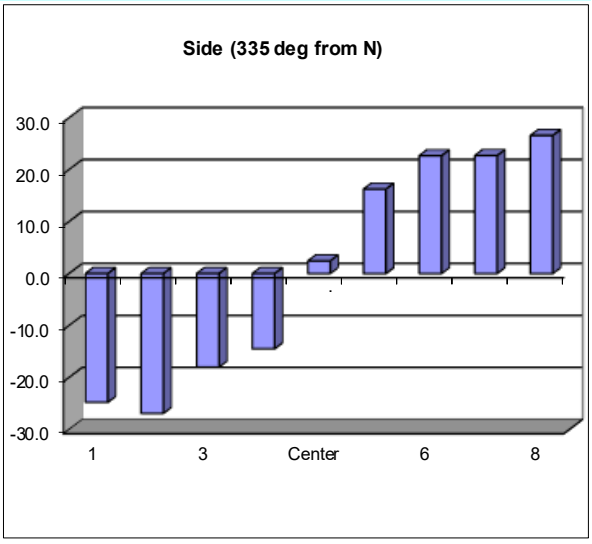
		Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Order -->		First				Second			
Traverse-->									
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	46.46	28.1	27.7	27.4	27.7	-26.9	-24.3	-23.1	-24.8
2	42.96	25.5	23.0	24.8	24.4	-27.0	-26.8	-26.9	-26.9
3	38.69	21.7	23.4	22.9	22.7	-19.1	-18.2	-16.7	-18.0
4	32.50	20.4	17.7	18.1	18.7	-13.3	-15.1	-15.0	-14.5
Center	24.00	5.8	3.5	2.8	4.0	3.1	2.2	2.0	2.4
5	15.50	-13.8	-14.2	-14.4	-14.1	16.9	16.7	15.1	16.2
6	9.31	-20.0	-19.8	-19.3	-19.7	22.8	23.4	21.8	22.7
7	5.04	-25.3	-24.7	-24.8	-24.9	23.8	23.0	21.3	22.7
8	1.54	-25.8	-24.3	-26.7	-25.6	26.9	26.3	26.5	26.6
Mean of absolute values:					20.2				19.4
" " w/o points by wall:					18.4				17.6
								Grand mean ABS	19.8
								Grand mean ABS w/o wall pts	18.0

Instuments Used:		Cal. Due
S-type pitot (ID: 7A, 7ft)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuracy check prior to each use; field recalibration as necessar
Fluid Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
- Traverse point depth = the distance from inside stack wall to each point.
- Sign on flow angle indicates which direction the pitot was turned to achieve null angle
- Approx. air velocity was derived from all points on the Velocity Traverse Forms
- PNNL- Side 1, 2nd traverse, Point 4 entered as 17.7, Bison had "17..7". This changes the Point 4 Mean, the Mean of abolute values & " "w/o points by w all values





FLOW ANGLE DATA FORM

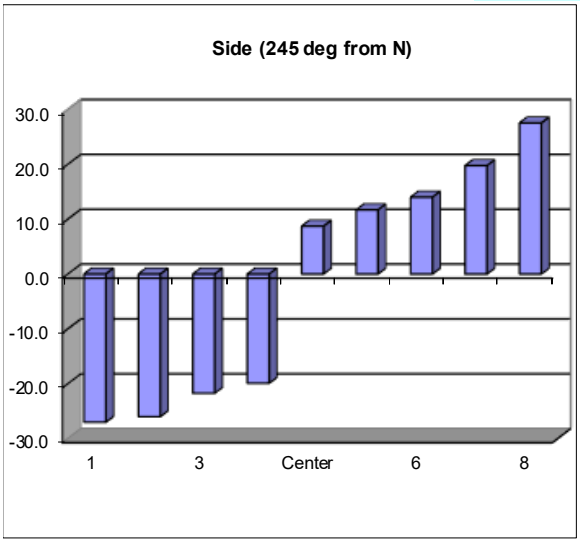
Stack	LB-C2	Run No.	FA-3
Date	10/16/2019	Fan Setting	N/A Hz
Start/End Time	9:04 9:17	Fan Configuration	Fan A only
Testers	ZDH/LCE	Stack Temp	63.7 deg F
Stack Dia.	48 in		
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

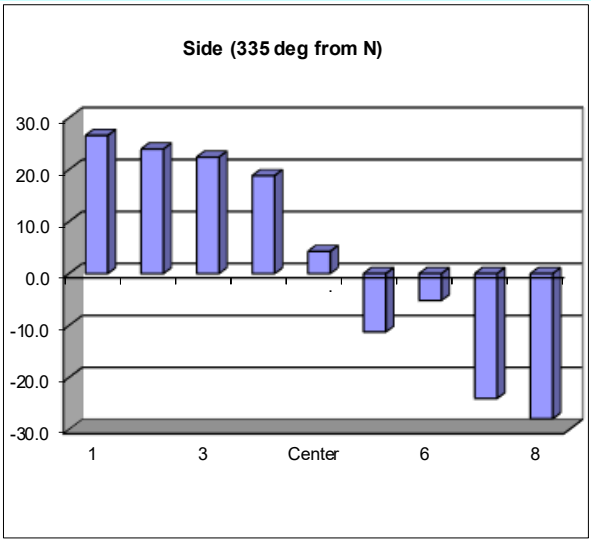
Order -->		First				Second			
Traverse-->		Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	46.46	-28.6	-26.5	-25.9	-27.0	25.3	26.8	27.6	26.6
2	42.96	-24.2	-27.5	-26.3	-26.0	26.5	22.2	23.2	24.0
3	38.69	-21.8	-21.9	-21.5	-21.7	23.3	22.9	21.0	22.4
4	32.50	-19.7	-19.5	-20.5	-19.9	19.0	18.7	18.8	18.8
Center	24.00	9.5	8.3	8.4	8.7	5.0	3.7	4.1	4.3
5	15.50	11.9	11.5	11.7	11.7	-13.3	-10.3	-10.1	-11.2
6	9.31	13.5	13.6	14.9	14.0	-15.2	-14.7	14.4	-5.2
7	5.04	20.8	18.8	19.7	19.8	-24.1	-24.8	-23.2	-24.0
8	1.54	27.2	27.3	28.1	27.5	-28.9	-27.7	-27.2	-27.9
Mean of absolute values:					19.6				18.3
" " w/o points by wall:					17.4				15.7
								Grand mean ABS	18.9
								Grand mean ABS w/o wall pts	16.6

Instuments Used:		Cal. Due
S-type pitot (ID: 7A, 7ft)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuracy check prior to each use; field recalibration as necessar
Fluid Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point.
Sign of flow angle indicates which direction the pitot was turned to achieve null angle.
Approx. air velocity was derived from all points on the Velocity Traverse Forms





FLOW ANGLE DATA FORM

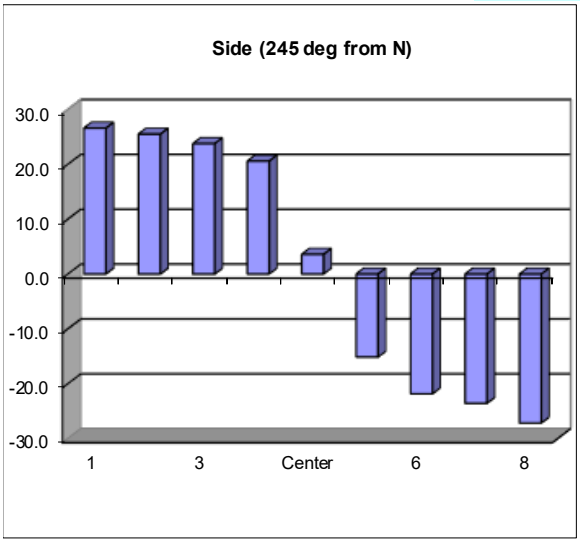
Stack	LB-C2	Run No.	FA-4
Date	10/16/2019	Fan Setting	N/A Hz
Start/End Time	10:24 10:35	Fan Configuration	Fan A only
Testers	ZDH/LCE	Stack Temp	65.4 deg F
Stack Dia.	48 in		
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

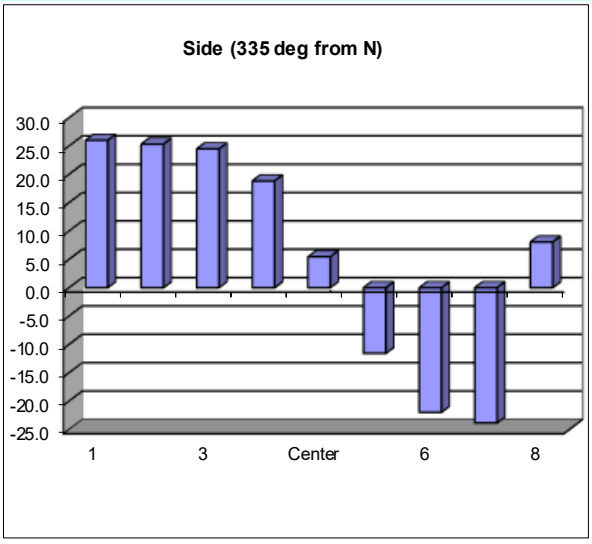
Order -->	First				Second			
Traverse-->	Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Trial ---->	1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw			deg. cw			
1	46.46	26.7	26.5	26.6	26.5	25.7	25.8	26.0
2	42.96	25.7	25.9	24.9	25.5	24.8	25.3	25.9	25.3
3	38.69	24.7	23.6	23.0	23.8	24.5	24.4	24.6	24.5
4	32.50	22.3	20.0	19.4	20.6	18.7	18.9	18.9	18.8
Center	24.00	3.1	3.8	3.9	3.6	5.8	5.4	5.2	5.5
5	15.50	-17.2	-14.4	-13.8	-15.1	-11.6	-11.4	-11.7	-11.6
6	9.31	-21.9	-21.9	-21.7	-21.8	-23.4	-21.3	-21.2	-22.0
7	5.04	-23.6	-23.6	-23.5	-23.6	-24.0	-24.0	-23.5	-23.8
8	1.54	-27.1	-27.5	-26.9	-27.2	-25.0	24.3	24.9	8.1
Mean of absolute values:					20.9				18.4
" " w/o points by wall:					19.1				18.8
								Grand mean ABS	19.6
								Grand mean ABS w/o wall pts	19.0

Instuments Used:		Cal. Due
S-type pitot (ID: 7A, 7ft)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuracy check prior to each use; field recalibration as necessar
Fluid Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point.
Sign of flow angle indicates which direction the pitot was turned to achieve null angle.
Approx. air velocity was derived from all points on the Velocity Traverse Forms





FLOW ANGLE DATA FORM

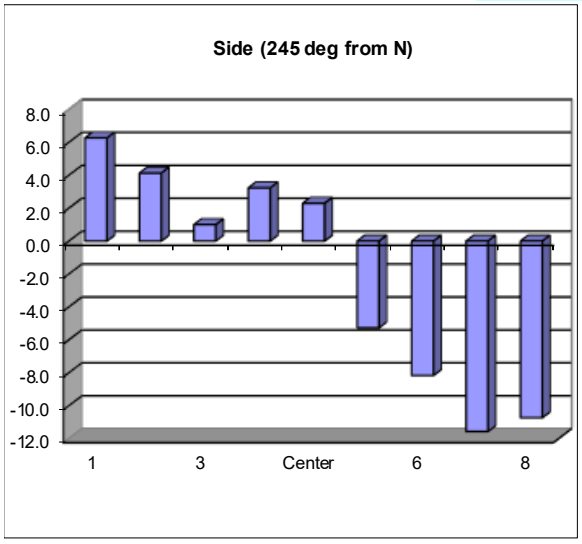
Stack	LB-C2	Run No.	FA-5
Date	10/16/2019	Fan Setting	N/A Hz
Start/End Time	12:49 12:58	Fan Configuration	Fan B only
Testers	ZDH/LCE	Stack Temp	68.5 deg F
Stack Dia.	48 in		
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

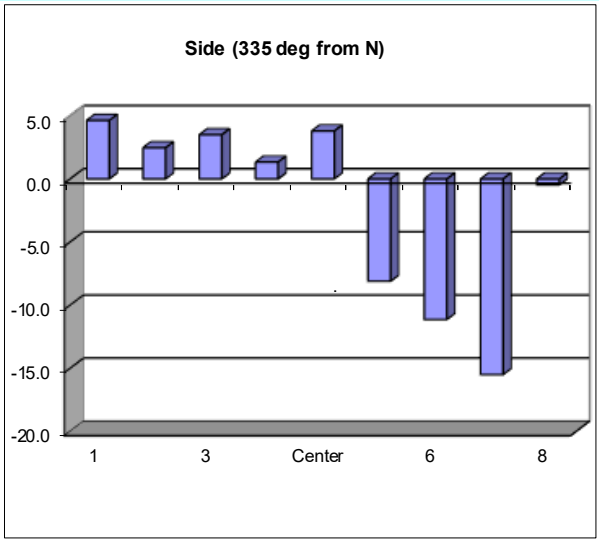
Order -->		First				Second			
Traverse-->		Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	46.46	6.9	6.5	5.4	6.3	5.1	4.3	4.5	4.6
2	42.96	3.0	4.0	5.4	4.1	3.6	1.2	2.6	2.5
3	38.69	1.6	0.8	0.6	1.0	3.8	3.5	3.2	3.5
4	32.50	3.4	3.2	3.1	3.2	1.4	1.6	1.0	1.3
Center	24.00	1.4	1.6	3.9	2.3	3.9	3.7	3.8	3.8
5	15.50	-6.9	-4.6	-4.3	-5.3	-8.1	-7.9	-8.3	-8.1
6	9.31	-7.7	-8.2	-8.6	-8.2	-11.7	-11.5	-10.2	-11.1
7	5.04	-11.7	-11.8	-11.2	-11.6	-15.5	-15.8	-15.2	-15.5
8	1.54	-10.8	-10.9	-10.5	-10.7	-0.1	-0.8	-0.5	-0.5
Mean of absolute values:					5.9				5.7
" " w/o points by wall:					5.1				6.5
								Grand mean ABS	5.8
								Grand mean ABS w/o wall pts	5.8

Instuments Used:		Cal. Due
S-type pitot (ID: 7A, 7ft)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuracy check prior to each use; field recalibration as necessary
Fluid Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point.
Sign of flow angle indicates which direction the pitot was turned to achieve null angle.
Approx. air velocity was derived from all points on the Velocity Traverse Forms





FLOW ANGLE DATA FORM

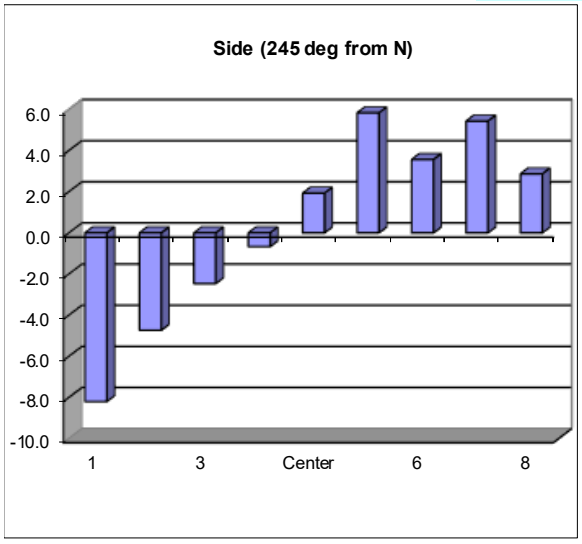
Stack	LB-C2	Run No.	FA-6
Date	10/16/2019	Fan Setting	N/A Hz
Start/End Time	13:55 14:00	Fan Configuration	Fan B only
Testers	ZDH/LCE	Stack Temp	68.5 deg F
Stack Dia.	48 in		
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

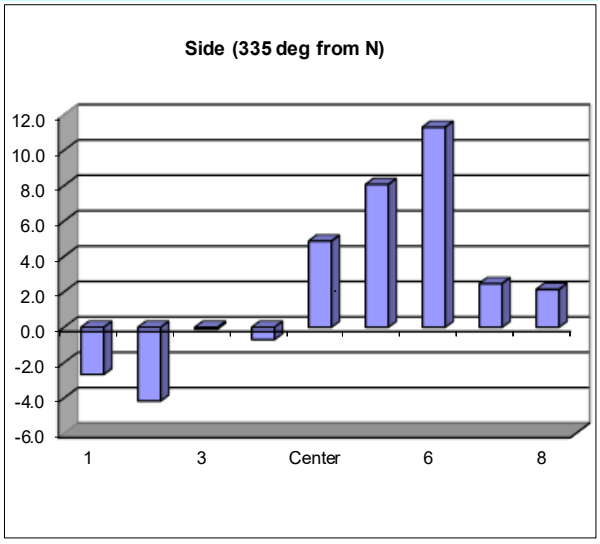
Order -->		First				Second			
Traverse-->		Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	46.46	-7.4	-8.8	-8.4	-8.2	-3.0	-2.9	-2.1	-2.7
2	42.96	-4.3	-4.6	-5.3	-4.7	-7.8	-2.4	-2.3	-4.2
3	38.69	-2.7	-2.4	-2.3	-2.5	-0.3	0.0	0.0	-0.1
4	32.50	-0.5	-0.7	-0.8	-0.7	-0.7	-0.8	-0.6	-0.7
Center	24.00	2.1	1.9	1.8	1.9	4.6	4.9	5.1	4.9
5	15.50	5.6	5.8	6.1	5.8	8.3	8.2	7.7	8.1
6	9.31	3.6	3.5	3.6	3.6	11.6	11.1	11.2	11.3
7	5.04	5.2	5.8	5.3	5.4	2.1	2.3	3.0	2.5
8	1.54	2.9	3.0	2.7	2.9	2.3	2.7	1.4	2.1
Mean of absolute values:					4.0				4.1
" " w/o points by wall:					3.5				4.5
								Grand mean ABS	4.0
								Grand mean ABS w/o wall pts	4.0

Instuments Used:		Cal. Due
S-type pitot (ID: 7A, 7ft)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuracy check prior to each use; field recalibration as necessary
Fluid Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point.
Sign of flow angle indicates which direction the pitot was turned to achieve null angle.
Approx. air velocity was derived from all points on the Velocity Traverse Forms





FLOW ANGLE DATA FORM

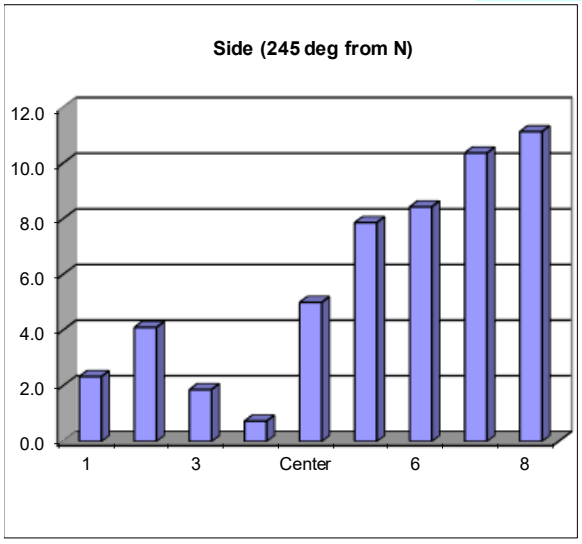
Stack	LB-C2	Run No.	FA-7
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	9:00 9:10	Fan Configuration	Fan B only
Testers	ZDH/LCE	Stack Temp	66.5 deg F
Stack Dia.	48 in		
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

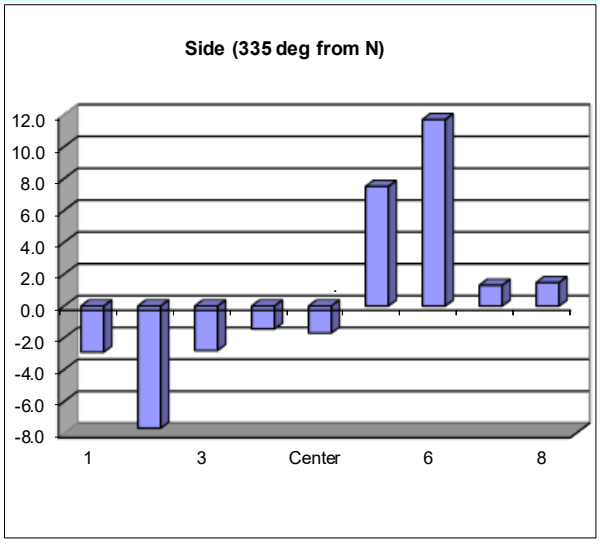
Order -->		First				Second			
Traverse-->		Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	46.46	1.4	2.8	2.8	2.3	-2.5	-3.3	-2.9	-2.9
2	42.96	5.6	4.5	2.2	4.1	-10.7	-6.5	-5.8	-7.7
3	38.69	2.7	2.1	0.8	1.9	-3.6	-3.1	-1.7	-2.8
4	32.50	0.2	0.9	1.1	0.7	-1.4	-1.6	-1.3	-1.4
Center	24.00	5.0	5.4	4.6	5.0	-5.4	4.8	-4.5	-1.7
5	15.50	7.9	8.1	7.6	7.9	7.8	7.1	7.6	7.5
6	9.31	9.8	7.6	7.9	8.4	12.0	11.7	11.4	11.7
7	5.04	10.4	10.4	10.3	10.4	0.7	1.3	1.9	1.3
8	1.54	11.2	11.3	10.9	11.1	2.2	1.3	0.9	1.5
Mean of absolute values:					5.8				4.3
" " w/o points by wall:					5.5				4.9
								Grand mean ABS	5.0
								Grand mean ABS w/o wall pts	5.2

Instuments Used:		Cal. Due
S-type pitot (ID: 7A, 7ft)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuracy check prior to each use; field recalibration as necessary
Fluid Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point.
Sign of flow angle indicates which direction the pitot was turned to achieve null angle.
Approx. air velocity was derived from all points on the Velocity Traverse Forms





FLOW ANGLE DATA FORM

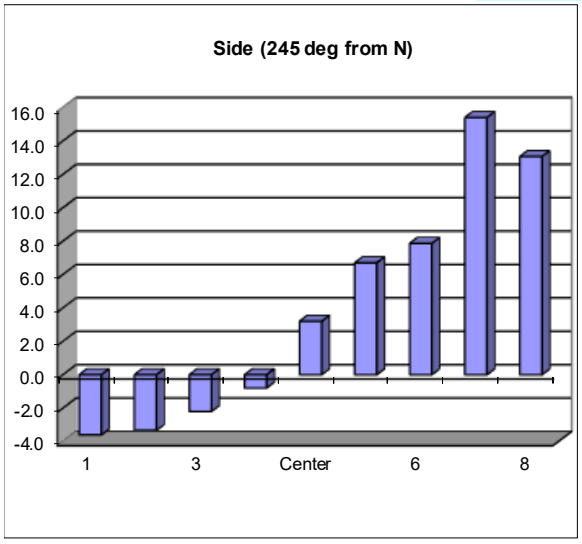
Stack	LB-C2	Run No.	FA-8
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	10:05 10:17	Fan Configuration	Fan B only
Testers	ZDH/LCE	Stack Temp	68.4 deg F
Stack Dia.	48 in		
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

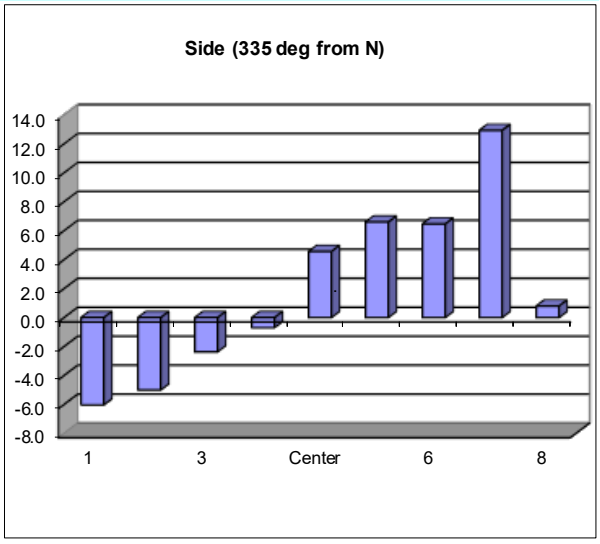
		Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Order -->		First				Second			
Traverse-->									
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	46.46	-3.8	-3.4	-3.6	-3.6	-6.9	-5.5	-5.7	-6.0
2	42.96	-3.7	-3.9	-2.4	-3.3	-5.5	-4.2	-5.3	-5.0
3	38.69	-2.5	-2.4	-1.7	-2.2	-2.9	-2.0	-2.2	-2.4
4	32.50	-0.4	-1.2	-0.8	-0.8	-1.5	-0.5	-0.1	-0.7
Center	24.00	2.6	4.2	2.8	3.2	5.0	4.4	4.3	4.6
5	15.50	7.5	6.4	6.2	6.7	4.8	7.4	7.6	6.6
6	9.31	7.9	7.9	7.8	7.9	5.9	7.0	6.5	6.5
7	5.04	15.7	15.3	15.2	15.4	12.8	13.3	12.7	12.9
8	1.54	13.1	13.3	12.8	13.1	1.2	0.9	0.3	0.8
Mean of absolute values:					6.2				5.1
" " w/o points by wall:					5.6				5.5
								Grand mean ABS	5.6
								Grand mean ABS w/o wall pts	5.6

Instuments Used:		Cal. Due
S-type pitot (ID: 7A, 7ft)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuracy check prior to each use; field recalibration as necessary
Fluid Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point.
Sign of flow angle indicates which direction the pitot was turned to achieve null angle.
Approx. air velocity was derived from all points on the Velocity Traverse Forms





FLOW ANGLE DATA FORM

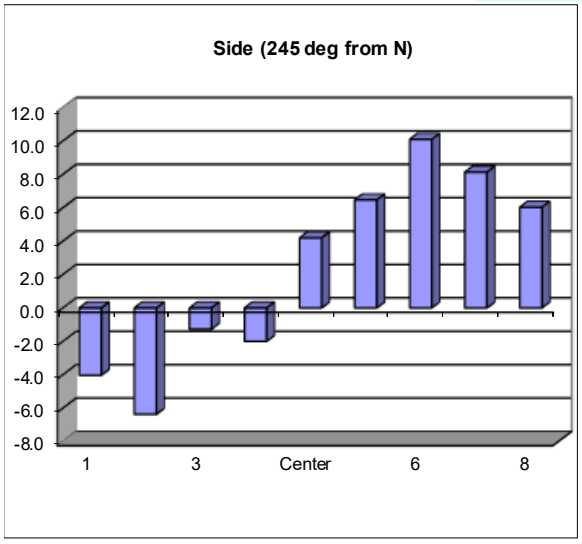
Stack	LB-C2	Run No.	FA-9
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	11:13 11:20	Fan Configuration	Fan B only
Testers	ZDH/LCE	Stack Temp	71.4 deg F
Stack Dia.	48 in		
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

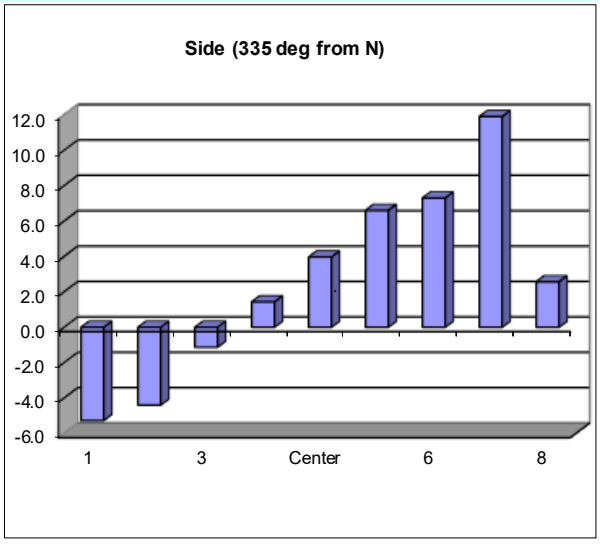
Order -->		First				Second			
Traverse-->		Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	46.46	-5.3	-3.2	-3.6	-4.0	-6.4	-4.3	-5.1	-5.3
2	42.96	-6.9	-6.1	-6.1	-6.4	-5.4	-4.9	-2.9	-4.4
3	38.69	-0.7	-0.5	-2.6	-1.3	-0.9	-1.1	-1.4	-1.1
4	32.50	-2.0	-1.9	-2.1	-2.0	1.5	1.1	1.7	1.4
Center	24.00	3.9	3.8	4.9	4.2	4.2	3.8	3.9	4.0
5	15.50	5.9	6.6	6.9	6.5	6.2	6.7	6.9	6.6
6	9.31	13.4	8.2	8.7	10.1	7.3	7.4	7.2	7.3
7	5.04	7.9	8.2	8.3	8.1	12.6	11.7	11.4	11.9
8	1.54	5.6	6.3	6.2	6.0	2.6	2.7	2.4	2.6
Mean of absolute values:					5.4				5.0
" " w/o points by wall:					5.5				5.2
								Grand mean ABS	5.2
								Grand mean ABS w/o wall pts	5.4

Instuments Used:		Cal. Due
S-type pitot (ID: 7A, 7ft)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuracy check prior to each use; field recalibration as necessary
Fluid Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point.
Sign of flow angle indicates which direction the pitot was turned to achieve null angle.
Approx. air velocity was derived from all points on the Velocity Traverse Forms





FLOW ANGLE DATA FORM

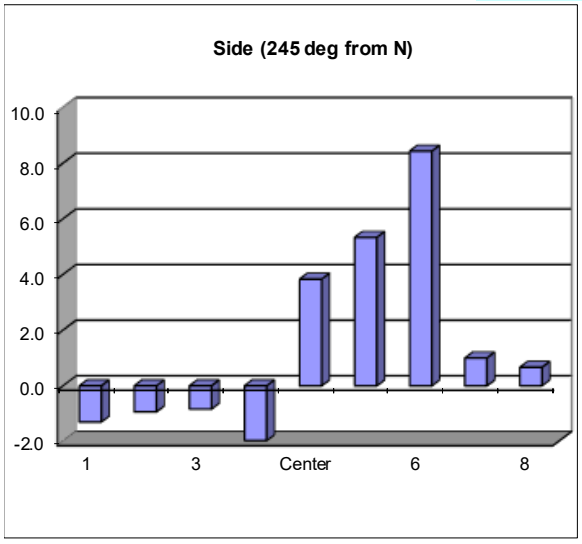
Stack	LB-C2	Run No.	FA-10
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	14:09 14:16	Fan Configuration	Fans A & B
Testers	ZDH/LCE	Stack Temp	68.1 deg F
Stack Dia.	48 in		
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

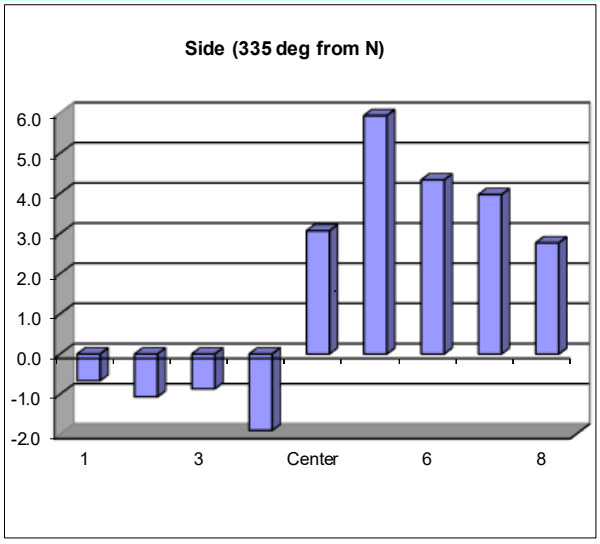
Order -->		First				Second			
Traverse-->		Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	46.46	-1.0	-2.2	-0.7	-1.3	-0.4	-1.2	-0.4	-0.7
2	42.96	-0.5	-1.1	-1.2	-0.9	-1.1	-0.9	-1.2	-1.1
3	38.69	-1.0	-0.7	-0.8	-0.8	-1.3	-0.6	-0.7	-0.9
4	32.50	-1.9	-2.2	-1.8	-2.0	-2.6	-1.8	-1.3	-1.9
Center	24.00	4.5	2.7	4.3	3.8	3.3	2.9	3.0	3.1
5	15.50	6.2	5.9	3.9	5.3	7.0	5.2	5.6	5.9
6	9.31	8.7	8.4	8.2	8.4	4.5	4.4	4.1	4.3
7	5.04	1.0	1.2	0.8	1.0	4.1	4.0	3.8	4.0
8	1.54	0.5	0.7	0.8	0.7	3.0	2.8	2.5	2.8
Mean of absolute values:					2.7				2.7
" " w/o points by wall:					3.2				3.0
								Grand mean ABS	2.7
								Grand mean ABS w/o wall pts	3.1

Instuments Used:		Cal. Due
S-type pitot (ID: 7A, 7ft)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuracy check prior to each use; field recalibration as necessary
Fluid Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point.
Sign of flow angle indicates which direction the pitot was turned to achieve null angle.
Approx. air velocity was derived from all points on the Velocity Traverse Forms





FLOW ANGLE DATA FORM

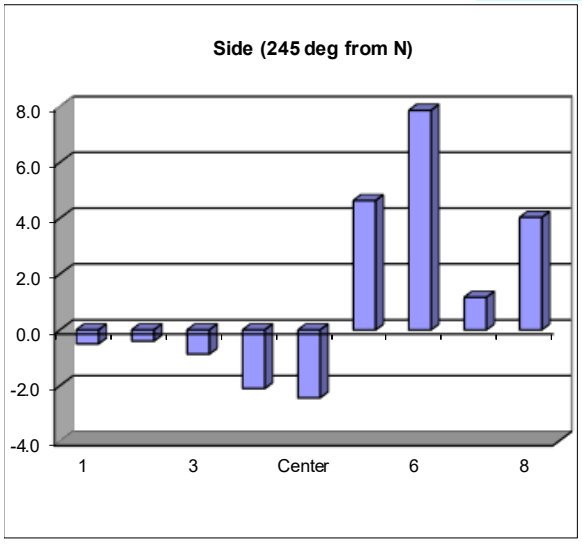
Stack	LB-C2	Run No.	FA-11
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	15:15 15:21	Fan Configuration	Fans A & B
Testers	ZDH/LCE	Stack Temp	68.9 deg F
Stack Dia.	48 in		
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

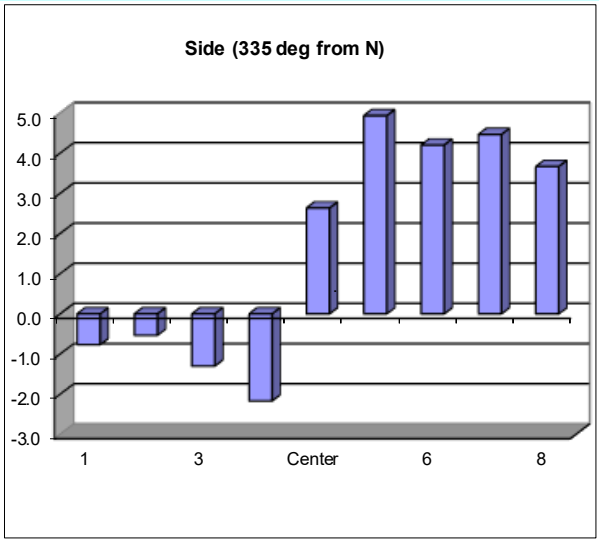
Order -->	First				Second			
Traverse-->	Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Trial ---->	1	2	3	Mean	1	2	3	Mean
Point / Depth, in.	deg. cw				deg. cw			
1 / 46.46	-1.0	-0.2	-0.3	-0.5	-0.8	-0.7	-0.8	-0.8
2 / 42.96	-0.1	-0.5	-0.6	-0.4	-0.7	-0.3	-0.6	-0.5
3 / 38.69	-1.9	-0.4	-0.3	-0.9	-1.1	-1.8	-1.0	-1.3
4 / 32.50	-2.9	-1.2	-2.2	-2.1	-1.9	-1.8	-2.8	-2.2
Center / 24.00	-2.5	-2.3	-2.5	-2.4	2.0	2.2	3.7	2.6
5 / 15.50	4.8	4.5	4.6	4.6	6.8	2.8	5.2	4.9
6 / 9.31	8.4	7.8	7.4	7.9	3.9	4.1	4.6	4.2
7 / 5.04	1.2	1.0	1.3	1.2	4.2	4.5	4.7	4.5
8 / 1.54	4.2	3.8	4.1	4.0	5.1	3.0	2.9	3.7
Mean of absolute values:				2.7				2.7
" " w/o points by wall:				2.8				2.9
							Grand mean ABS	2.7
							Grand mean ABS w/o wall pts	2.8

Instuments Used:		Cal. Due
S-type pitot (ID: 7A, 7ft)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuracy check prior to each use; field recalibration as necessary
Fluid Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point.
Sign of flow angle indicates which direction the pitot was turned to achieve null angle.
Approx. air velocity was derived from all points on the Velocity Traverse Forms





FLOW ANGLE DATA FORM

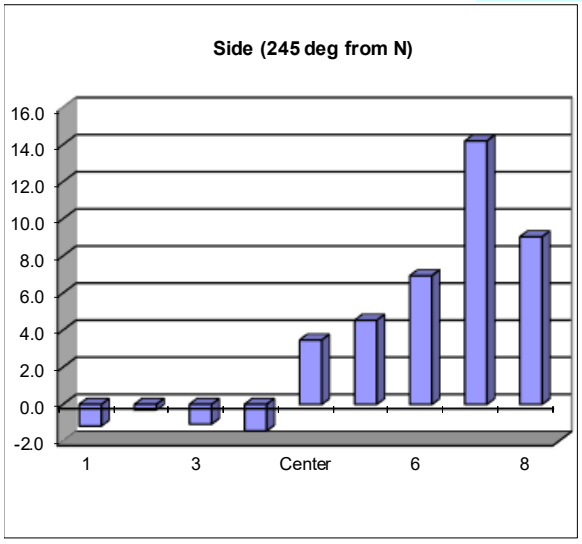
Stack	LB-C2	Run No.	FA-12
Date	10/18/2019	Fan Setting	N/A Hz
Start/End Time	8:56 9:04	Fan Configuration	Fans A & B
Testers	ZDH/LCE	Stack Temp	62.8 deg F
Stack Dia.	48 in		
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

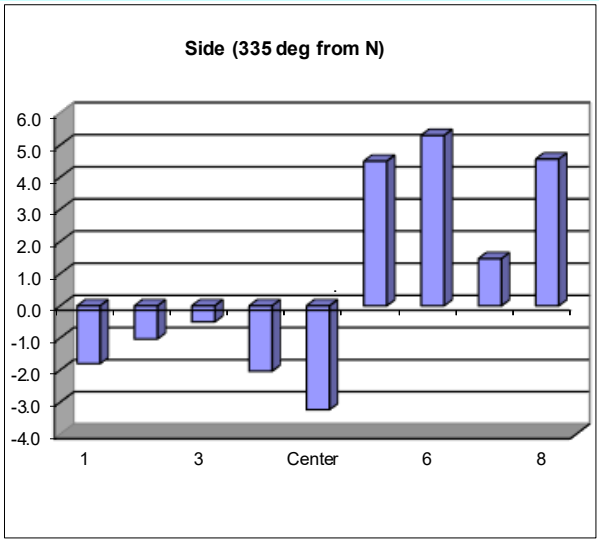
Order -->		First				Second			
Traverse-->		Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	46.46	-1.6	-0.6	-1.3	-1.2	-2.7	-2.0	-0.7	-1.8
2	42.96	0.0	-0.5	-0.4	-0.3	-1.1	-1.0	-1.0	-1.0
3	38.69	-0.9	-1.2	-1.1	-1.1	-0.6	-0.7	-0.2	-0.5
4	32.50	-1.8	-1.2	-1.3	-1.4	-2.7	-1.8	-1.6	-2.0
Center	24.00	3.8	2.7	3.9	3.5	-3.0	-2.8	-3.9	-3.2
5	15.50	4.1	4.3	5.2	4.5	4.2	4.7	4.6	4.5
6	9.31	7.9	6.5	6.4	6.9	5.4	4.9	5.6	5.3
7	5.04	14.2	14.3	14.1	14.2	1.6	1.3	1.5	1.5
8	1.54	9.6	8.7	8.8	9.0	5.2	4.7	3.8	4.6
Mean of absolute values:					4.7				2.7
" " w/o points by wall:					4.6				2.6
								Grand mean ABS	3.7
								Grand mean ABS w/o wall pts	3.6

Instuments Used:		Cal. Due
S-type pitot (ID: 7A, 7ft)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuracy check prior to each use; field recalibration as necessary
Fluid Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point.
Sign of flow angle indicates which direction the pitot was turned to achieve null angle.
Approx. air velocity was derived from all points on the Velocity Traverse Forms





FLOW ANGLE DATA FORM

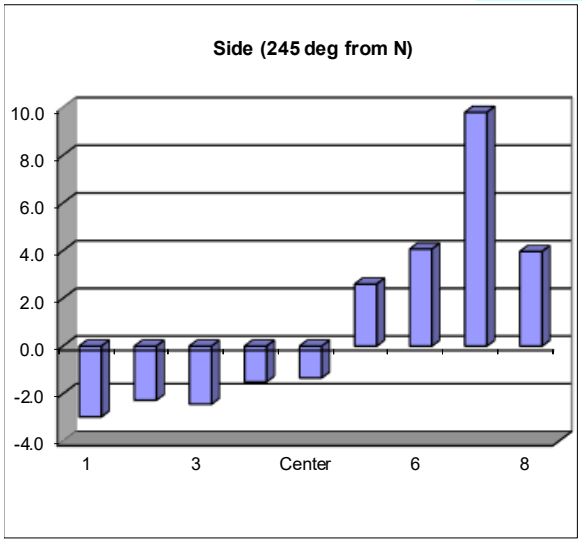
Stack	LB-C2	Run No.	FA-13
Date	10/18/2019	Fan Setting	N/A Hz
Start/End Time	10:02 10:10	Fan Configuration	Fans A & B
Testers	ZDH/LCE	Stack Temp	64.9 deg F
Stack Dia.	48 in		
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

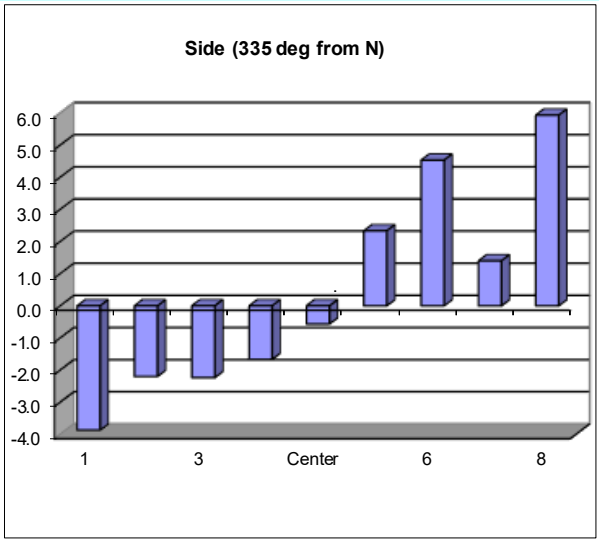
Order -->		First				Second			
Traverse-->		Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	46.46	-2.6	-3.4	-2.9	-3.0	-4.6	-3.6	-3.4	-3.9
2	42.96	-1.5	-1.8	-3.5	-2.3	-2.2	-2.3	-2.1	-2.2
3	38.69	-2.4	-2.2	-2.7	-2.4	-2.8	-1.7	-2.2	-2.2
4	32.50	-1.3	-1.5	-1.7	-1.5	-1.9	-1.9	-1.2	-1.7
Center	24.00	-1.5	-1.1	-1.4	-1.3	-0.1	-1.0	-0.6	-0.6
5	15.50	3.0	2.8	2.0	2.6	2.1	2.4	2.5	2.3
6	9.31	4.1	4.1	4.0	4.1	6.1	3.5	4.0	4.5
7	5.04	9.6	9.8	10.0	9.8	1.5	1.2	1.5	1.4
8	1.54	4.1	4.0	3.8	4.0	6.2	5.6	6.0	5.9
Mean of absolute values:					3.4				2.7
" " w/o points by wall:					3.4				2.1
								Grand mean ABS	3.1
								Grand mean ABS w/o wall pts	2.8

Instuments Used:		Cal. Due
S-type pitot (ID: 7A, 7ft)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuracy check prior to each use; field recalibration as necessary
Fluid Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point.
Sign of flow angle indicates which direction the pitot was turned to achieve null angle.
Approx. air velocity was derived from all points on the Velocity Traverse Forms





FLOW ANGLE DATA FORM

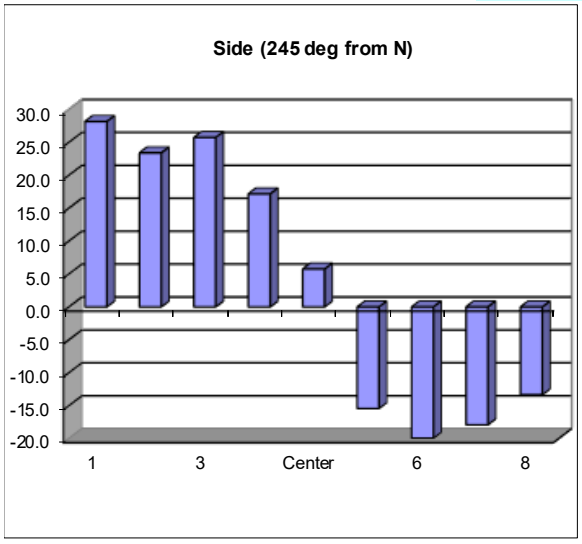
Stack	LB-C2	Run No.	FA-14
Date	10/19/2019	Fan Setting	N/A Hz
Start/End Time	9:06 9:15	Fan Configuration	Fan A
Testers	ZDH/LCE	Stack Temp	61.9 deg F
Stack Dia.	48 in		
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

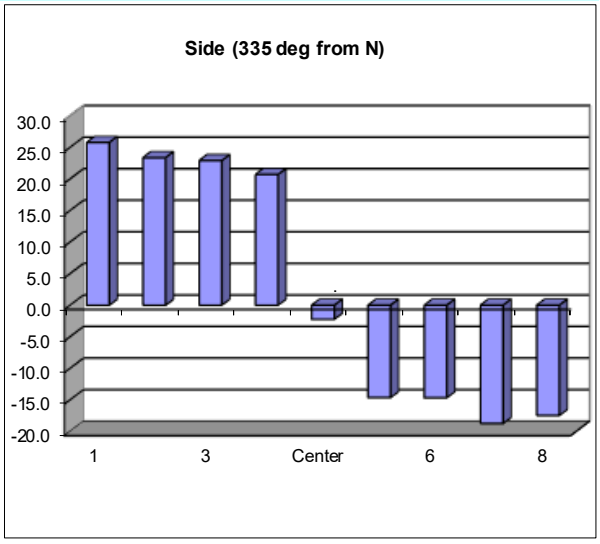
Order -->		First				Second			
Traverse-->		Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	46.46	27.6	28.2	28.7	28.2	26.5	26.0	24.8	25.8
2	42.96	23.3	23.3	23.6	23.4	23.6	23.0	23.5	23.4
3	38.69	26.0	25.7	25.5	25.7	23.1	22.9	22.7	22.9
4	32.50	16.9	17.4	17.2	17.2	21.8	20.8	19.5	20.7
Center	24.00	6.0	5.8	5.5	5.8	-4.7	-0.8	-1.2	-2.2
5	15.50	-17.1	-14.4	-14.8	-15.4	-15.5	-13.1	-15.3	-14.6
6	9.31	-20.8	-19.2	-19.8	-19.9	-14.2	-15.0	-14.8	-14.7
7	5.04	-21.1	-16.4	-16.2	-17.9	-18.3	-19.0	-18.9	-18.7
8	1.54	-14.3	-12.9	-12.8	-13.3	-17.6	-17.4	-17.4	-17.5
Mean of absolute values:					18.5				17.8
" " w/o points by wall:					17.9				16.7
								Grand mean ABS	18.2
								Grand mean ABS w/o wall pts	17.3

Instuments Used:		Cal. Due
S-type pitot (ID: 7A, 7ft)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuracy check prior to each use; field recalibration as necessary
Fluid Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point.
Sign of flow angle indicates which direction the pitot was turned to achieve null angle.
Approx. air velocity was derived from all points on the Velocity Traverse Forms





A.2 Velocity Transverse Data Forms

VELOCITY TRAVERSE DATA FORM

Stack	**LB-C2**	Run No.	**VT-1**
Date	**10/15/19**	Fan Configuration	**Fan A only**
Testers	ZDH/LCE	Fan Setting	**N/A** **Hz**
Stack Dia.	48 in.	Stack Temp	61.30 deg F
Stack X-Area	1809.6 in.2	Start/End Time	11:10 11:18
Test Port	2	Center 2/3 from	4.40 to: 43.60
Distance to disturbance	53.3 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (245 deg from N)				Side2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	46.46	2,637.1	2,545.6	2,576.5	2,586.4	2,696.4	2,545.6	2,607.0	2,616.3
2	42.96	2,811.2	2,811.2	2,839.2	2,820.5	2,894.3	2,754.4	2,725.5	2,791.4
3	38.69	2,866.9	2,839.2	2,921.5	2,875.9	2,894.3	2,866.9	2,866.9	2,876.0
4	32.50	2,975.0	2,948.4	2,975.0	2,966.2	2,839.2	2,894.3	2,921.5	2,885.0
Center	24.00	2,894.3	2,839.2	2,811.2	2,848.2	3,001.5	2,921.5	2,782.9	2,902.0
5	15.50	2,921.5	2,754.4	2,811.2	2,829.0	2,811.2	2,866.9	2,811.2	2,829.7
6	9.31	2,839.2	2,754.4	2,839.2	2,810.9	2,839.2	2,811.2	2,782.9	2,811.1
7	5.04	2,725.5	2,696.4	2,666.9	2,696.3	2,725.5	2,754.4	2,576.5	2,685.5
8	1.54	2,666.9	2,637.1	2,576.5	2,626.8	2,666.9	2,514.3	2,696.4	2,625.9
Averages ---------->		2,815.3	2,758.4	2,779.7	2,784.5	2,818.7	2,769.9	2,752.3	2,780.3

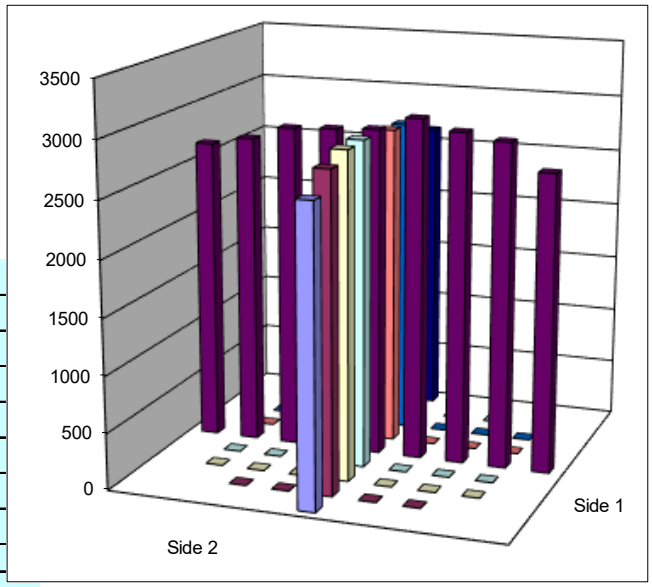
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	2782.4		Mean	2835.3	2825.8	2830.5
Min Point	2586.4	-7.0%	Std. Dev.	80.7	74.1	74.6
Max Point	2966.2	6.6%	COV as %	2.8	2.6	**2.6**

Flow w/o C-Pt 34819 cfm

Vel Avg w/o C-Pt 2771 fpm

	Start	Finish	
Stack temp	60.70	61.90	F
Equipment temp	58.30	64.60	F
Ambient temp	58.30	64.60	F
Stack static	1.29	1.32	mbars
Ambient pressure	992.55	992.21	mbars
Total Stack pressure	993.8	993.5	mbars
Ambient humidity	40%	33%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST5, 5ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm) (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

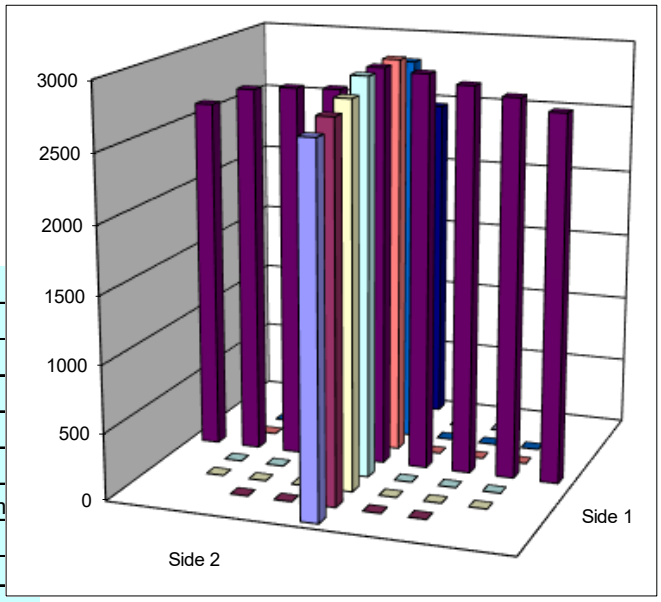
Stack	LB-C2	Run No.	VT-2
Date	10/15/19	Fan Configuration	Fan A only
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	48 in.	Stack Temp	67.50 deg F
Stack X-Area	1809.6 in.2	Start/End Time	14:35 14:53
Test Port	2	Center 2/3 from	4.40 to: 43.60
Distance to disturbance	53.3 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (245 deg from N)				Side2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	46.46	2,739.3	2,620.1	2,768.3	2,709.2	2,620.1	2,650.4	2,680.4	2,650.3
2	42.96	2,739.3	2,796.9	2,853.5	2,796.6	2,768.3	2,680.4	2,739.3	2,729.3
3	38.69	2,963.2	2,853.5	2,768.3	2,861.6	2,825.3	2,768.3	2,796.9	2,796.8
4	32.50	2,908.8	2,881.2	2,990.1	2,926.7	2,936.2	2,963.2	2,796.9	2,898.8
Center	24.00	3,095.0	2,908.8	2,853.5	2,952.4	2,990.1	2,881.2	2,853.5	2,908.3
5	15.50	2,825.3	2,739.3	2,768.3	2,777.6	2,908.8	2,825.3	3,016.7	2,916.9
6	9.31	2,680.4	2,825.3	2,796.9	2,767.5	2,881.2	2,825.3	2,853.5	2,853.3
7	5.04	2,709.9	2,796.9	2,709.9	2,738.9	2,680.4	2,650.4	2,709.9	2,680.2
8	1.54	2,589.4	2,650.4	2,589.4	2,609.8	2,260.2	2,527.0	2,463.1	2,416.8
Averages ---------->		2,805.6	2,785.8	2,788.7	2,793.4	2,763.4	2,752.4	2,767.8	2,761.2

All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	2777.3		Mean	2831.6	2826.2	2828.9
Min Point	2416.8	-13.0%	Std. Dev.	83.1	93.6	85.0
Max Point	2952.4	6.3%	COV as %	2.9	3.3	**3.0**

Flow w/o C-Pt	34660 cfm	**Instuments Used:**	Cal Due
Vel Avg w/o C-Pt	2758 fpm	Standard pitot (ID: BST5, 5ft)	Post-test inspection
		Digi-sense 20250-13 Manometer	9/15/2020
		Workhorse Thermometer	Verified prior to each field use

	Start	Finish	
Stack temp	68.40	66.60	F
Equipment temp	67.10	66.60	F
Ambient temp	67.10	63.50	F
Stack static	2.04	5.45	mbars
Ambient pressure	992.55	990.86	mbars
Total Stack pressure	994.59	996.31	mbars
Ambient humidity	30%	33%	RH



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

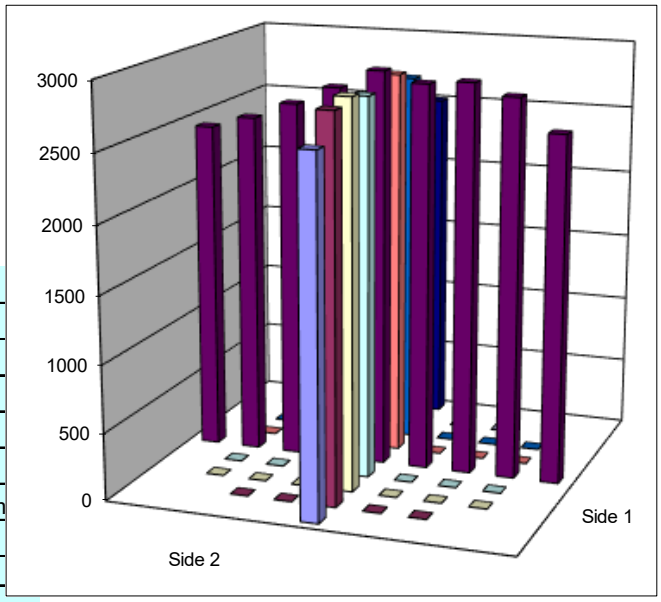
Stack	LB-C2	Run No.	VT-3
Date	10/16/19	Fan Configuration	Fan A only
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	48 in.	Stack Temp	63.75 deg F
Stack X-Area	1809.6 in.2	Start/End Time	8:53 9:00
Test Port	2	Center 2/3 from	4.40 to: 43.60
Distance to disturbance	53.3 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (245 deg from N)				Side2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	46.46	2,560.2	2,528.7	2,591.2	2,560.0	2,497.0	2,591.2	2,560.2	2,549.5
2	42.96	2,741.1	2,798.8	2,855.4	2,798.4	2,741.1	2,741.1	2,770.1	2,750.8
3	38.69	2,827.2	2,910.8	2,910.8	2,882.9	2,741.1	2,855.4	2,770.1	2,788.9
4	32.50	2,883.2	2,798.8	2,883.2	2,855.1	2,652.2	2,770.1	2,798.8	2,740.4
Center	24.00	2,938.2	2,910.8	2,938.2	2,929.0	2,798.8	2,965.2	2,827.2	2,863.7
5	15.50	2,855.4	2,770.1	2,741.1	2,788.9	2,741.1	2,883.2	2,741.1	2,788.4
6	9.31	2,682.1	2,652.2	2,621.9	2,652.1	2,711.8	2,741.1	2,682.1	2,711.7
7	5.04	2,497.0	2,560.2	2,528.7	2,528.6	2,591.2	2,652.2	2,621.9	2,621.8
8	1.54	2,464.7	2,365.4	2,497.0	2,442.4	2,464.7	2,399.0	2,464.7	2,442.8
Averages ---------->		2,716.6	2,699.5	2,729.7	2,715.3	2,659.9	2,733.2	2,692.9	2,695.3

All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	2705.3		Mean	2776.4	2752.2	2764.3
Min Point	2442.4	-9.7%	Std. Dev.	140.4	75.2	108.9
Max Point	2929.0	8.3%	COV as %	5.1	2.7	**3.9**

Flow w/o C-Pt	33696 cfm	**Instuments Used:**	Cal Due
Vel Avg w/o C-Pt	2681 fpm	Standard pitot (ID: BST5, 5ft)	Post-test inspection
		Digi-sense 20250-13 Manometer	9/15/2020
		Workhorse Thermometer	Verified prior to each field use

	Start	Finish	
Stack temp	63.80	63.70	F
Equipment temp	54.50	63.70	F
Ambient temp	54.50	54.60	F
Stack static	1.69	2.22	mbars
Ambient pressure	985.10	985.10	mbars
Total Stack pressure	986.8	987.3	mbars
Ambient humidity	52%	51%	RH



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

Stack	LB-C2	Run No.	VT-4
Date	10/16/19	Fan Configuration	Fan A only
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	48 in.	Stack Temp	65.15 deg F
Stack X-Area	1809.6 in.2	Start/End Time	10:15 10:23
Test Port	2	Center 2/3 from	4.40 to: 43.60
Distance to disturbance	53.3 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

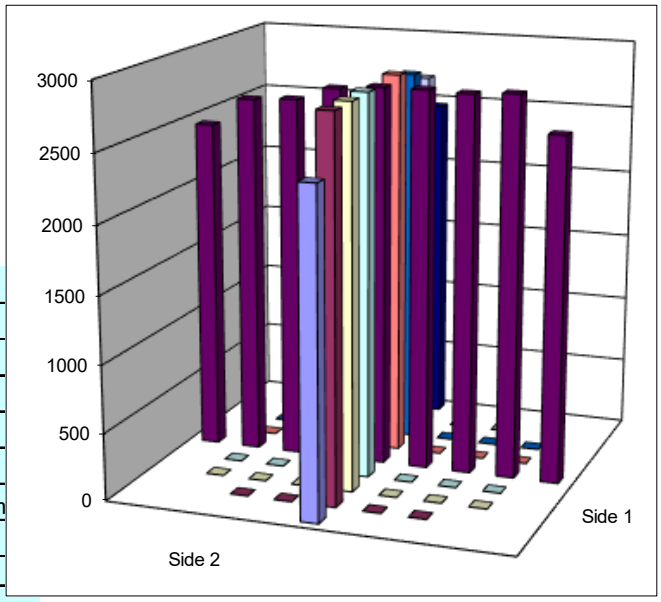
Order -->		First port				Second port			
Traverse-->		Side1 (245 deg from N)				Side2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	46.46	2,532.2	2,594.8	2,532.2	2,553.1	2,300.0	2,368.7	2,468.1	2,378.9
2	42.96	2,802.7	2,802.7	2,859.3	2,821.6	2,859.3	2,744.8	2,802.7	2,802.3
3	38.69	2,831.1	2,802.7	2,773.9	2,802.6	2,802.7	2,831.1	2,802.7	2,812.2
4	32.50	2,831.1	2,773.9	2,831.1	2,812.0	2,887.2	2,773.9	2,802.7	2,821.3
Center	24.00	2,744.8	2,887.2	2,802.7	2,811.6	2,802.7	2,715.5	2,887.2	2,801.8
5	15.50	2,685.8	2,802.7	2,859.3	2,782.6	2,887.2	2,831.1	2,802.7	2,840.3
6	9.31	2,773.9	2,563.6	2,715.5	2,684.3	2,773.9	2,802.7	2,802.7	2,793.1
7	5.04	2,625.5	2,685.8	2,685.8	2,665.7	2,715.5	2,685.8	2,744.8	2,715.4
8	1.54	2,402.3	2,468.1	2,500.3	2,456.9	2,532.2	2,402.3	2,402.3	2,445.6
Averages ---------->		2,692.2	2,709.1	2,728.9	2,710.0	2,729.0	2,684.0	2,724.0	2,712.3

All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	2711.2		Mean	2768.6	2798.0	2783.3
Min Point	2378.9	-12.3%	Std. Dev.	65.3	39.6	54.1
Max Point	2840.3	4.8%	COV as %	2.4	1.4	**1.9**

Flow w/o C-Pt	33920	cfm
Vel Avg w/o C-Pt	2699	fpm

	Start	Finish	
Stack temp	64.90	65.40	F
Equipment temp	60.00	65.40	F
Ambient temp	60.00	62.60	F
Stack static	1.97	2.12	mbars
Ambient pressure	985.10	984.76	mbars
Total Stack pressure	987.1	986.9	mbars
Ambient humidity	44%	40%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST5, 5ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

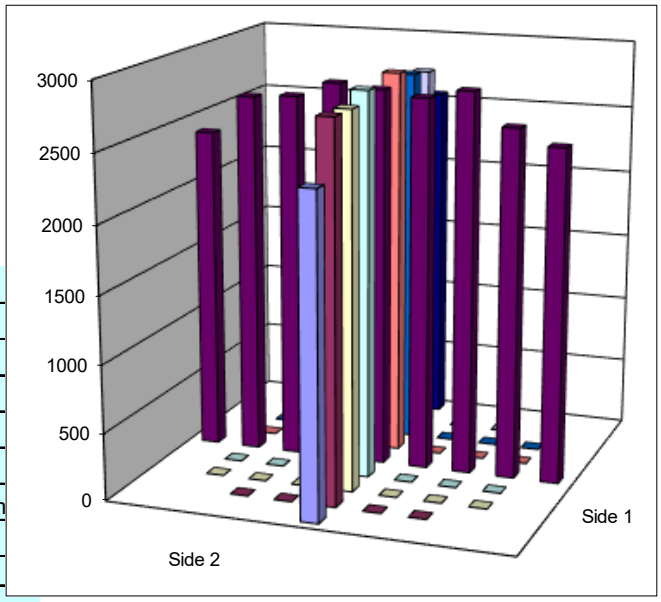
Stack	LB-C2	Run No.	VT-5
Date	10/16/19	Fan Configuration	Fan B only
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	48 in.	Stack Temp	68.55 deg F
Stack X-Area	1809.6 in.2	Start/End Time	12:40 12:47
Test Port	2	Center 2/3 from	4.40 to: 43.60
Distance to disturbance	53.3 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (245 deg from N)				Side2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	46.46	2,443.4	2,540.5	2,410.2	2,464.7	2,376.5	2,272.3	2,200.1	2,283.0
2	42.96	2,664.6	2,603.3	2,476.2	2,581.4	2,694.6	2,840.4	2,540.5	2,691.9
3	38.69	2,896.7	2,753.8	2,811.9	2,820.8	2,753.8	2,868.7	2,443.4	2,688.7
4	32.50	2,694.6	2,753.8	2,811.9	2,753.4	2,694.6	2,840.4	2,753.8	2,763.0
Center	24.00	2,811.9	2,724.4	2,840.4	2,792.2	2,603.3	2,783.0	2,753.8	2,713.4
5	15.50	2,753.8	2,840.4	2,868.7	2,821.0	2,840.4	2,664.6	2,840.4	2,781.8
6	9.31	2,811.9	2,868.7	2,443.4	2,708.0	2,753.8	2,694.6	2,724.4	2,724.3
7	5.04	2,724.4	2,634.1	2,694.6	2,684.4	2,664.6	2,634.1	2,783.0	2,693.9
8	1.54	2,342.3	2,443.4	2,410.2	2,398.6	2,443.4	2,443.4	2,540.5	2,475.8
Averages ---------->		2,682.6	2,684.7	2,640.8	2,669.4	2,647.2	2,671.3	2,620.0	2,646.2

All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	2657.8		Mean	2737.3	2722.4	2729.9
Min Point	2283.0	-14.1%	Std. Dev.	86.8	36.8	64.5
Max Point	2821.0	6.1%	COV as %	3.2	1.4	**2.4**

			Start	Finish	
Flow w/o C-Pt	33250 cfm	Stack temp	68.60	68.50	F
Vel Avg w/o C-Pt	2646 fpm	Equipment temp	62.30	68.50	F
		Ambient temp	62.30	66.30	F
		Stack static	2.56	3.01	mbars
		Ambient pressure	984.08	984.08	mbars
		Total Stack pressure	986.6	987.1	mbars
		Ambient humidity	42%	43%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST5, 5ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

Stack	LB-C2	Run No.	VT-6
Date	10/16/19	Fan Configuration	Fan B only
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	48 in.	Stack Temp	69.25 deg F
Stack X-Area	1809.6 in.2	Start/End Time	13:47 13:54
Test Port	2	Center 2/3 from	4.40 to: 43.60
Distance to disturbance	53.3 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (245 deg from N)				Side2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	46.46	2,575.5	2,479.5	2,511.9	2,522.3	2,413.3	2,379.6	2,413.3	2,402.1
2	42.96	2,786.7	2,757.5	2,698.2	2,747.5	2,310.6	2,379.6	2,575.5	2,421.9
3	38.69	2,698.2	2,728.0	2,757.5	2,727.9	2,575.5	2,728.0	2,786.7	2,696.7
4	32.50	2,728.0	2,786.7	2,637.5	2,717.4	2,637.5	2,815.5	2,757.5	2,736.8
Center	24.00	2,844.2	2,728.0	2,815.5	2,795.9	2,786.7	2,728.0	2,575.5	2,696.7
5	15.50	2,698.2	2,606.7	2,815.5	2,706.8	2,786.7	2,815.5	2,815.5	2,805.9
6	9.31	2,757.5	2,786.7	2,872.5	2,805.5	2,757.5	2,757.5	2,698.2	2,737.7
7	5.04	2,757.5	2,698.2	2,606.7	2,687.5	2,698.2	2,698.2	2,575.5	2,657.3
8	1.54	2,479.5	2,310.6	2,413.3	2,401.1	2,698.2	2,757.5	2,757.5	2,737.7
Averages ---------->		2,702.8	2,653.5	2,681.0	2,679.1	2,629.4	2,673.3	2,661.7	2,654.8

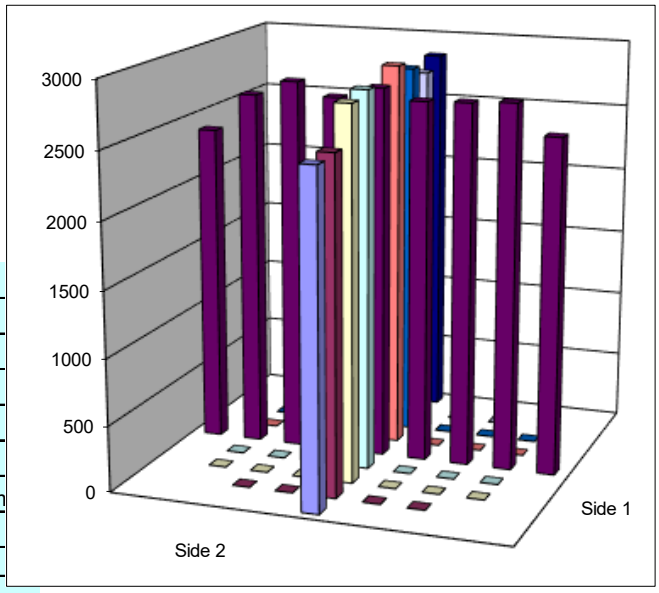
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	2666.9		Mean	2741.2	2679.0	2710.1
Min Point	2401.1	-10.0%	Std. Dev.	44.7	122.5	94.3
Max Point	2805.9	5.2%	COV as %	1.6	4.6	**3.5**

Flow w/o C-Pt 33389 cfm

Vel Avg w/o C-Pt 2657 fpm

	Start	Finish	
Stack temp	69.50	69.00	F
Equipment temp	70.80	69.00	F
Ambient temp	70.80	70.80	F
Stack static	3.14	1.19	mbars
Ambient pressure	983.41	983.41	mbars
Total Stack pressure	986.5	984.6	mbars
Ambient humidity	31%	32%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST5, 5ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

Stack	LB-C2	Run No.	VT-7
Date	10/17/19	Fan Configuration	Fan B only
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	48 in.	Stack Temp	66.50 deg F
Stack X-Area	1809.6 in.2	Start/End Time	8:52 8:58
Test Port	2	Center 2/3 from	4.40 to: 43.60
Distance to disturbance	53.3 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (245 deg from N)				Side2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	46.46	2,344.1	2,344.1	2,412.1	2,366.8	2,636.1	2,726.5	2,378.3	2,580.3
2	42.96	2,870.9	2,756.0	2,785.2	2,804.0	2,842.6	2,814.0	2,785.2	2,813.9
3	38.69	2,814.0	2,785.2	2,756.0	2,785.1	2,814.0	2,814.0	2,785.2	2,804.4
4	32.50	2,870.9	2,870.9	2,842.6	2,861.4	2,898.9	2,785.2	2,926.7	2,870.3
Center	24.00	2,785.2	2,842.6	2,954.2	2,860.7	2,785.2	2,814.0	2,785.2	2,794.8
5	15.50	2,870.9	2,814.0	2,756.0	2,813.6	2,756.0	2,842.6	2,756.0	2,784.9
6	9.31	2,842.6	2,898.9	2,870.9	2,870.8	2,666.6	2,842.6	2,696.8	2,735.3
7	5.04	2,814.0	2,785.2	2,666.6	2,755.3	2,666.6	2,636.1	2,696.8	2,666.5
8	1.54	2,574.1	2,666.6	2,478.1	2,573.0	2,344.1	2,478.1	2,542.5	2,454.9
Averages ---------->		2,754.1	2,751.5	2,724.6	2,743.4	2,712.2	2,750.4	2,705.9	2,722.8

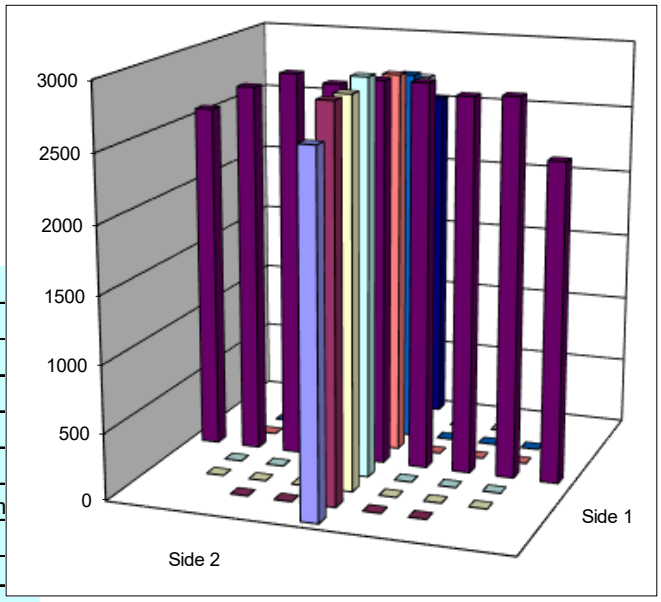
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	2733.1		Mean	2821.6	2781.4	2801.5
Min Point	2366.8	-13.4%	Std. Dev.	44.0	64.5	57.0
Max Point	2870.8	5.0%	COV as %	1.6	2.3	**2.0**

Flow w/o C-Pt 34197 cfm

Vel Avg w/o C-Pt 2721 fpm

	Start	Finish	
Stack temp	66.20	66.80	F
Equipment temp	53.00	66.80	F
Ambient temp	53.00	56.60	F
Stack static	1.97	2.39	mbars
Ambient pressure	980.02	978.67	mbars
Total Stack pressure	982.0	981.1	mbars
Ambient humidity	57%	53%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST5, 5ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

Stack	LB-C2	Run No.	VT-8
Date	10/17/19	Fan Configuration	Fan B only
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	48 in.	Stack Temp	69.5 deg F
Stack X-Area	1809.6 in.2	Start/End Time	9:59 10:05
Test Port	2	Center 2/3 from	4.40 to: 43.60
Distance to disturbance	53.3 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (245 deg from N)				Side2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	46.46	2,484.4	2,451.5	2,516.8	2,484.2	2,703.5	2,548.9	2,642.8	2,631.7
2	42.96	2,703.5	2,762.9	2,792.2	2,752.9	2,792.2	2,673.3	2,733.4	2,733.0
3	38.69	2,878.1	2,703.5	2,849.8	2,810.4	2,849.8	2,849.8	2,849.8	2,849.8
4	32.50	2,762.9	2,703.5	2,878.1	2,781.5	2,792.2	2,703.5	2,849.8	2,781.8
Center	24.00	2,906.2	2,906.2	2,849.8	2,887.4	2,878.1	2,878.1	2,792.2	2,849.4
5	15.50	2,906.2	2,906.2	2,878.1	2,896.8	2,703.5	2,821.1	2,878.1	2,800.9
6	9.31	2,878.1	2,906.2	2,961.5	2,915.3	2,792.2	2,878.1	2,849.8	2,840.0
7	5.04	2,821.1	2,703.5	2,792.2	2,772.3	2,733.4	2,762.9	2,849.8	2,782.0
8	1.54	2,642.8	2,548.9	2,484.4	2,558.7	2,642.8	2,451.5	2,279.8	2,458.0
Averages ---------->		2,775.9	2,732.5	2,778.1	2,762.2	2,765.3	2,729.7	2,747.3	2,747.4

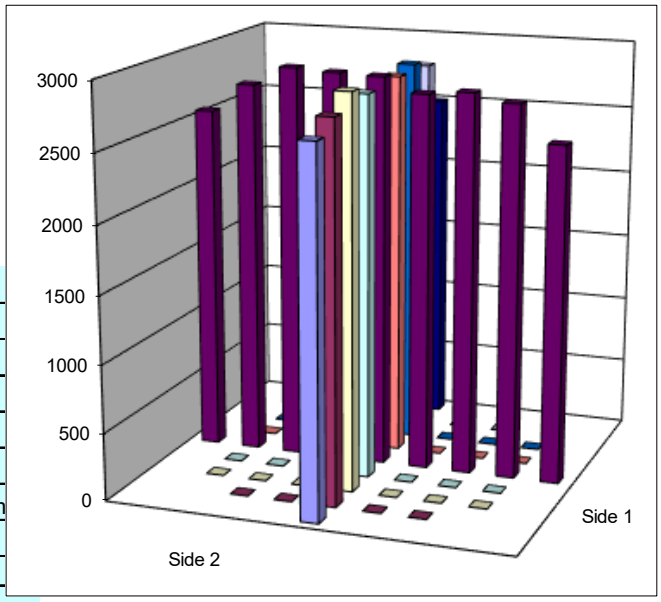
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	2754.8		Mean	2830.9	2805.3	2818.1
Min Point	2458.0	-10.8%	Std. Dev.	67.1	43.7	56.0
Max Point	2915.3	5.8%	COV as %	2.4	1.6	**2.0**

Flow w/o C-Pt 34439 cfm

Vel Avg w/o C-Pt 2741 fpm

	Start	Finish	
Stack temp	70.50	68.40	F
Equipment temp	59.10	68.40	F
Ambient temp	59.10	58.50	F
Stack static	2.12	1.34	mbars
Ambient pressure	980.36	980.36	mbars
Total Stack pressure	982.5	981.7	mbars
Ambient humidity	44%	44%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST5, 5ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

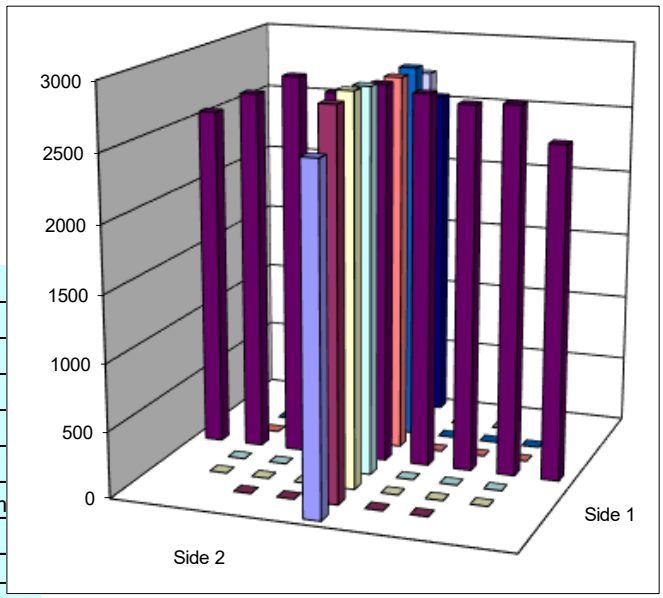
Stack	LB-C2	Run No.	VT-9
Date	10/17/19	Fan Configuration	Fan B only
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	48 in.	Stack Temp	71.40 deg F
Stack X-Area	1809.6 in.2	Start/End Time	11:06 11:11
Test Port	2	Center 2/3 from	4.40 to: 43.60
Distance to disturbance	53.3 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (245 deg from N)				Side2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	46.46	2,456.5	2,423.0	2,585.9	2,488.5	2,554.1	2,585.9	2,389.2	2,509.7
2	42.96	2,709.1	2,739.0	2,797.9	2,748.7	2,797.9	2,826.9	2,797.9	2,807.6
3	38.69	2,678.8	2,739.0	2,768.6	2,728.8	2,797.9	2,855.6	2,884.0	2,845.9
4	32.50	2,826.9	2,678.8	2,855.6	2,787.1	2,739.0	2,940.0	2,797.9	2,825.6
Center	24.00	2,855.6	2,826.9	2,826.9	2,836.5	2,768.6	2,739.0	2,855.6	2,787.7
5	15.50	2,826.9	2,585.9	2,855.6	2,756.1	2,855.6	2,768.6	2,739.0	2,787.7
6	9.31	2,855.6	2,855.6	2,855.6	2,855.6	2,797.9	2,797.9	2,826.9	2,807.6
7	5.04	2,678.8	2,678.8	2,768.6	2,708.8	2,709.1	2,739.0	2,709.1	2,719.0
8	1.54	2,554.1	2,522.0	2,585.9	2,554.0	2,522.0	2,489.4	2,456.5	2,489.3
erages ---------->		2,715.8	2,672.1	2,766.8	2,718.2	2,726.9	2,749.2	2,717.3	2,731.1

All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	2724.7		Mean	2774.5	2797.3	2785.9
Min Point	2488.5	-8.7%	Std. Dev.	54.7721	40.2	47.6
Max Point	2855.6	4.8%	COV as %	2.0	1.4	**1.7**

Flow w/o C-Pt	34102 cfm	**Instuments Used:**	Cal Due
Vel Avg w/o C-Pt	2714 fpm	Standard pitot (ID: BST5, 5ft)	Post-test inspection
		Digi-sense 20250-13 Manometer	9/15/2020
		Workhorse Thermometer	Verified prior to each field use

	Start	Finish	
Stack temp	71.90	70.90	F
Equipment temp	61.40	70.90	F
Ambient temp	61.40	61.80	F
Stack static	0.90	1.05	mbars
Ambient pressure	980.70	980.70	mbars
Total Stack pressure	981.6	981.7	mbars
Ambient humidity	41%	39%	RH



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

Stack	LB-C2	Run No.	VT-10
Date	10/17/19	Fan Configuration	Fan A&B
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	48 in.	Stack Temp	68.80 deg F
Stack X-Area	1809.6 in.2	Start/End Time	14:02 14:08
Test Port	2	Center 2/3 from	4.40 to: 43.60
Distance to disturbance	53.3 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (245 deg from N)				Side2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	46.46	2,610.3	2,671.7	2,610.3	2,630.8	2,579.0	2,515.3	2,547.4	2,547.2
2	42.96	2,987.0	3,014.0	3,014.0	3,005.0	2,932.2	2,819.4	3,040.8	2,930.8
3	38.69	3,171.4	3,093.8	3,171.4	3,145.5	2,987.0	3,014.0	2,987.0	2,996.0
4	32.50	3,067.5	3,119.9	3,067.5	3,084.9	3,067.5	3,040.8	3,119.9	3,076.1
Center	24.00	3,040.8	3,093.8	3,067.5	3,067.4	3,014.0	3,067.5	3,040.8	3,040.8
5	15.50	3,014.0	3,014.0	3,040.8	3,023.0	3,014.0	3,040.8	2,987.0	3,014.0
6	9.31	2,987.0	3,067.5	3,040.8	3,031.8	3,014.0	3,040.8	3,067.5	3,040.8
7	5.04	2,959.7	3,014.0	2,959.7	2,977.8	3,040.8	2,904.4	2,904.4	2,949.9
8	1.54	2,671.7	2,610.3	2,579.0	2,620.4	2,848.0	2,671.7	2,701.9	2,740.6
Averages ---------->		2,945.5	2,966.6	2,950.1	2,954.1	2,944.1	2,901.7	2,933.0	2,926.2

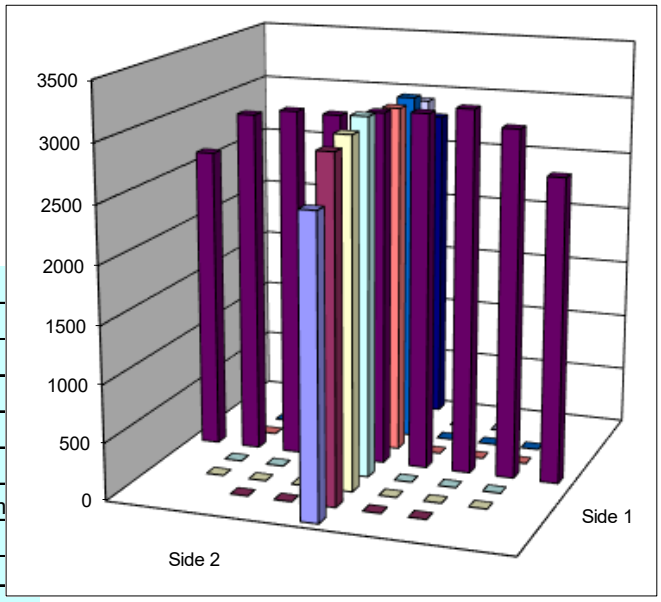
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	2940.1		Mean	3047.9	3006.9	3027.4
Min Point	2547.2	-13.4%	Std. Dev.	56.1	52.1	56.2
Max Point	3145.5	7.0%	COV as %	1.8	1.7	**1.9**

Flow w/o C-Pt 36768 cfm

Vel Avg w/o C-Pt 2926 fpm

	Start	Finish	
Stack temp	69.50	68.10	F
Equipment temp	59.90	68.10	F
Ambient temp	59.80	60.10	F
Stack static	1.44	1.29	mbars
Ambient pressure	980.70	980.70	mbars
Total Stack pressure	982.14	981.99	mbars
Ambient humidity	45%	45%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST5, 5ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

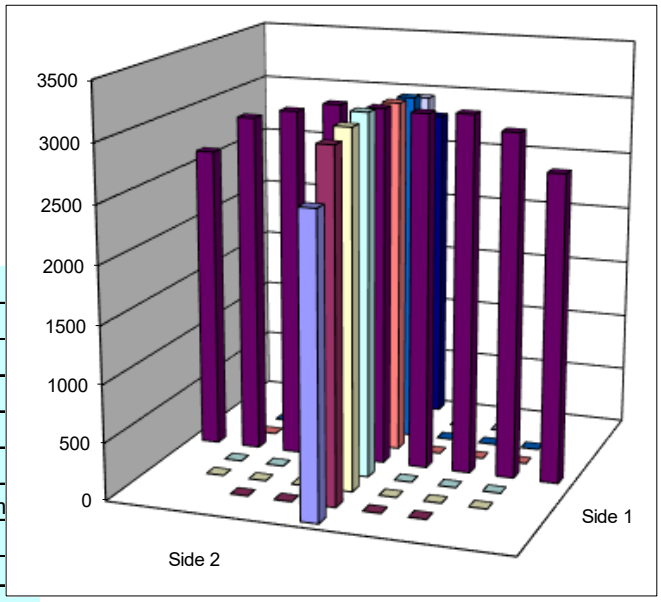
Stack	LB-C2	Run No.	VT-11
Date	10/17/19	Fan Configuration	Fan A&B
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	48 in.	Stack Temp	68.95 deg F
Stack X-Area	1809.6 in.2	Start/End Time	15:09 15:14
Test Port	2	Center 2/3 from	4.40 to: 43.60
Distance to disturbance	53.3 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (245 deg from N)				Side2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	46.46	2,672.0	2,702.2	2,610.5	2,661.6	2,610.5	2,515.6	2,547.6	2,557.9
2	42.96	3,094.1	3,014.3	2,819.7	2,976.0	3,067.8	2,987.3	2,876.7	2,977.3
3	38.69	3,146.0	3,067.8	3,094.1	3,102.6	3,146.0	3,041.1	2,960.0	3,049.1
4	32.50	3,094.1	3,041.1	3,120.2	3,085.1	3,067.8	3,094.1	3,146.0	3,102.6
Center	24.00	3,067.8	3,120.2	3,120.2	3,102.7	3,041.1	3,067.8	3,094.1	3,067.7
5	15.50	3,146.0	3,094.1	3,094.1	3,111.4	3,041.1	3,067.8	3,041.1	3,050.0
6	9.31	3,120.2	3,014.3	2,960.0	3,031.5	2,987.3	3,014.3	3,094.1	3,031.9
7	5.04	2,932.5	2,904.7	3,014.3	2,950.5	2,960.0	2,987.3	2,960.0	2,969.1
8	1.54	2,610.5	2,672.0	2,610.5	2,631.0	2,732.0	2,790.7	2,702.2	2,741.6
Averages ---------->		2,987.0	2,959.0	2,938.2	2,961.4	2,961.5	2,951.8	2,935.8	2,949.7

All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	2955.5		Mean	3051.4	3035.4	3043.4
Min Point	2557.9	-13.5%	Std. Dev.	66.1	47.9	56.1
Max Point	3111.4	5.3%	COV as %	2.2	1.6	**1.8**

Flow w/o C-Pt	36937 cfm	**Instuments Used:**	Cal Due
Vel Avg w/o C-Pt	2939 fpm	Standard pitot (ID: BST5, 5ft)	Post-test inspection
		Digi-sense 20250-13 Manometer	9/15/2020
		Workhorse Thermometer	Verified prior to each field use

	Start	Finish	
Stack temp	69.00	68.90	F
Equipment temp	61.80	68.90	F
Ambient temp	61.80	62.00	F
Stack static	1.34	1.22	mbars
Ambient pressure	981.04	980.70	mbars
Total Stack pressure	982.4	981.9	mbars
Ambient humidity	42%	42%	RH



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm) (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

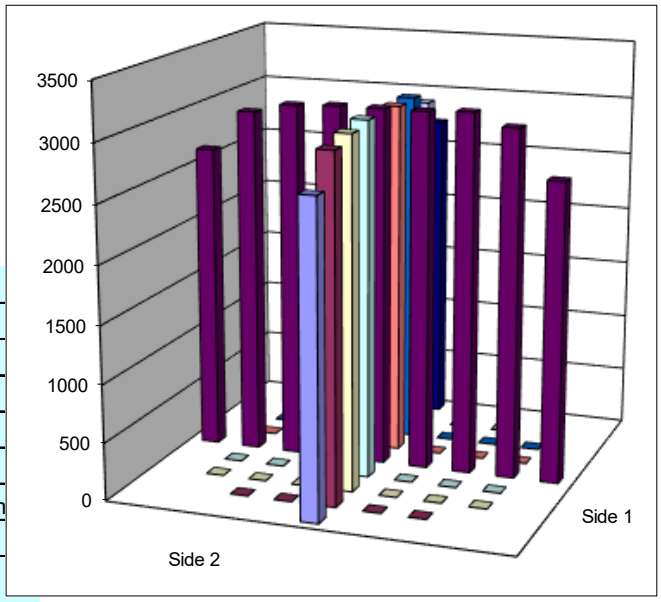
Stack	LB-C2	Run No.	VT-12
Date	10/18/19	Fan Configuration	Fan A&B
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	48 in.	Stack Temp	61.80 deg F
Stack X-Area	1809.6 in.2	Start/End Time	8:49 8:55
Test Port	2	Center 2/3 from	4.40 to: 43.60
Distance to disturbance	53.3 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (245 deg from N)				Side2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	46.46	2,524.0	2,647.2	2,555.3	2,575.5	2,706.7	2,677.1	2,677.1	2,686.9
2	42.96	2,932.6	3,013.0	3,013.0	2,986.2	2,905.3	2,959.6	3,039.3	2,968.1
3	38.69	3,039.3	3,142.3	3,091.3	3,091.0	2,986.4	3,065.3	3,039.3	3,030.4
4	32.50	3,091.3	3,065.3	3,065.3	3,074.0	3,091.3	3,039.3	3,091.3	3,073.9
Center	24.00	3,091.3	3,039.3	3,091.3	3,073.9	3,065.3	3,091.3	3,142.3	3,099.6
5	15.50	3,065.3	3,039.3	3,116.9	3,073.8	3,039.3	3,065.3	3,065.3	3,056.7
6	9.31	3,013.0	3,116.9	3,039.3	3,056.4	3,039.3	3,065.3	3,091.3	3,065.3
7	5.04	2,986.4	3,091.3	2,850.0	2,975.9	2,877.8	2,959.6	3,039.3	2,958.9
8	1.54	2,647.2	2,586.3	2,647.2	2,626.9	2,706.7	2,735.9	2,706.7	2,716.4
Averages ---------->		2,932.3	2,971.2	2,941.1	2,948.2	2,935.3	2,962.1	2,988.0	2,961.8

All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	2955.0		Mean	3047.3	3036.1	3041.7
Min Point	2575.5	-12.8%	Std. Dev.	46.5	53.8	48.6
Max Point	3099.6	4.9%	COV as %	1.5	1.8	**1.6**

Flow w/o C-Pt	36926 cfm	**Instuments Used:**	Cal Due
Vel Avg w/o C-Pt	2939 fpm	Standard pitot (ID: BST5, 5ft)	Post-test inspection
		Digi-sense 20250-13 Manometer	9/15/2020
		Workhorse Thermometer	Verified prior to each field use

	Start	Finish	
Stack temp	60.8	62.8	F
Equipment temp	50.3	53.7	F
Ambient temp	50.3	53.7	F
Stack static	1.6	1.3	mbars
Ambient pressure	985.4	985.8	mbars
Total Stack pressure	987.0	987.1	mbars
Ambient humidity	50%	45%	RH



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

Stack	LB-C2	Run No.	VT-13
Date	10/18/19	Fan Configuration	Fan A&B
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	48 in.	Stack Temp	64.5 deg F
Stack X-Area	1809.6 in.2	Start/End Time	9:55 10:01
Test Port	2	Center 2/3 from	4.40 to: 43.60
Distance to disturbance	53.3 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (245 deg from N)				Side2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	46.46	2,653.2	2,799.9	2,742.1	2,731.7	2,529.7	2,683.1	2,742.1	2,651.6
2	42.96	2,939.2	3,072.2	2,993.2	3,001.5	3,072.2	3,019.7	2,993.2	3,028.4
3	38.69	3,098.2	3,019.7	3,098.2	3,072.0	3,072.2	3,046.1	3,046.1	3,054.8
4	32.50	3,098.2	3,046.1	3,123.9	3,089.4	3,019.7	2,966.3	3,046.1	3,010.7
Center	24.00	3,046.1	3,046.1	2,993.2	3,028.5	3,019.7	3,072.2	3,046.1	3,046.0
5	15.50	3,072.2	3,046.1	3,072.2	3,063.5	3,072.2	3,046.1	2,993.2	3,037.2
6	9.31	3,072.2	2,966.3	3,046.1	3,028.2	3,019.7	3,072.2	3,019.7	3,037.2
7	5.04	2,966.3	2,911.9	2,939.2	2,939.1	3,019.7	2,966.3	3,019.7	3,001.9
8	1.54	2,622.8	2,561.1	2,592.1	2,592.0	2,712.8	2,653.2	2,712.8	2,692.9
Averages ---------->		2,952.0	2,941.1	2,955.6	2,949.6	2,948.7	2,947.3	2,957.7	2,951.2

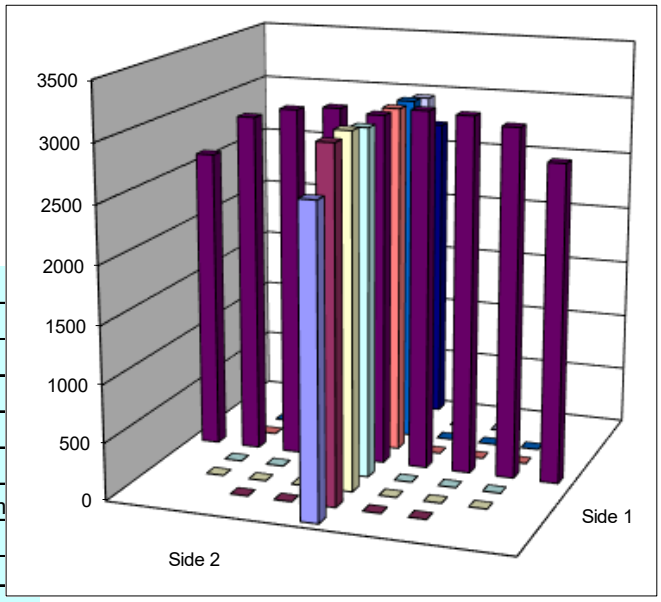
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	2950.4		Mean	3031.8	3030.9	3031.3
Min Point	2592.0	-12.1%	Std. Dev.	50.8	18.9	36.8
Max Point	3089.4	4.7%	COV as %	1.7	0.6	**1.2**

Flow w/o C-Pt 36939 cfm

Vel Avg w/o C-Pt 2940 fpm

	Start	Finish	
Stack temp	64	64.9	F
Equipment temp	56.8	64.9	F
Ambient temp	56.8	56.4	F
Stack static	1.2	1.3	mbars
Ambient pressure	986.5	986.5	mbars
Total Stack pressure	987.7	987.8	mbars
Ambient humidity	38%	37%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST5, 5ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

Stack	LB-C2	Run No.	VT-14
Date	10/19/19	Fan Configuration	Fan A
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	48 in.	Stack Temp	61.80 deg F
Stack X-Area	1809.6 in.2	Start/End Time	8:55 9:05
Test Port	2	Center 2/3 from	4.40 to: 43.60
Distance to disturbance	53.3 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (245 deg from N)				Side2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	46.46	3,081.4	2,864.9	2,975.2	2,973.8	2,750.3	2,691.2	2,599.8	2,680.4
2	42.96	3,055.2	2,975.2	2,975.2	3,001.8	2,808.2	2,864.9	2,864.9	2,846.0
3	38.69	3,055.2	3,055.2	3,055.2	3,055.2	2,920.5	2,975.2	2,892.9	2,929.5
4	32.50	3,055.2	3,081.4	3,055.2	3,063.9	2,779.4	2,920.5	2,779.4	2,826.4
Center	24.00	2,975.2	2,864.9	3,028.8	2,956.3	3,055.2	2,920.5	3,002.1	2,992.6
5	15.50	3,028.8	2,836.7	3,002.1	2,955.8	2,892.9	2,920.5	2,975.2	2,929.5
6	9.31	3,081.4	3,055.2	3,002.1	3,046.2	2,947.9	2,975.2	2,975.2	2,966.1
7	5.04	2,920.5	2,947.9	3,028.8	2,965.8	2,920.5	2,836.7	2,947.9	2,901.7
8	1.54	2,947.9	2,836.7	2,892.9	2,892.5	2,720.8	2,720.8	2,864.9	2,768.8
Averages ---------->		3,022.3	2,946.4	3,001.7	2,990.1	2,866.2	2,869.5	2,878.0	2,871.2

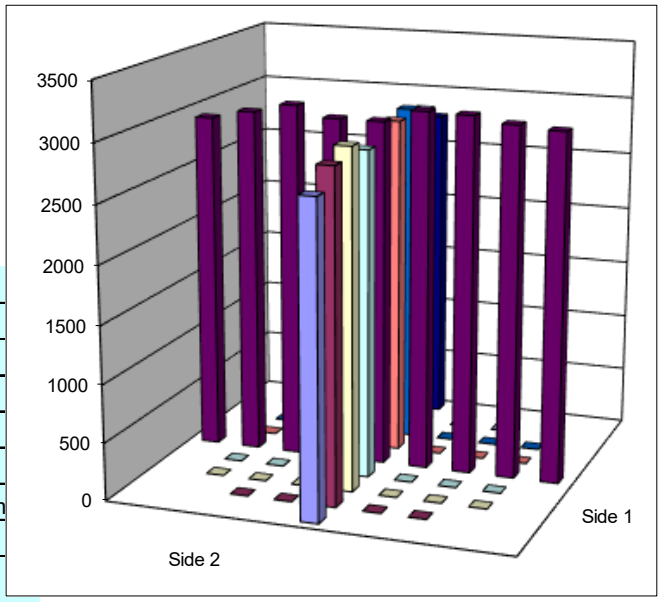
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	2930.7		Mean	3006.4	2913.1	2959.8
Min Point	2680.4	-8.5%	Std. Dev.	48.3	60.3	71.4
Max Point	3063.9	4.5%	COV as %	1.6	2.1	**2.4**

Flow w/o C-Pt 36759 cfm

Vel Avg w/o C-Pt 2925 fpm

	Start	Finish	
Stack temp	61.7	61.9	F
Equipment temp	45.8	47.1	F
Ambient temp	45.8	47.1	F
Stack static	1.6	1.5	mbars
Ambient pressure	975.3	975.3	mbars
Total Stack pressure	976.9	976.8	mbars
Ambient humidity	87%	86%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST5, 5ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

Appendix B – LB-S1 Stack Verification Data Sheets

B.1 Flow Angle Data Forms

FLOW ANGLE DATA FORM

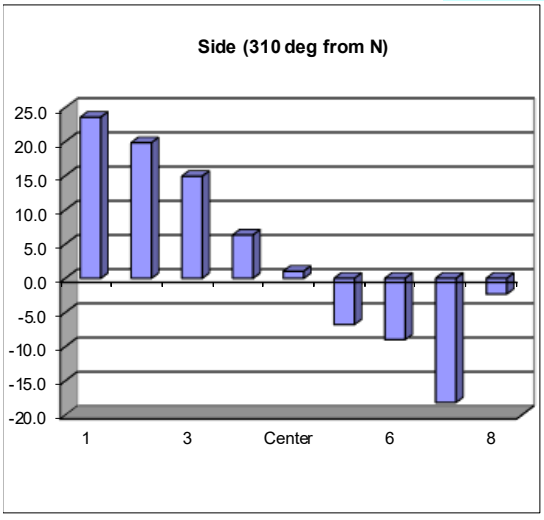
Stack	LB-S1	Run No.	FA-1
Date	10/15/2019	Fan Setting	N/A Hz
Start/End Time	13:26 13:42	Fan Configuration	Fan A & B
Testers	ZDH/LCE	Stack Temp	66.5 deg F
Stack Dia.	60 in		
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

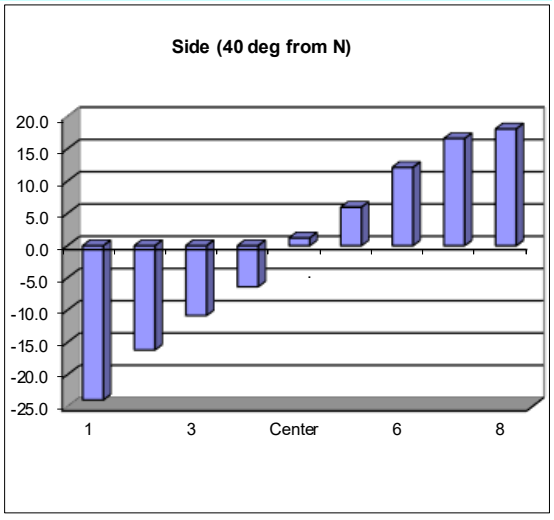
Order -->		First				Second			
Traverse-->		Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	58.08	22.8	25.0	22.9	23.6	-28.4	-21.7	-21.6	-23.9
2	53.70	20.8	18.0	20.7	19.8	-16.1	-16.3	-16.1	-16.2
3	48.36	14.9	14.3	15.6	14.9	-12.0	-8.4	-12.1	-10.8
4	40.62	6.8	7.9	4.3	6.3	-6.1	-6.4	-6.6	-6.4
Center	30.00	1.7	0.8	0.6	1.0	1.9	1.2	0.5	1.2
5	19.38	-8.6	-6.8	-4.9	-6.8	6.2	5.4	6.3	6.0
6	11.64	-9.5	-7.9	-9.5	-9.0	12.9	12.1	11.4	12.1
7	6.30	-16.4	-19.0	-19.1	-18.2	17.4	16.4	16.0	16.6
8	1.92	-2.7	-2.9	-1.3	-2.3	18.2	17.7	18.4	18.1
Mean of absolute values:					11.3				12.4
" " w/o points by wall:					10.9				9.9
								Grand mean ABS	11.8
								Grand mean ABS w/o wall pts	10.4

Instuments Used:		Cal. Due
S-type pitot (ID: 7A)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuacy check prior to each use; field recalibration as necessar
Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
- Traverse point depth = the distance from inside stack wall to each point
- Sign of flow angle indicates which direction the pitot was turned to achieve null angle
- Approx. air velocity was derived from all points on the Velocity Transverse For





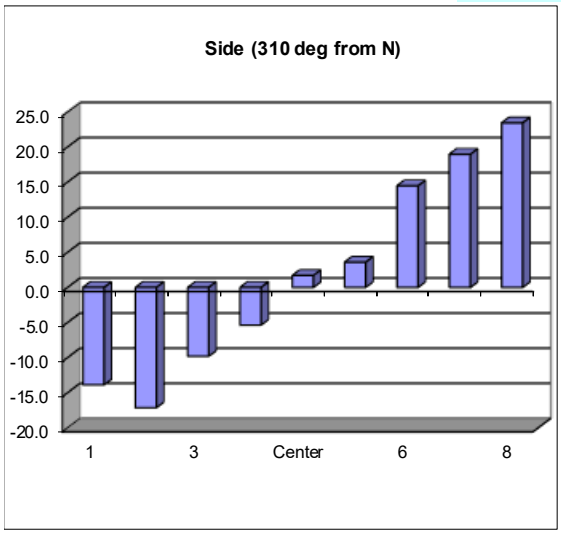
FLOW ANGLE DATA FORM

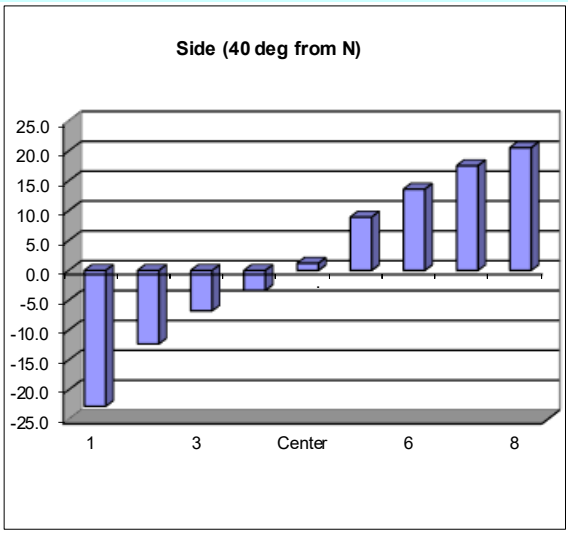
Stack	LB-S1	Run No.	FA-2
Date	10/15/2019	Fan Setting	N/A Hz
Start/End Time	15:32 15:42	Fan Configuration	Fan A & B
Testers	ZDH/LCE	Stack Temp	67 deg F
Stack Dia.	60 in		
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

Order -->	First				Second			
Traverse-->	Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Trial ---->	1	2	3	Mean	1	2	3	Mean
Point / Depth, in.	deg. cw				deg. cw			
1 / 58.08	-14.0	-13.9	-13.7	-13.9	-23.2	-22.8	-22.2	-22.7
2 / 53.70	-17.4	-17.1	-16.9	-17.1	-13.5	-12.4	-11.0	-12.3
3 / 48.36	-10.1	-9.7	-9.6	-9.8	-7.0	-6.8	-6.5	-6.8
4 / 40.62	-6.1	-5.1	-4.9	-5.4	-3.2	-3.6	-3.2	-3.3
Center / 30.00	2.9	1.0	1.2	1.7	2.0	0.6	1.0	1.2
5 / 19.38	3.0	4.1	3.7	3.6	9.8	8.3	8.7	8.9
6 / 11.64	14.2	14.3	14.9	14.5	12.9	13.4	14.5	13.6
7 / 6.30	19.7	18.4	18.8	19.0	18.7	16.2	17.7	17.5
8 / 1.92	23.3	24.0	23.0	23.4	21.1	20.6	19.9	20.5
Mean of absolute values:				12.0				11.9
" " w/o points by wall:				10.1				9.1
							Grand mean ABS	12.0
Instuments Used:				**Cal. Due**			Grand mean ABS w/o wall pts	9.6
S-type pitot (ID: 7A)				Post-test				
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)			Accuacy check prior to each use; field recalibration as necessar				
Manometer	5D			Primary standard				

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle
Approx. air velocity was derived from all points on the Velocity Transverse For





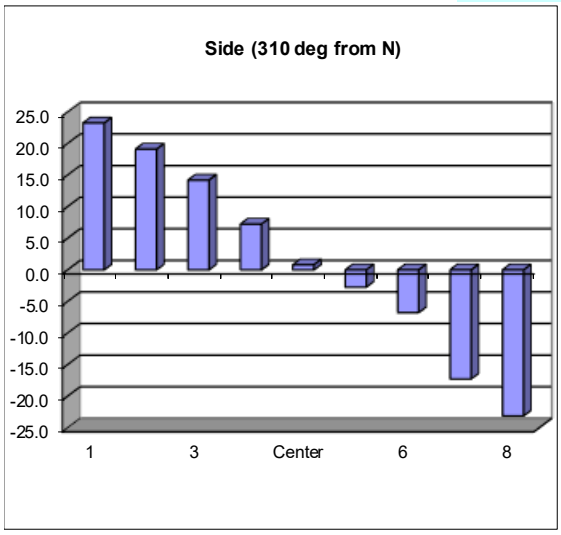
FLOW ANGLE DATA FORM

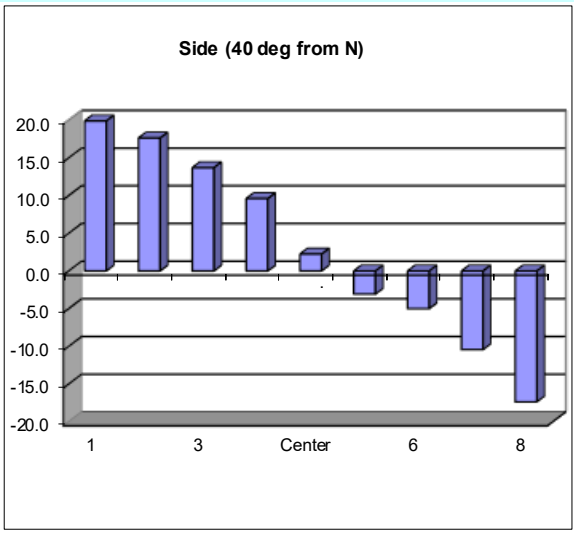
Stack	LB-S1	Run No.	FA-3
Date	10/16/2019	Fan Setting	N/A Hz
Start/End Time	9:30 9:41	Fan Configuration	Fan A & B
Testers	ZDH/LCE	Stack Temp	63.6 deg F
Stack Dia.	60 in		
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

		Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Order -->		First				Second			
Traverse-->									
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	58.08	23.3	23.1	23.3	23.2	21.6	18.3	19.8	19.9
2	53.70	19.4	19.3	18.6	19.1	18.0	17.7	17.2	17.6
3	48.36	15.2	13.9	13.5	14.2	14.2	13.4	13.5	13.7
4	40.62	9.0	7.1	5.6	7.2	9.8	8.3	10.7	9.6
Center	30.00	0.5	1.2	0.7	0.8	3.2	1.8	1.7	2.2
5	19.38	-2.7	-3.2	-2.3	-2.7	-3.2	-3.3	-2.7	-3.1
6	11.64	-6.3	-7.2	-6.8	-6.8	-5.2	-4.6	-5.2	-5.0
7	6.30	-18.3	-17.7	-15.8	-17.3	-10.5	-10.6	-10.2	-10.4
8	1.92	-23.2	-23.1	-23.0	-23.1	-17.7	-17.5	-16.9	-17.4
Mean of absolute values:					12.7				11.0
" " w/o points by wall:					9.7				8.8
								Grand mean ABS	11.9
Instuments Used:					**Cal. Due**			Grand mean ABS w/o wall pts	9.3
S-type pitot (ID: 7A)					Post-test				
Angle indicator		SPI Tronic PRO 360 (SN 31-038-3)			Accuacy check prior to each use; field recalibration as necessary				
Manometer		5D			Primary standard				

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle
Approx. air velocity was derived from all points on the Velocity Transverse Form





FLOW ANGLE DATA FORM

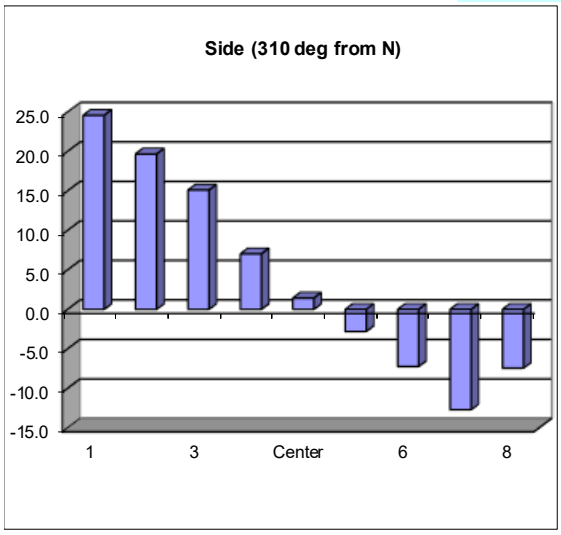
Stack	LB-S1	Run No.	FA-4
Date	10/16/2019	Fan Setting	N/A Hz
Start/End Time	10:56 11:08	Fan Configuration	Fan A & B
Testers	ZDH/LCE	Stack Temp	66.3 deg F
Stack Dia.	60 in		
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

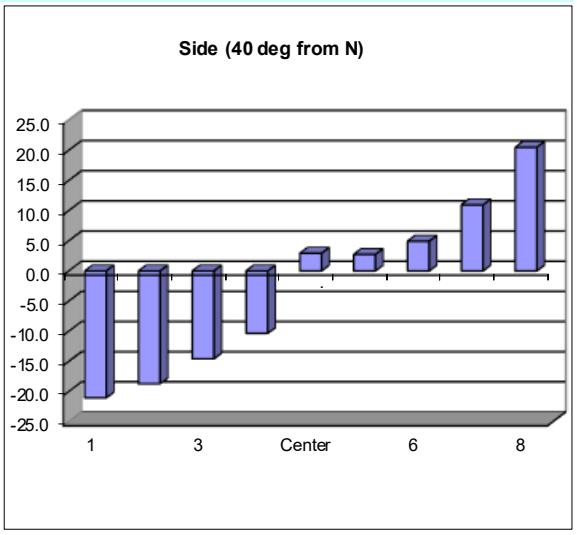
Order -->	First				Second			
Traverse-->	Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Trial ---->	1	2	3	Mean	1	2	3	Mean
Point / Depth, in.	deg. cw				deg. cw			
1 / 58.08	24.8	24.5	24.4	24.6	-21.1	-21.5	-20.5	-21.0
2 / 53.70	18.9	20.6	19.5	19.7	-19.2	-19.4	-17.5	-18.7
3 / 48.36	15.4	13.8	16.1	15.1	-14.9	-14.5	-14.3	-14.6
4 / 40.62	6.7	7.1	7.3	7.0	-9.8	-10.5	-10.7	-10.3
Center / 30.00	1.5	1.2	1.6	1.4	3.8	2.5	2.5	2.9
5 / 19.38	-2.8	-2.5	-3.1	-2.8	2.6	2.7	2.9	2.7
6 / 11.64	-7.4	-7.2	-7.1	-7.2	5.1	4.9	4.8	4.9
7 / 6.30	-12.1	-13.2	-12.8	-12.7	11.0	10.9	11.0	11.0
8 / 1.92	-7.9	-7.3	-7.1	-7.4	21.1	20.6	19.8	20.5
Mean of absolute values:				10.9				11.9
" " w/o points by wall:				9.4				9.3
							Grand mean ABS	11.4
							Grand mean ABS w/o wall pts	9.4

Instuments Used:		Cal. Due
S-type pitot (ID: 7A)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuacy check prior to each use; field recalibration as necessary
Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle
Approx. air velocity was derived from all points on the Velocity Transverse Form





FLOW ANGLE DATA FORM

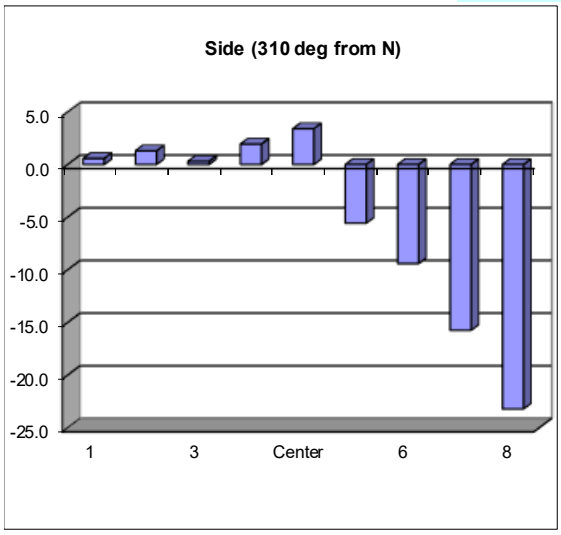
Stack	LB-S1	Run No.	FA-5
Date	10/16/2019	Fan Setting	N/A Hz
Start/End Time	13:10 13:20	Fan Configuration	Fan B&C
Testers	ZDH/LCE	Stack Temp	67.8 deg F
Stack Dia.	60 in		
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

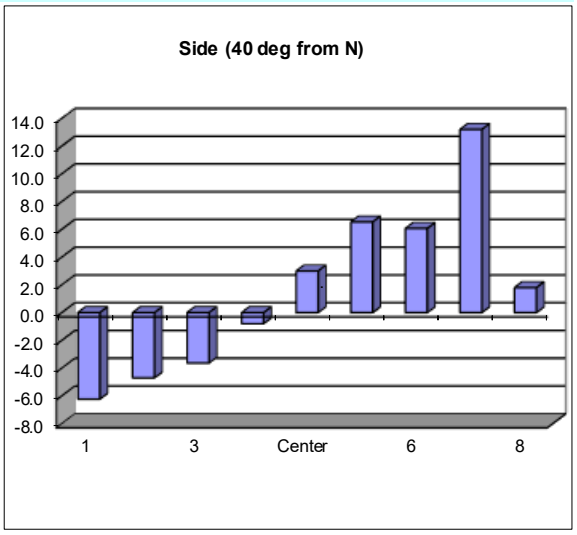
		Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Order -->		First				Second			
Traverse-->									
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	58.08	0.4	0.7	0.6	0.6	-7.1	-5.9	-5.7	-6.2
2	53.70	0.8	1.2	1.9	1.3	-3.5	-5.4	-5.2	-4.7
3	48.36	0.3	0.5	0.1	0.3	-5.0	-3.6	-2.3	-3.6
4	40.62	1.7	1.9	2.2	1.9	-1.5	-0.4	-0.5	-0.8
Center	30.00	3.3	3.5	3.4	3.4	3.1	2.6	3.3	3.0
5	19.38	-5.5	-5.6	-5.6	-5.6	6.5	6.3	6.8	6.5
6	11.64	-9.3	-9.3	-9.6	-9.4	6.0	5.9	6.3	6.1
7	6.30	-15.7	-16.1	-15.4	-15.7	13.7	13.6	12.3	13.2
8	1.92	-21.5	-24.2	-23.9	-23.2	2.0	1.6	1.8	1.8
Mean of absolute values:					6.8				5.1
" " w/o points by wall:					5.4				5.4
								Grand mean ABS	6.0
								Grand mean ABS w/o wall pts	5.4

Instuments Used:		Cal. Due
S-type pitot (ID: 7A)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuacy check prior to each use; field recalibration as necessary
Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle
Approx. air velocity was derived from all points on the Velocity Transverse Form





FLOW ANGLE DATA FORM

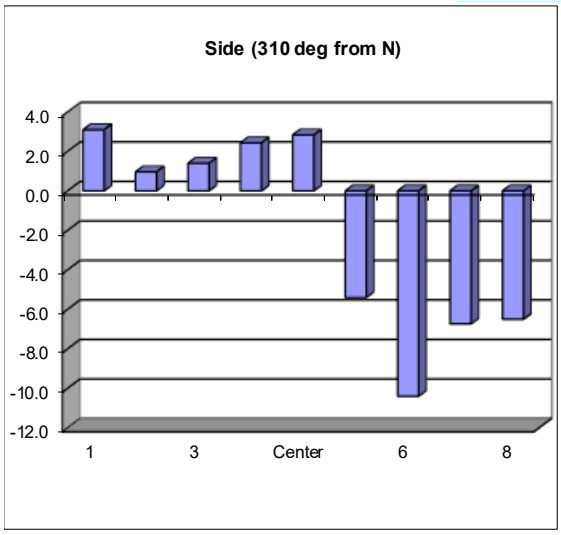
Stack	LB-S1	Run No.	FA-6
Date	10/16/2019	Fan Setting	N/A Hz
Start/End Time	14:15 14:24	Fan Configuration	Fan B&C
Testers	ZDH/LCE	Stack Temp	68.7 deg F
Stack Dia.	60 in		
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

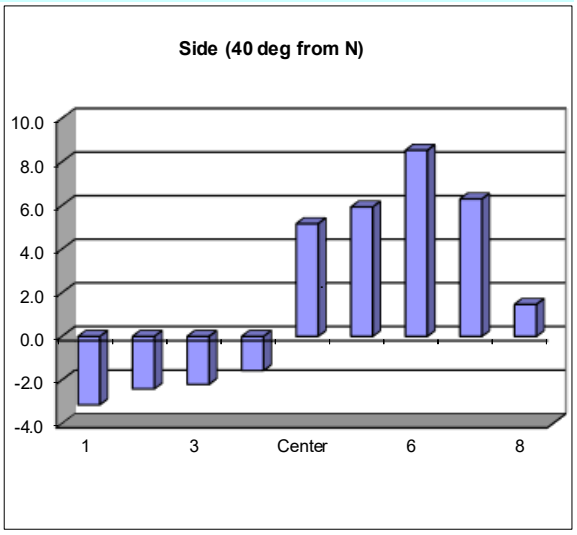
Order -->	First				Second			
Traverse-->	Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Trial ---->	1	2	3	Mean	1	2	3	Mean
Point / Depth, in.	deg. cw				deg. cw			
1 / 58.08	3.0	2.7	3.6	3.1	-1.7	-2.1	-5.6	-3.1
2 / 53.70	1.2	1.2	0.5	1.0	-2.6	-2.1	-2.5	-2.4
3 / 48.36	1.2	2.2	0.8	1.4	-1.2	-2.0	-3.4	-2.2
4 / 40.62	2.8	2.8	1.7	2.4	-1.7	-1.5	-1.5	-1.6
Center / 30.00	3.0	2.8	2.7	2.8	5.4	5.6	4.5	5.2
5 / 19.38	-6.4	-3.7	-6.1	-5.4	5.9	5.7	6.2	5.9
6 / 11.64	-11.9	-9.9	-9.4	-10.4	9.5	8.2	7.9	8.5
7 / 6.30	-7.0	-6.5	-6.7	-6.7	5.8	6.3	6.8	6.3
8 / 1.92	-7.1	-5.6	-6.8	-6.5	1.3	1.2	1.9	1.5
Mean of absolute values:				4.4				4.1
" " w/o points by wall:				4.3				4.6
							Grand mean ABS	4.2
							Grand mean ABS w/o wall pts	4.4

Instuments Used:		Cal. Due
S-type pitot (ID: 7A)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuacy check prior to each use; field recalibration as necessary
Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle
Approx. air velocity was derived from all points on the Velocity Transverse Form





FLOW ANGLE DATA FORM

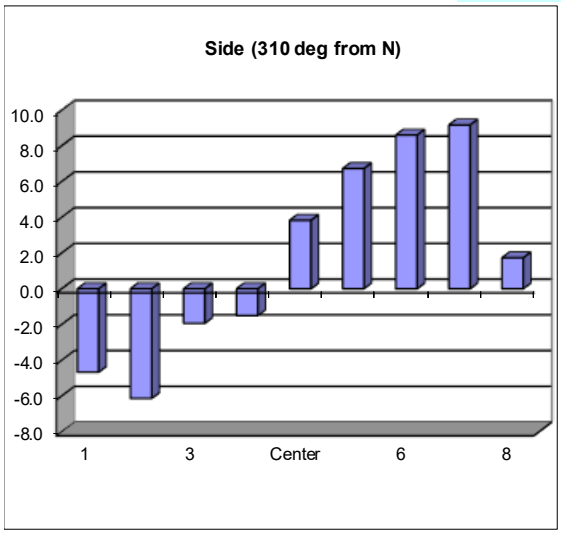
Stack	LB-S1	Run No.	FA-7
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	9:23 9:32	Fan Configuration	Fan B&C
Testers	ZDH/LCE	Stack Temp	65.7 deg F
Stack Dia.	60 in		
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

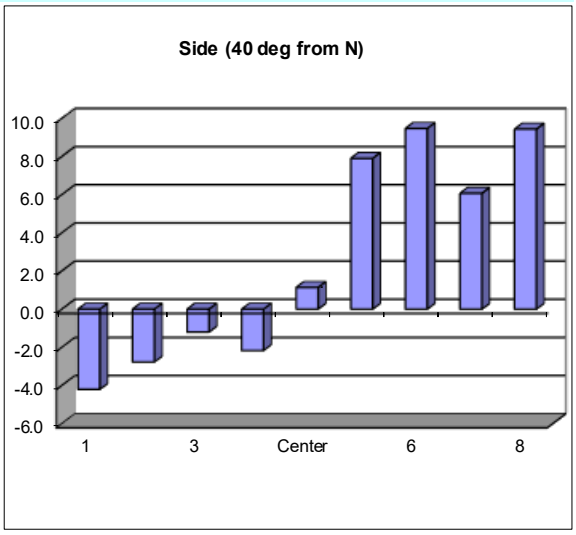
Order -->	First				Second			
Traverse-->	Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Trial ---->	1	2	3	Mean	1	2	3	Mean
Point / Depth, in.	deg. cw				deg. cw			
1 / 58.08	-4.0	-5.2	-4.8	-4.7	-3.9	-4.4	-4.3	-4.2
2 / 53.70	-6.1	-6.6	-5.7	-6.1	-2.9	-2.9	-2.5	-2.8
3 / 48.36	-1.5	-2.0	-2.3	-1.9	-0.2	-1.6	-1.8	-1.2
4 / 40.62	-1.5	-1.4	-1.6	-1.5	-2.4	-2.3	-1.8	-2.2
Center / 30.00	3.8	3.6	4.1	3.8	1.4	1.0	1.0	1.1
5 / 19.38	6.7	6.9	6.6	6.7	8.1	7.8	7.8	7.9
6 / 11.64	8.1	9.1	8.6	8.6	9.5	9.6	9.3	9.5
7 / 6.30	9.3	8.8	9.4	9.2	5.7	6.1	6.4	6.1
8 / 1.92	2.2	1.8	1.2	1.7	9.7	9.3	9.3	9.4
Mean of absolute values:				4.9				4.9
" " w/o points by wall:				5.4				4.4
							Grand mean ABS	4.9
							Grand mean ABS w/o wall pts	4.9

Instuments Used:		Cal. Due
S-type pitot (ID: 7A)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuacy check prior to each use; field recalibration as necessary
Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle
Approx. air velocity was derived from all points on the Velocity Transverse Form





FLOW ANGLE DATA FORM

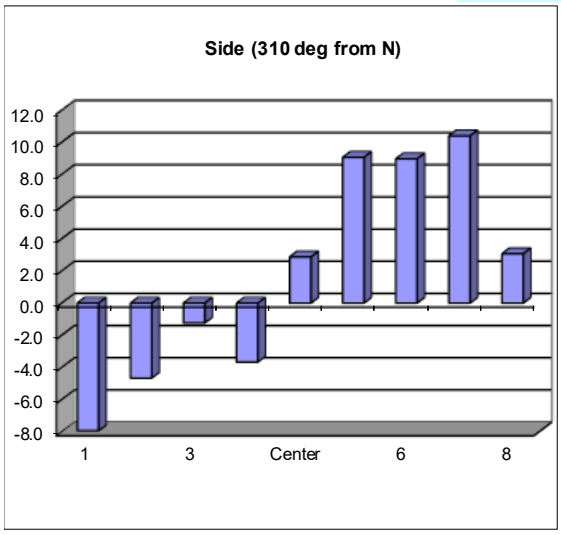
Stack	LB-S1	Run No.	FA-8
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	10:31 10:40	Fan Configuration	Fan B&C
Testers	ZDH/LCE	Stack Temp	68.7 deg F
Stack Dia.	60 in		
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

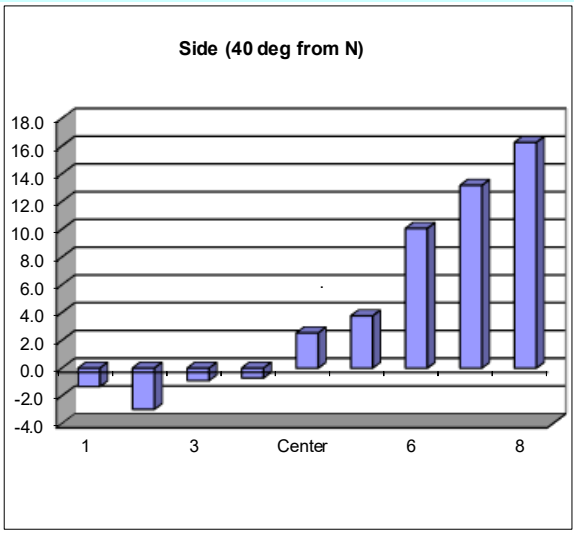
Order -->	First				Second			
Traverse-->	Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Trial ---->	1	2	3	Mean	1	2	3	Mean
Point / Depth, in.	deg. cw				deg. cw			
1 / 58.08	-8.2	-7.9	-7.7	-7.9	-1.5	-1.6	-0.9	-1.3
2 / 53.70	-5.0	-4.2	-4.8	-4.7	-3.2	-2.9	-2.8	-3.0
3 / 48.36	-1.4	-1.1	-1.2	-1.2	-0.8	-1.2	-0.7	-0.9
4 / 40.62	-4.3	-3.4	-3.3	-3.7	-1.5	-0.2	-0.4	-0.7
Center / 30.00	3.0	2.8	2.8	2.9	2.7	2.6	2.3	2.5
5 / 19.38	9.1	9.4	8.7	9.1	3.5	3.7	4.1	3.8
6 / 11.64	9.1	9.2	8.6	9.0	9.9	9.7	10.6	10.1
7 / 6.30	10.1	10.7	10.4	10.4	13.4	13.3	12.8	13.2
8 / 1.92	3.1	3.2	2.9	3.1	16.3	16.1	16.4	16.3
Mean of absolute values:				5.8				5.7
" " w/o points by wall:				5.8				4.9
							Grand mean ABS	5.8
							Grand mean ABS w/o wall pts	5.4

Instuments Used:		Cal. Due
S-type pitot (ID: 7A)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuacy check prior to each use; field recalibration as necessary
Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle
Approx. air velocity was derived from all points on the Velocity Transverse Form





FLOW ANGLE DATA FORM

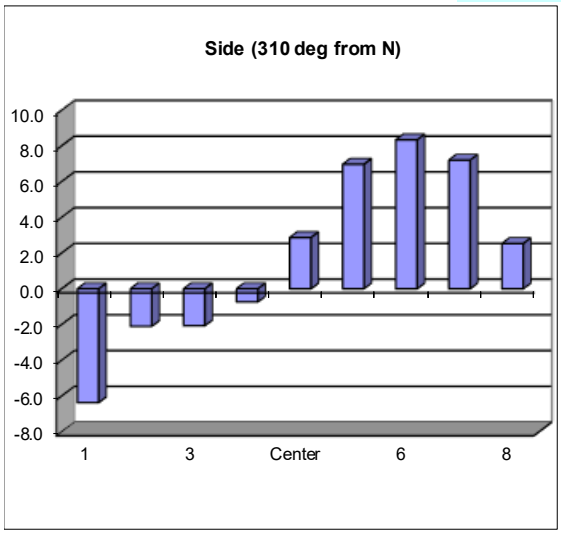
Stack	LB-S1	Run No.	FA-9
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	11:39 11:47	Fan Configuration	Fan B&C
Testers	ZDH/LCE	Stack Temp	70.2 deg F
Stack Dia.	60 in		
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

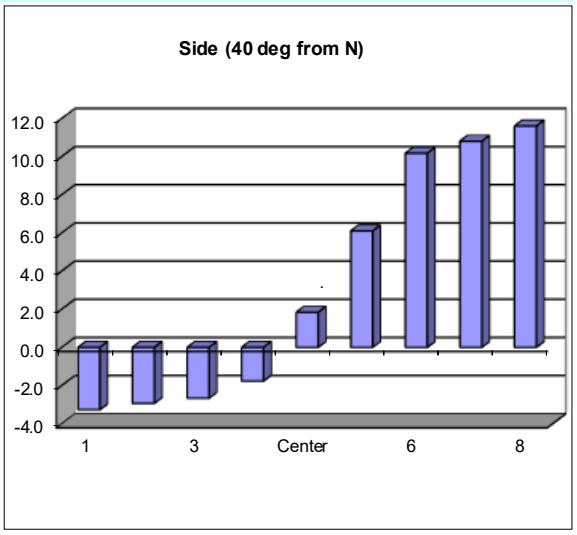
		Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Order -->		First				Second			
Traverse-->									
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	58.08	-7.0	-6.1	-6.0	-6.4	-2.7	-3.6	-3.5	-3.3
2	53.70	-1.8	-1.9	-2.6	-2.1	-1.2	-3.5	-4.1	-2.9
3	48.36	-1.6	-2.7	-1.9	-2.1	-2.5	-2.9	-2.6	-2.7
4	40.62	-1.0	-0.7	-0.5	-0.7	-2.1	-1.7	-1.5	-1.8
Center	30.00	2.9	2.4	3.3	2.9	1.8	1.8	1.9	1.8
5	19.38	8.0	6.5	6.4	7.0	6.4	5.9	6.0	6.1
6	11.64	9.1	7.5	8.4	8.3	9.9	10.8	9.8	10.2
7	6.30	7.4	6.5	7.7	7.2	10.5	10.9	11.0	10.8
8	1.92	2.9	2.4	2.3	2.5	12.3	11.9	10.6	11.6
Mean of absolute values:					4.4				5.7
" " w/o points by wall:					4.3				5.2
								Grand mean ABS	5.0
								Grand mean ABS w/o wall pts	4.8

Instuments Used:		Cal. Due
S-type pitot (ID: 7A)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuacy check prior to each use; field recalibration as necessary
Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle
Approx. air velocity was derived from all points on the Velocity Transverse Form





FLOW ANGLE DATA FORM

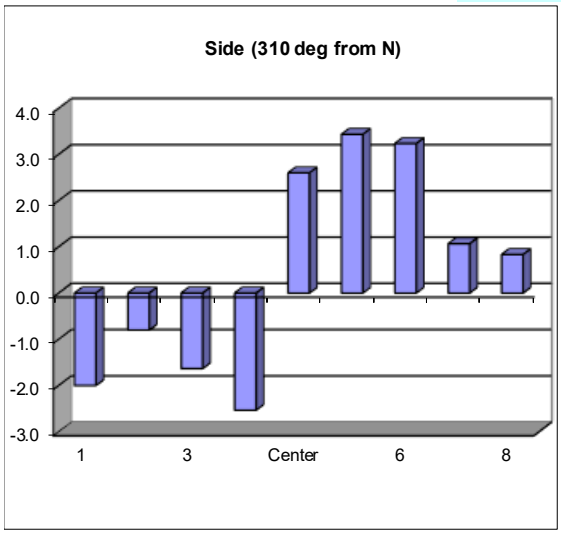
Stack	LB-S1	Run No.	FA-10
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	14:26 14:36	Fan Configuration	Fan A&C
Testers	ZDH/LCE	Stack Temp	69.7 deg F
Stack Dia.	60 in		
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

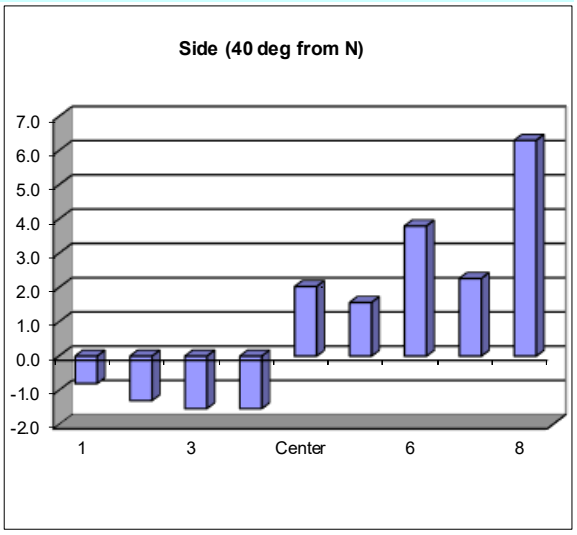
Order -->		First				Second			
Traverse-->		Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	58.08	-2.2	-2.0	-1.8	-2.0	-0.8	-0.6	-1.0	-0.8
2	53.70	-0.5	-0.5	-1.4	-0.8	-1.7	-0.9	-1.3	-1.3
3	48.36	-1.2	-1.7	-2.0	-1.6	-1.0	-2.6	-1.0	-1.5
4	40.62	-2.0	-3.2	-2.4	-2.5	-0.7	-2.1	-1.8	-1.5
Center	30.00	3.0	2.4	2.4	2.6	2.2	2.1	1.8	2.0
5	19.38	2.5	3.8	4.0	3.4	0.6	2.3	1.8	1.6
6	11.64	3.3	3.7	2.7	3.2	4.5	3.8	3.1	3.8
7	6.30	0.4	1.1	1.7	1.1	3.2	1.6	2.0	2.3
8	1.92	0.2	1.1	1.2	0.8	6.8	5.9	6.2	6.3
Mean of absolute values:					2.0				2.3
" " w/o points by wall:					2.2				2.0
								Grand mean ABS	2.2
								Grand mean ABS w/o wall pts	2.1

Instuments Used:		Cal. Due
S-type pitot (ID: 7A)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuacy check prior to each use; field recalibration as necessary
Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle
Approx. air velocity was derived from all points on the Velocity Transverse Form





FLOW ANGLE DATA FORM

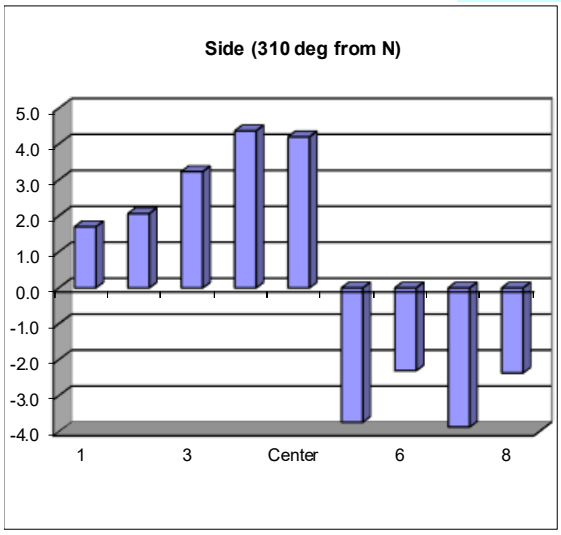
Stack	LB-S1	Run No.	FA-11
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	15:34 15:41	Fan Configuration	Fan A&C
Testers	ZDH/LCE	Stack Temp	70.5 deg F
Stack Dia.	60 in		
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

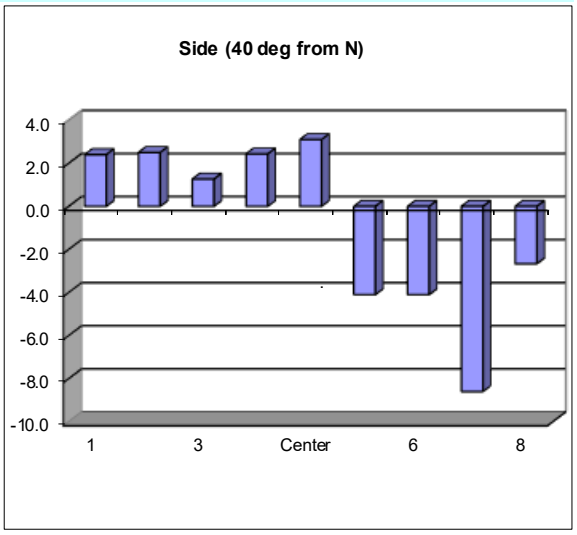
		Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Order -->		First				Second			
Traverse-->									
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	58.08	1.2	2.5	1.4	1.7	1.7	2.8	2.7	2.4
2	53.70	4.4	0.4	1.4	2.1	2.6	2.8	2.1	2.5
3	48.36	2.3	4.2	3.2	3.2	1.6	0.9	1.3	1.3
4	40.62	4.5	4.6	4.0	4.4	2.4	2.4	2.5	2.4
Center	30.00	4.3	4.5	3.8	4.2	3.2	3.2	2.9	3.1
5	19.38	-4.0	-3.7	-3.5	-3.7	-4.0	-4.3	-4.0	-4.1
6	11.64	-1.4	-2.4	-3.1	-2.3	-3.4	-3.9	-5.0	-4.1
7	6.30	-3.9	-4.0	-3.7	-3.9	-9.2	-8.6	-8.0	-8.6
8	1.92	-3.3	-1.9	-1.9	-2.4	-2.0	-2.7	-3.3	-2.7
Mean of absolute values:					3.1				3.5
" " w/o points by wall:					3.4				3.7
								Grand mean ABS	3.3
								Grand mean ABS w/o wall pts	3.6

Instuments Used:		Cal. Due
S-type pitot (ID: 7A)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuacy check prior to each use; field recalibration as necessary
Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle
Approx. air velocity was derived from all points on the Velocity Transverse Form





FLOW ANGLE DATA FORM

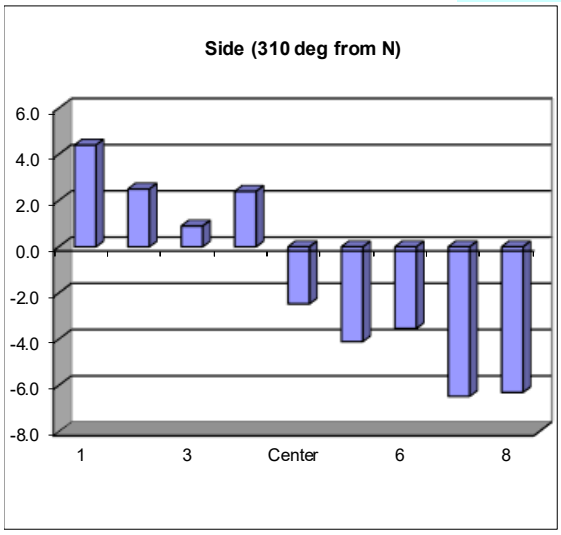
Stack	LB-S1	Run No.	FA-12
Date	10/18/2019	Fan Setting	N/A Hz
Start/End Time	9:14 9:22	Fan Configuration	Fan A&C
Testers	ZDH/LCE	Stack Temp	63.7 deg F
Stack Dia.	60 in		
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

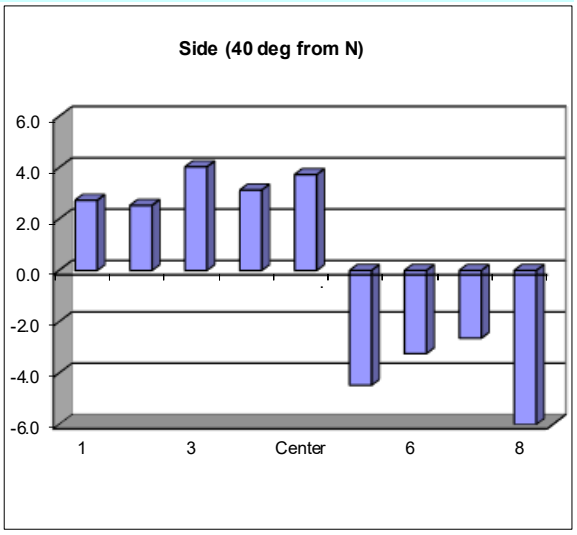
Order -->		First				Second			
Traverse-->		Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	58.08	4.3	4.4	4.5	4.4	3.2	2.3	2.7	2.7
2	53.70	2.9	2.2	2.4	2.5	4.0	2.4	1.2	2.5
3	48.36	0.8	0.8	1.1	0.9	4.5	3.9	3.7	4.0
4	40.62	1.8	2.6	2.8	2.4	2.9	3.6	2.9	3.1
Center	30.00	-2.3	-2.7	-2.4	-2.5	3.5	3.5	4.2	3.7
5	19.38	-3.9	-4.3	-4.1	-4.1	-4.4	-4.8	-4.2	-4.5
6	11.64	-3.5	-3.5	-3.6	-3.5	-3.6	-2.9	-3.2	-3.2
7	6.30	-6.3	-6.6	-6.5	-6.5	-2.1	-3.0	-2.8	-2.6
8	1.92	-6.9	-6.1	-5.9	-6.3	-6.0	-6.1	-5.9	-6.0
Mean of absolute values:					3.7				3.6
" " w/o points by wall:					3.2				3.4
								Grand mean ABS	3.6
								Grand mean ABS w/o wall pts	3.3

Instuments Used:		Cal. Due
S-type pitot (ID: 7A)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuacy check prior to each use; field recalibration as necessary
Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle
Approx. air velocity was derived from all points on the Velocity Transverse Form





FLOW ANGLE DATA FORM

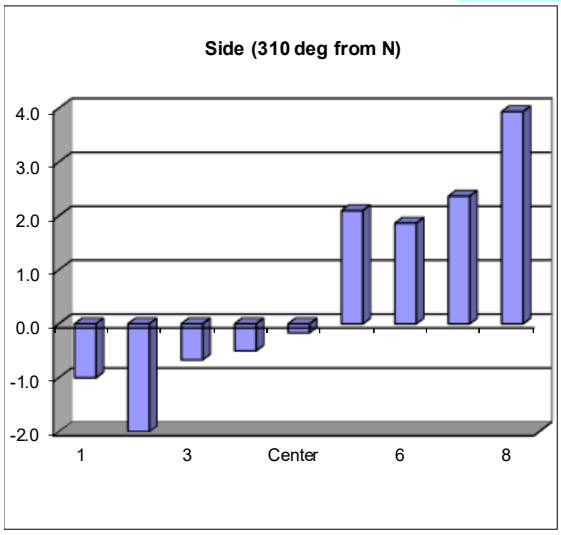
Stack	LB-S1	Run No.	FA-13
Date	10/18/2019	Fan Setting	N/A Hz
Start/End Time	10:22 10:31	Fan Configuration	Fan A&C
Testers	ZDH/LCE	Stack Temp	66 deg F
Stack Dia.	60 in		
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

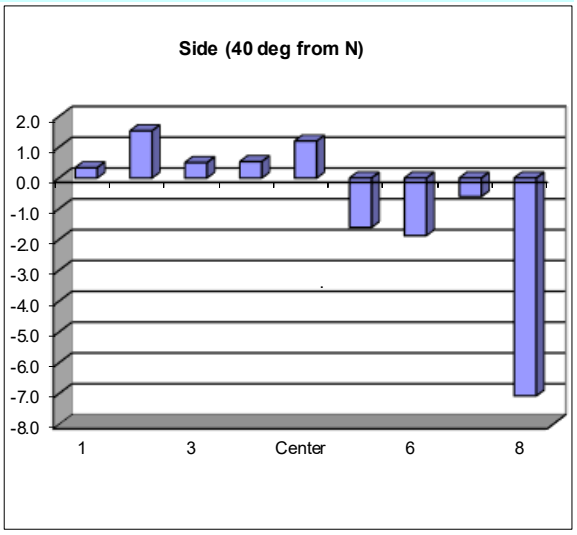
		Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Order -->		First				Second			
Traverse-->									
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	58.08	-0.5	-1.1	-1.4	-1.0	0.1	0.1	0.8	0.3
2	53.70	-2.3	-1.8	-1.9	-2.0	1.6	1.4	1.6	1.5
3	48.36	-0.5	-0.7	-0.8	-0.7	0.4	0.5	0.6	0.5
4	40.62	-0.6	-0.3	-0.6	-0.5	0.7	0.3	0.6	0.5
Center	30.00	-0.2	-0.3	0.0	-0.2	1.2	1.4	1.0	1.2
5	19.38	2.3	2.1	1.9	2.1	-1.2	-2.1	-1.5	-1.6
6	11.64	2.2	2.0	1.4	1.9	-2.2	-1.8	-1.6	-1.9
7	6.30	2.5	2.3	2.3	2.4	-1.1	-0.5	-0.2	-0.6
8	1.92	3.8	4.0	4.0	3.9	-7.1	-7.2	-6.9	-7.1
Mean of absolute values:					1.6				1.7
" " w/o points by wall:					1.4				1.1
								Grand mean ABS	1.7
								Grand mean ABS w/o wall pts	1.3

Instuments Used:		Cal. Due
S-type pitot (ID: 7A)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuacy check prior to each use; field recalibration as necessary
Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle
Approx. air velocity was derived from all points on the Velocity Transverse Form





FLOW ANGLE DATA FORM

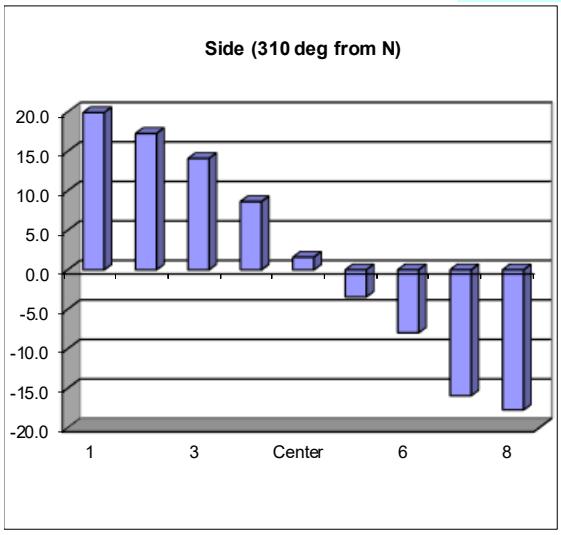
Stack	LB-S1	Run No.	FA-14
Date	10/19/2019	Fan Setting	N/A Hz
Start/End Time	9:26 9:33	Fan Configuration	Fan A &B
Testers	ZDH/LCE	Stack Temp	61.8 deg F
Stack Dia.	60 in		
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

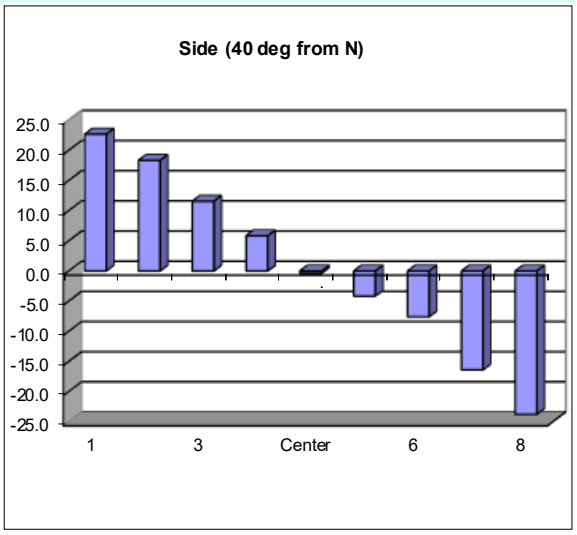
Order -->		First				Second			
Traverse-->		Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	58.08	19.4	19.8	20.5	19.9	23.3	21.9	22.8	22.7
2	53.70	15.9	17.9	18.0	17.3	18.6	18.6	17.8	18.3
3	48.36	14.3	14.2	13.8	14.1	11.8	11.4	11.5	11.6
4	40.62	9.4	8.4	8.1	8.6	5.4	5.9	6.2	5.8
Center	30.00	2.2	1.6	1.0	1.6	0.0	-0.1	-1.1	-0.4
5	19.38	-4.3	-3.2	-2.8	-3.4	-4.1	-4.4	-4.0	-4.2
6	11.64	-8.0	-8.1	-7.8	-8.0	-7.1	-7.8	-7.9	-7.6
7	6.30	-16.3	-15.8	-15.7	-15.9	-15.8	-16.6	-16.8	-16.4
8	1.92	-17.5	-17.8	-17.9	-17.7	-23.5	-24.1	-23.7	-23.8
Mean of absolute values:					11.8				12.3
" " w/o points by wall:					9.8				9.2
								Grand mean ABS	12.1
								Grand mean ABS w/o wall pts	9.5

Instuments Used:		Cal. Due
S-type pitot (ID: 7A)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuacy check prior to each use; field recalibration as necessary
Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle
Approx. air velocity was derived from all points on the Velocity Transverse Form





B.2 Velocity Transverse Data Forms

VELOCITY TRAVERSE DATA FORM

Stack	**LB-S1**	Run No.	**VT-1**
Date	**10/15/19**	Fan Configuration	**Fan A & B**
Testers	ZDH/LCE	Fan Setting	**NA** **Hz**
Stack Dia.	60 in.	Stack Temp	65.85 deg F
Stack X-Area	2827.4 in.2	Start/End Time	13:12 13:19
Test Port	1	Center 2/3 from	5.51 to: 54.49
Distance to disturbance	56.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		**Side1 (310 deg from N)**				**Side2 (40 deg from N)**			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	58.1	3,954.5	3,893.5	3,810.7	3,886.2	3,726.0	3,789.7	3,747.3	3,754.3
2	53.7	4,073.8	3,994.6	3,934.3	4,000.9	3,914.0	3,934.3	3,831.6	3,893.3
3	48.4	3,893.5	3,934.3	3,974.6	3,934.1	3,810.7	3,934.3	3,934.3	3,893.1
4	40.6	3,934.3	3,893.5	3,872.9	3,900.2	3,852.3	3,726.0	3,872.9	3,817.1
Center	30.0	3,810.7	3,934.3	3,831.6	3,858.8	3,831.6	3,768.5	3,872.9	3,824.3
5	19.4	3,994.6	3,974.6	3,872.9	3,947.4	4,014.6	3,934.3	3,974.6	3,974.5
6	11.6	3,872.9	3,994.6	3,934.3	3,933.9	4,073.8	4,189.7	4,034.4	4,099.3
7	6.3	3,831.6	3,934.3	3,852.3	3,872.7	4,093.3	4,054.1	4,014.6	4,054.0
8	1.9	3,617.3	3,459.5	3,528.0	3,534.9	3,810.7	3,893.5	3,810.7	3,838.3
Averages ---------->		3,887.0	3,890.4	3,845.7	3,874.4	3,903.0	3,913.8	3,899.3	3,905.3

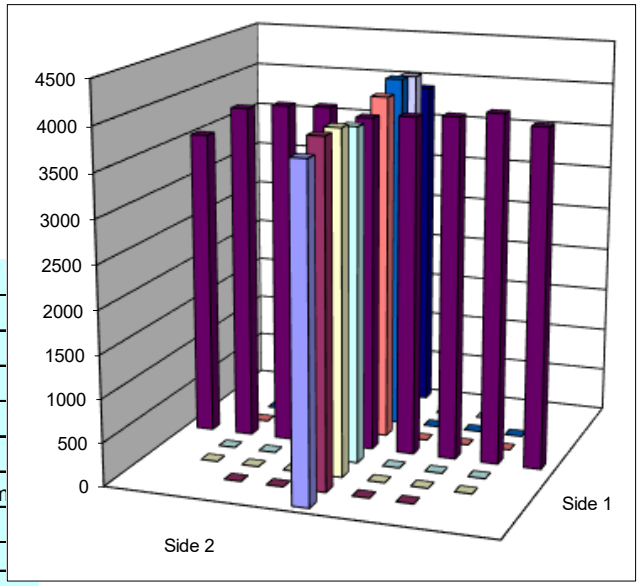
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	3889.9		Mean	3921.2	3936.5	3928.8
Min Point	3534.9	-9.1%	Std. Dev.	48.4	109.8	81.9
Max Point	4099.3	5.4%	COV as %	1.2	2.8	**2.1**

Flow w/o C-Pt 76496 cfm

Vel Avg w/o C-Pt 3896 fpm

	Start	Finish	
Stack temp	65.80	65.90	F
Equipment temp	63.10	63.10	F
Ambient temp	63.10	63.10	F
Stack static	0.90	1.00	mbars
Ambient pressure	991.87	991.87	mbars
Total Stack pressure	992.8	992.9	mbars
Ambient humidity	32%	33%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST8, 8ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

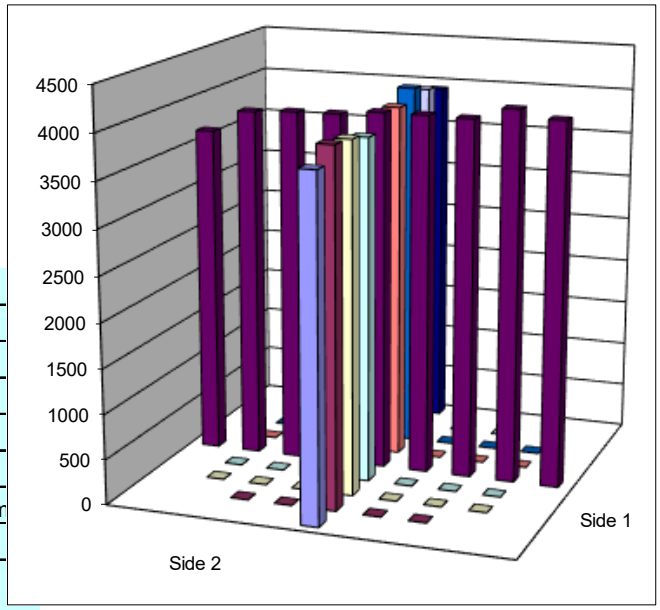
Stack	LB-S1	Run No.	VT-2
Date	10/15/19	Fan Configuration	Fan A & B
Testers	ZDH/LCE	Fan Setting	NA Hz
Stack Dia.	60 in.	Stack Temp	66.75 deg F
Stack X-Area	2827.4 in.2	Start/End Time	15:15 15:28
Test Port	1	Center 2/3 from	5.51 to: 54.49
Distance to disturbance	56.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (310 deg from N)				Side2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	58.1	4,096.4	3,997.7	3,957.5	4,017.2	3,707.3	3,750.1	3,813.6	3,757.0
2	53.7	4,096.4	4,115.8	4,096.4	4,102.9	3,957.5	3,875.9	3,917.0	3,916.8
3	48.4	3,957.5	3,917.0	4,037.5	3,970.7	3,896.5	3,896.5	3,855.2	3,882.7
4	40.6	3,997.7	3,977.6	3,957.5	3,977.6	3,750.1	3,896.5	3,792.5	3,813.0
Center	30.0	3,957.5	3,977.6	3,997.7	3,977.6	4,037.5	3,977.6	3,957.5	3,990.9
5	19.4	3,957.5	3,896.5	3,937.2	3,930.4	3,937.2	3,997.7	3,957.5	3,964.2
6	11.6	3,834.4	3,896.5	4,037.5	3,922.8	4,037.5	4,154.5	4,096.4	4,096.2
7	6.3	3,896.5	3,875.9	3,917.0	3,896.5	3,957.5	4,076.9	3,977.6	4,004.0
8	1.9	3,664.0	3,664.0	3,620.0	3,649.3	3,896.5	3,917.0	3,957.5	3,923.7
Averages ---------->		3,939.8	3,924.3	3,950.9	3,938.3	3,908.6	3,949.2	3,925.0	3,927.6

All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	3933.0		Mean	3968.4	3952.5	3960.4
Min Point	3649.3	-7.2%	Std. Dev.	67.0	91.7	77.6
Max Point	4102.9	4.3%	COV as %	1.7	2.3	**2.0**

Flow w/o C-Pt	77098 cfm	**Instuments Used:**	Cal Due
Vel Avg w/o C-Pt	3927 fpm	Standard pitot (ID: BST8, 8ft)	Post-test inspection
		Digi-sense 20250-13 Manometer	9/15/2020
		Workhorse Thermometer	Verified prior to each field use

	Start	Finish	
Stack temp	66.50	67.00	F
Equipment temp	62.30	67.00	F
Ambient temp	62.30	63.10	F
Stack static	2.86	0.42	mbars
Ambient pressure	991.87	990.86	mbars
Total Stack pressure	994.7	991.3	mbars
Ambient humidity	34%	33%	RH



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

Stack	LB-S1	Run No.	VT-3
Date	10/16/19	Fan Configuration	Fan A & B
Testers	ZDH/LCE	Fan Setting	NA Hz
Stack Dia.	60 in.	Stack Temp	63.45 deg F
Stack X-Area	2827.4 in.2	Start/End Time	9:21 9:29
Test Port	1	Center 2/3 from	5.51 to: 54.49
Distance to disturbance	56.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

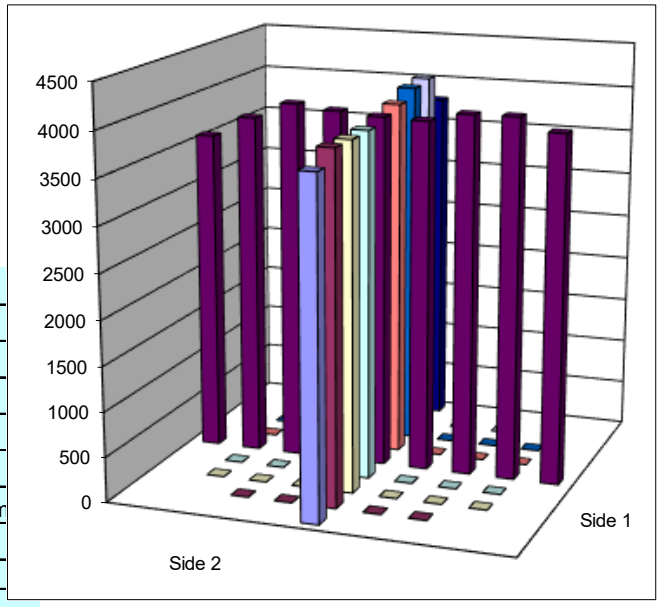
Order -->		First port				Second port			
Traverse-->		Side1 (310 deg from N)				Side2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	58.1	3,874.7	3,833.2	3,895.2	3,867.7	3,727.6	3,770.2	3,596.8	3,698.2
2	53.7	3,996.4	4,036.2	3,996.4	4,009.7	3,833.2	3,833.2	3,874.7	3,847.0
3	48.4	3,996.4	4,095.1	3,915.7	4,002.4	3,812.3	3,895.2	3,812.3	3,840.0
4	40.6	3,936.1	3,854.0	3,915.7	3,901.9	3,833.2	3,854.0	3,854.0	3,847.1
Center	30.0	3,936.1	3,854.0	3,956.3	3,915.4	3,936.1	3,915.7	3,854.0	3,901.9
5	19.4	3,996.4	3,874.7	3,976.4	3,949.2	3,976.4	3,956.3	3,936.1	3,956.3
6	11.6	3,976.4	4,036.2	3,976.4	3,996.3	4,055.9	4,036.2	4,075.6	4,055.9
7	6.3	3,812.3	3,874.7	3,749.0	3,812.0	4,075.6	4,153.3	4,036.2	4,088.4
8	1.9	3,574.5	3,529.6	3,641.0	3,581.7	3,684.6	3,854.0	3,749.0	3,762.5
Averages ---------->		3,899.9	3,887.5	3,891.3	3,892.9	3,881.7	3,918.7	3,865.4	3,888.6

All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	3890.8		Mean	3941.0	3933.8	3937.4
Min Point	3581.7	-7.9%	Std. Dev.	71.2	103.4	85.4
Max Point	4088.4	5.1%	COV as %	1.8	2.6	**2.2**

Flow w/o C-Pt	76351	cfm
Vel Avg w/o C-Pt	3889	fpm

	Start	Finish	
Stack temp	63.30	63.60	F
Equipment temp	54.50	63.60	F
Ambient temp	54.50	55.10	F
Stack static	2.44	1.49	mbars
Ambient pressure	985.44	985.44	mbars
Total Stack pressure	987.9	986.9	mbars
Ambient humidity	52%	50%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST8, 8ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

Stack	LB-S1	Run No.	VT-4
Date	10/16/19	Fan Configuration	Fan A & B
Testers	ZDH/LCE	Fan Setting	NA Hz
Stack Dia.	60 in.	Stack Temp	65.90 deg F
Stack X-Area	2827.4 in.2	Start/End Time	10:47 10:56
Test Port	1	Center 2/3 from	5.51 to: 54.49
Distance to disturbance	56.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (310 deg from N)				Side2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	58.1	3,777.6	3,861.5	3,861.5	3,833.5	3,669.9	3,559.0	3,625.9	3,618.3
2	53.7	4,063.8	4,004.2	4,103.1	4,057.0	3,691.7	3,798.7	3,669.9	3,720.1
3	48.4	3,819.8	4,004.2	3,902.8	3,908.9	3,798.7	3,861.5	3,669.9	3,776.7
4	40.6	3,902.8	3,819.8	3,840.7	3,854.4	3,734.9	3,777.6	3,840.7	3,784.4
Center	30.0	3,840.7	3,902.8	3,923.3	3,888.9	3,882.2	3,798.7	3,923.3	3,868.1
5	19.4	3,964.0	3,943.6	3,923.3	3,943.6	3,923.3	4,044.0	4,083.5	4,016.9
6	11.6	3,923.3	3,902.8	3,840.7	3,888.9	4,044.0	4,024.2	4,063.8	4,044.0
7	6.3	3,756.3	3,734.9	3,798.7	3,763.3	4,004.2	3,902.8	4,083.5	3,996.8
8	1.9	3,559.0	3,444.6	3,490.8	3,498.1	3,756.3	3,444.6	3,691.7	3,630.8
Averages ---------->		3,845.2	3,846.5	3,853.9	3,848.5	3,833.9	3,801.2	3,850.2	3,828.5

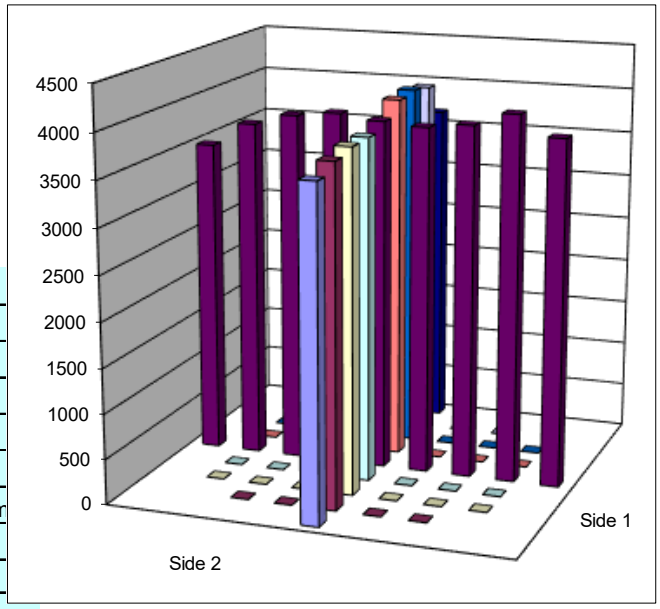
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	3838.5		Mean	3900.7	3886.7	3893.7
Min Point	3498.1	-8.9%	Std. Dev.	89.1	132.0	108.4
Max Point	4057.0	5.7%	COV as %	2.3	3.4	**2.8**

Flow w/o C-Pt 75271 cfm

Vel Avg w/o C-Pt 3833 fpm

	Start	Finish	
Stack temp	65.60	66.20	F
Equipment temp	64.80	66.20	F
Ambient temp	64.80	63.70	F
Stack static	3.96	2.56	mbars
Ambient pressure	985.10	984.76	mbars
Total Stack pressure	989.1	987.3	mbars
Ambient humidity	36%	38%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST8, 8ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

Stack	LB-S1	Run No.	VT-5
Date	10/16/19	Fan Configuration	Fan B&C
Testers	ZDH/LCE	Fan Setting	NA Hz
Stack Dia.	60 in.	Stack Temp	67.8 deg F
Stack X-Area	2827.4 in.2	Start/End Time	13:03 13:09
Test Port	1	Center 2/3 from	5.51 to: 54.49
Distance to disturbance	56.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (310 deg from N)				Side2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	58.1	3,357.0	3,451.6	3,404.6	3,404.4	3,655.4	3,677.4	3,931.3	3,754.7
2	53.7	3,806.5	3,785.2	3,848.6	3,813.4	4,091.8	3,972.1	3,806.5	3,956.8
3	48.4	3,951.7	3,827.5	3,848.6	3,875.9	3,992.2	4,111.5	4,072.1	4,058.6
4	40.6	4,052.3	3,910.8	3,992.2	3,985.1	4,032.3	3,972.1	3,992.2	3,998.9
Center	30.0	3,992.2	3,931.3	4,012.4	3,978.6	3,848.6	3,992.2	3,951.7	3,930.8
5	19.4	3,806.5	3,677.4	3,655.4	3,713.1	3,890.1	3,972.1	3,992.2	3,951.5
6	11.6	4,052.3	3,972.1	3,869.4	3,964.6	3,869.4	3,827.5	3,910.8	3,869.2
7	6.3	3,951.7	3,910.8	3,869.4	3,910.6	3,633.4	3,677.4	3,764.0	3,691.6
8	1.9	3,742.4	3,633.4	3,677.4	3,684.4	3,428.1	3,259.7	3,380.9	3,356.2
Averages ---------->		3,856.9	3,788.9	3,797.5	3,814.5	3,826.8	3,829.1	3,866.9	3,840.9

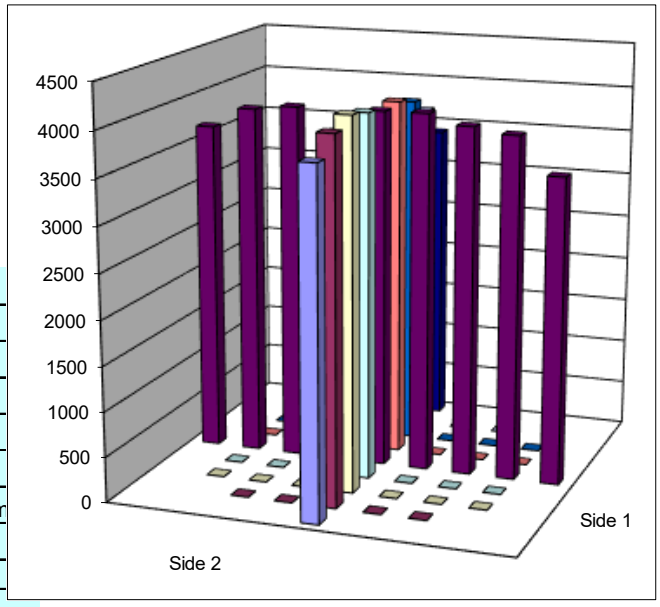
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	3827.7		Mean	3891.6	3922.5	3907.1
Min Point	3356.2	-12.3%	Std. Dev.	100.2	117.3	106.0
Max Point	4058.6	6.0%	COV as %	2.6	3.0	**2.7**

Flow w/o C-Pt 74845 cfm

Vel Avg w/o C-Pt 3812 fpm

	Start	Finish	
Stack temp	67.70	67.80	F
Equipment temp	68.10	67.80	F
Ambient temp	68.10	67.20	F
Stack static	3.78	4.33	mbars
Ambient pressure	983.75	983.41	mbars
Total Stack pressure	987.5	987.7	mbars
Ambient humidity	34%	35%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST8, 8ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

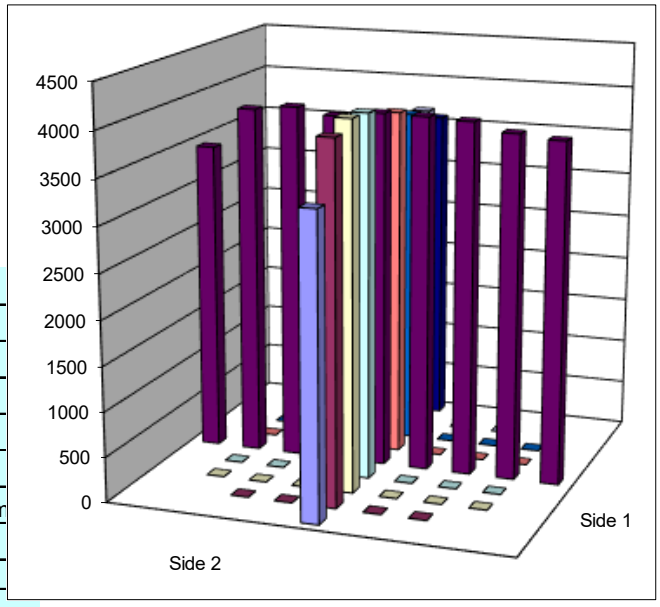
Stack	LB-S1	Run No.	VT-6
Date	10/16/19	Fan Configuration	Fan B&C
Testers	ZDH/LCE	Fan Setting	NA Hz
Stack Dia.	60 in.	Stack Temp	68.95 deg F
Stack X-Area	2827.4 in.2	Start/End Time	14:09 14:14
Test Port	1	Center 2/3 from	5.51 to: 54.49
Distance to disturbance	56.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (310 deg from N)				Side2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	58.1	3,660.2	3,811.4	3,895.2	3,788.9	3,263.9	3,337.2	3,361.3	3,320.8
2	53.7	3,768.8	3,811.4	3,915.8	3,832.0	3,895.2	3,997.4	3,936.4	3,943.0
3	48.4	3,915.8	3,874.4	3,997.4	3,929.2	4,057.6	4,057.6	4,037.7	4,051.0
4	40.6	3,977.2	3,895.2	3,977.2	3,949.9	4,057.6	3,956.8	4,057.6	4,024.0
Center	30.0	3,997.4	3,936.4	3,936.4	3,956.7	3,977.2	3,853.6	3,977.2	3,936.0
5	19.4	3,874.4	3,956.8	3,853.6	3,895.0	3,895.2	3,874.4	3,811.4	3,860.3
6	11.6	3,997.4	3,956.8	3,936.4	3,963.6	3,725.7	3,768.8	3,768.8	3,754.5
7	6.3	3,874.4	3,915.8	3,936.4	3,908.9	3,615.9	3,704.1	3,811.4	3,710.5
8	1.9	3,409.1	3,502.4	3,456.1	3,455.9	3,660.2	3,548.3	3,432.7	3,547.1
Averages ---------->		3,830.5	3,851.2	3,878.3	3,853.3	3,794.3	3,788.7	3,799.4	3,794.1

All	ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	3823.7		Mean	3919.3	3897.0	3908.2
Min Point	3320.8	-13.2%	Std. Dev.	46.0	129.1	93.8
Max Point	4051.0	5.9%	COV as %	1.2	3.3	**2.4**

Flow w/o C-Pt	74778 cfm	**Instuments Used:**	Cal Due
Vel Avg w/o C-Pt	3808 fpm	Standard pitot (ID: BST8, 8ft)	Post-test inspection
		Digi-sense 20250-13 Manometer	9/15/2020
		Workhorse Thermometer	Verified prior to each field use

	Start	Finish	
Stack temp	69.20	68.70	F
Equipment temp	70.70	68.70	F
Ambient temp	70.70	63.60	F
Stack static	4.13	3.98	mbars
Ambient pressure	983.41	983.07	mbars
Total Stack pressure	987.5	987.1	mbars
Ambient humidity	32%	36%	RH



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

Stack	**LB-S1**	Run No.	**VT-7**
Date	**10/17/19**	Fan Configuration	**Fan B&C**
Testers	ZDH/LCE	Fan Setting	**NA** **Hz**
Stack Dia.	60 in.	Stack Temp	66.40 deg F
Stack X-Area	2827.4 in.2	Start/End Time	9:12 9:21
Test Port	1	Center 2/3 from	5.51 to: 54.49
Distance to disturbance	56.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		**Side1 (310 deg from N)**				**Side2 (40 deg from N)**			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	58.1	3,478.6	3,570.2	3,547.5	3,532.1	3,501.8	3,408.3	3,547.5	3,485.9
2	53.7	4,096.4	3,976.5	4,036.9	4,036.6	3,956.1	3,894.4	3,894.4	3,915.0
3	48.4	3,935.6	4,016.8	4,115.9	4,022.8	3,935.6	3,956.1	3,996.6	3,962.8
4	40.6	3,976.5	3,935.6	3,976.5	3,962.8	3,915.1	3,956.1	3,831.7	3,901.0
Center	30.0	3,996.6	4,016.8	3,852.8	3,955.4	3,852.8	3,873.6	3,852.8	3,859.7
5	19.4	3,810.7	3,935.6	3,935.6	3,894.0	3,894.4	3,935.6	3,976.5	3,935.5
6	11.6	3,873.6	3,894.4	3,915.1	3,894.4	3,894.4	3,976.5	3,915.1	3,928.6
7	6.3	3,810.7	3,789.4	3,915.1	3,838.4	4,036.9	3,956.1	4,076.6	4,023.2
8	1.9	3,615.1	3,637.4	3,384.6	3,545.7	3,637.4	3,592.7	3,478.6	3,569.6
Averages ---------->		3,843.8	3,863.6	3,853.3	3,853.6	3,847.2	3,838.8	3,841.1	3,842.4

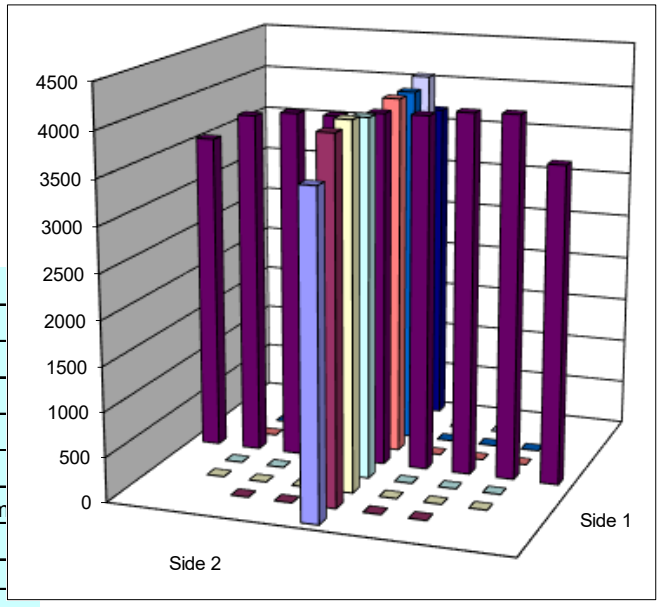
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	3848.0		Mean	3943.5	3932.3	3937.9
Min Point	3485.9	-9.4%	Std. Dev.	72.3	51.2	60.5
Max Point	4036.6	4.9%	COV as %	1.8	1.3	**1.5**

Flow w/o C-Pt 75408 cfm

Vel Avg w/o C-Pt 3841 fpm

	Start	Finish	
Stack temp	67.10	65.70	F
Equipment temp	65.60	65.70	F
Ambient temp	65.60	59.30	F
Stack static	2.39	3.11	mbars
Ambient pressure	980.02	980.36	mbars
Total Stack pressure	982.4	983.5	mbars
Ambient humidity	38%	43%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST8, 8ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

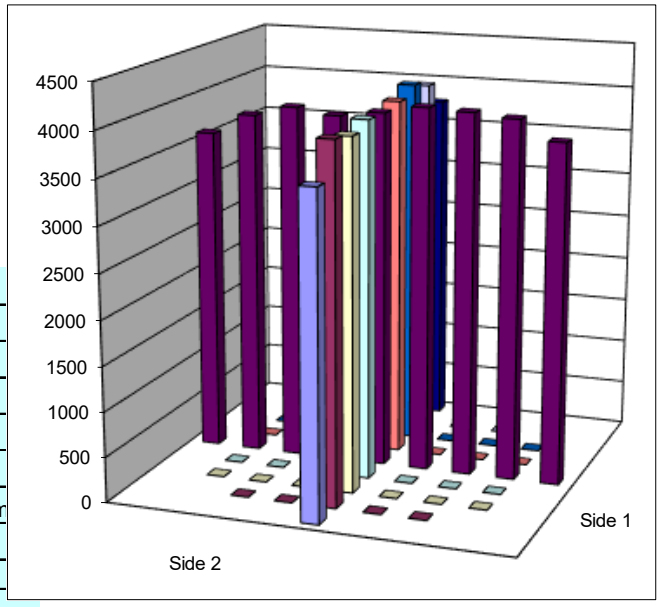
Stack	LB-S1	Run No.	VT-8
Date	10/17/19	Fan Configuration	Fan B&C
Testers	ZDH/LCE	Fan Setting	NA Hz
Stack Dia.	60 in.	Stack Temp	68.40 deg F
Stack X-Area	2827.4 in.2	Start/End Time	10:21 10:30
Test Port	1	Center 2/3 from	5.51 to: 54.49
Distance to disturbance	56.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (310 deg from N)				Side2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	58.1	3,815.1	3,793.7	3,707.5	3,772.1	3,574.3	3,388.5	3,528.7	3,497.1
2	53.7	4,001.2	3,981.0	3,981.0	3,987.7	3,878.1	3,836.1	3,919.5	3,877.9
3	48.4	4,140.2	4,001.2	3,940.2	4,027.2	3,836.1	3,898.9	3,729.3	3,821.4
4	40.6	4,041.4	4,101.0	4,001.2	4,047.9	4,001.2	3,836.1	3,878.1	3,905.1
Center	30.0	4,001.2	3,981.0	3,898.9	3,960.3	3,857.2	3,898.9	3,919.5	3,891.8
5	19.4	3,836.1	4,001.2	3,857.2	3,898.2	3,919.5	3,940.2	3,940.2	3,933.3
6	11.6	4,021.4	3,981.0	3,878.1	3,960.1	3,919.5	4,101.0	4,081.3	4,033.9
7	6.3	3,919.5	3,772.4	3,836.1	3,842.7	3,919.5	3,940.2	4,001.2	3,953.6
8	1.9	3,619.2	3,685.6	3,528.7	3,611.2	3,793.7	3,551.6	3,707.5	3,684.3
Averages ---------->		3,932.8	3,922.0	3,847.6	3,900.8	3,855.4	3,821.3	3,856.1	3,844.3

All	ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	3872.6		Mean	3960.6	3916.7	3938.7
Min Point	3497.1	-9.7%	Std. Dev.	71.4	66.7	70.2
Max Point	4047.9	4.5%	COV as %	1.8	1.7	**1.8**

Flow w/o C-Pt	75906 cfm	**Instuments Used:**	Cal Due
Vel Avg w/o C-Pt	3866 fpm	Standard pitot (ID: BST8, 8ft)	Post-test inspection
		Digi-sense 20250-13 Manometer	9/15/2020
		Workhorse Thermometer	Verified prior to each field use

	Start	Finish	
Stack temp	68.1	68.7	F
Equipment temp	58.7	68.7	F
Ambient temp	58.7	62.6	F
Stack static	2.1	5.3	mbars
Ambient pressure	980.7	980.7	mbars
Total Stack pressure	982.8	986.0	mbars
Ambient humidity	44%	37%	RH



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

Stack	LB-S1	Run No.	VT-9
Date	10/17/19	Fan Configuration	Fan B&C
Testers	ZDH/LCE	Fan Setting	NA Hz
Stack Dia.	60 in.	Stack Temp	70.30 deg F
Stack X-Area	2827.4 in.2	Start/End Time	11:30 11:38
Test Port	1	Center 2/3 from	5.51 to: 54.49
Distance to disturbance	56.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (310 deg from N)				Side2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	58.1	3,606.3	3,606.3	3,760.7	3,657.8	3,373.4	3,421.3	3,349.2	3,381.3
2	53.7	3,971.0	4,011.8	3,991.4	3,991.4	3,717.3	3,950.5	3,782.3	3,816.7
3	48.4	4,111.8	4,052.0	4,011.8	4,058.5	3,867.4	3,803.8	3,888.2	3,853.1
4	40.6	3,909.1	4,011.8	3,991.4	3,970.8	3,782.3	3,909.1	4,011.8	3,901.1
Center	30.0	3,825.0	4,011.8	3,909.1	3,915.3	4,072.1	3,929.9	3,909.1	3,970.4
5	19.4	3,739.1	3,950.5	3,846.2	3,845.3	3,929.9	3,888.2	4,111.8	3,976.6
6	11.6	3,909.1	3,825.0	3,888.2	3,874.1	4,052.0	3,991.4	4,011.8	4,018.4
7	6.3	3,803.8	3,950.5	3,971.0	3,908.4	3,929.9	4,011.8	4,052.0	3,997.9
8	1.9	3,695.4	3,397.4	3,491.8	3,528.2	3,673.3	3,739.1	3,782.3	3,731.6
Averages ---------->		3,841.2	3,868.6	3,873.5	3,861.1	3,822.0	3,849.4	3,877.6	3,849.7

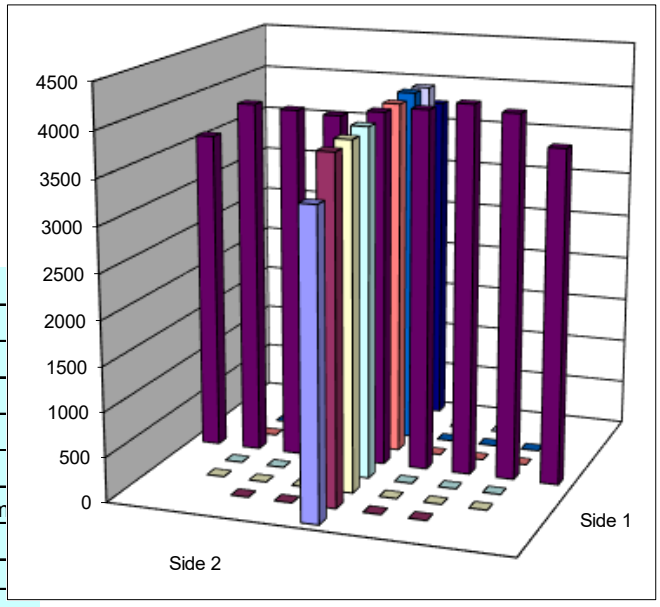
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	3855.4		Mean	3937.7	3933.5	3935.6
Min Point	3381.3	-12.3%	Std. Dev.	73.6	77.2	72.5
Max Point	4058.5	5.3%	COV as %	1.9	2.0	**1.8**

Flow w/o C-Pt 75486 cfm

Vel Avg w/o C-Pt 3844 fpm

	Start	Finish	
Stack temp	70.40	70.20	F
Equipment temp	60.50	70.20	F
Ambient temp	60.50	60.90	F
Stack static	2.12	2.04	mbars
Ambient pressure	981.04	980.36	mbars
Total Stack pressure	983.2	982.4	mbars
Ambient humidity	42%	41%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST8, 8ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

Stack	LB-S1	Run No.	VT-10
Date	10/17/19	Fan Configuration	Fans A&C
Testers	ZDH/LCE	Fan Setting	NA Hz
Stack Dia.	60 in.	Stack Temp	69.60 deg F
Stack X-Area	2827.4 in.2	Start/End Time	14:18 14:26
Test Port	1	Center 2/3 from	5.51 to: 54.49
Distance to disturbance	56.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (310 deg from N)				Side2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	58.1	3,758.3	3,885.8	3,670.9	3,771.6	3,779.9	3,648.7	3,714.8	3,714.5
2	53.7	4,109.1	3,968.4	4,029.3	4,035.6	4,049.4	4,109.1	4,009.1	4,055.9
3	48.4	4,009.1	4,128.8	4,029.3	4,055.7	3,968.4	4,089.3	4,128.8	4,062.2
4	40.6	4,264.2	4,226.0	4,226.0	4,238.7	4,187.4	4,049.4	4,089.3	4,108.7
Center	30.0	4,245.1	4,128.8	4,168.0	4,180.6	4,069.4	4,029.3	4,148.4	4,082.4
5	19.4	4,049.4	4,069.4	4,148.4	4,089.1	4,128.8	4,245.1	4,206.7	4,193.6
6	11.6	4,029.3	4,148.4	4,109.1	4,095.6	4,245.1	4,089.3	4,009.1	4,114.5
7	6.3	3,947.9	3,885.8	3,947.9	3,927.2	3,947.9	3,988.8	3,968.4	3,968.4
8	1.9	3,347.0	3,298.1	3,535.7	3,393.6	3,273.5	3,489.5	3,347.0	3,370.0
Averages ---------->		3,973.3	3,971.1	3,985.0	3,976.4	3,961.1	3,971.0	3,958.0	3,963.3

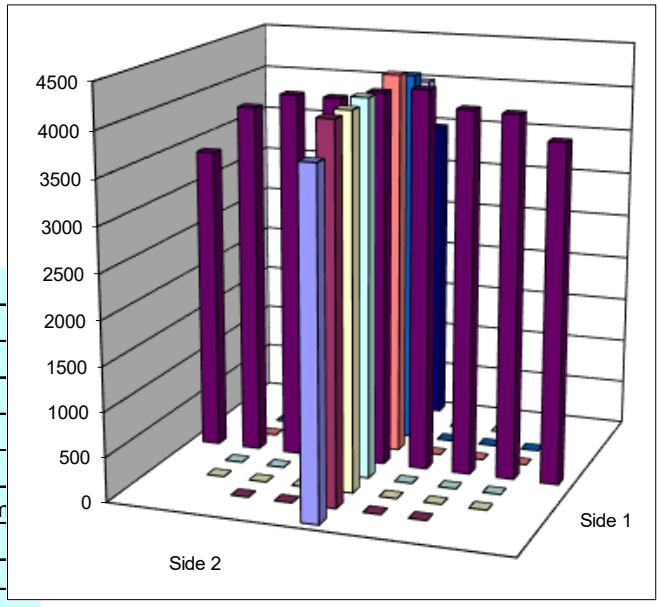
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	3969.9		Mean	4088.9	4083.6	4086.3
Min Point	3370.0	-15.1%	Std. Dev.	100.8	68.5	82.9
Max Point	4238.7	6.8%	COV as %	2.5	1.7	**2.0**

Flow w/o C-Pt 77552 cfm

Vel Avg w/o C-Pt 3950 fpm

	Start	Finish	
Stack temp	69.50	69.70	F
Equipment temp	59.70	69.70	F
Ambient temp	59.70	60.60	F
Stack static	2.32	2.61	mbars
Ambient pressure	981.04	980.70	mbars
Total Stack pressure	983.4	983.3	mbars
Ambient humidity	45%	44%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST8, 8ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

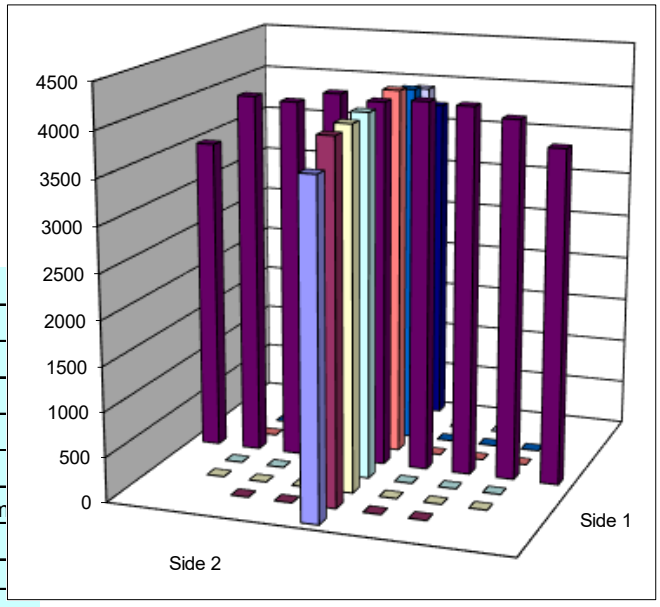
Stack	LB-S1	Run No.	VT-11
Date	10/17/19	Fan Configuration	Fans A&C
Testers	ZDH/LCE	Fan Setting	NA Hz
Stack Dia.	60 in.	Stack Temp	70.45 deg F
Stack X-Area	2827.4 in.2	Start/End Time	15:26 15:33
Test Port	1	Center 2/3 from	5.51 to: 54.49
Distance to disturbance	56.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (310 deg from N)				Side2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	58.1	3,673.7	3,651.5	3,761.2	3,695.5	3,782.7	3,717.6	3,561.3	3,687.2
2	53.7	3,930.3	4,072.6	3,909.6	3,970.8	4,171.2	3,846.7	3,930.3	3,982.7
3	48.4	4,132.0	4,092.4	4,012.1	4,078.9	4,171.2	3,888.7	3,991.9	4,017.3
4	40.6	4,032.4	4,132.0	4,132.0	4,098.8	4,052.5	4,072.6	4,032.4	4,052.5
Center	30.0	4,092.4	4,052.5	4,052.5	4,065.8	4,072.6	4,072.6	4,092.4	4,079.2
5	19.4	4,072.6	4,229.2	4,072.6	4,124.8	4,132.0	4,112.2	4,132.0	4,125.4
6	11.6	3,971.5	4,012.1	4,032.4	4,005.4	4,171.2	4,092.4	3,909.6	4,057.7
7	6.3	3,950.9	4,052.5	4,112.2	4,038.5	4,052.5	4,012.1	3,888.7	3,984.5
8	1.9	3,397.7	3,492.2	3,538.5	3,476.1	3,782.7	3,739.5	3,606.7	3,709.6
Averages ---------->		3,917.1	3,976.3	3,958.1	3,950.5	4,043.2	3,950.5	3,905.0	3,966.2

All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	3958.4		Mean	4054.7	4042.7	4048.7
Min Point	3476.1	-12.2%	Std. Dev.	53.7	51.9	51.1
Max Point	4125.4	4.2%	COV as %	1.3	1.3	**1.3**

Flow w/o C-Pt	77442 cfm	**Instuments Used:**	Cal Due
Vel Avg w/o C-Pt	3944 fpm	Standard pitot (ID: BST8, 8ft)	Post-test inspection
		Digi-sense 20250-13 Manometer	9/15/2020
		Workhorse Thermometer	Verified prior to each field use

	Start	Finish	
Stack temp	70.40	70.50	F
Equipment temp	61.90	70.50	F
Ambient temp	61.90	60.60	F
Stack static	2.51	2.12	mbars
Ambient pressure	980.70	980.36	mbars
Total Stack pressure	983.2	982.5	mbars
Ambient humidity	42%	44%	RH



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

Stack	LB-S1	Run No.	VT-12
Date	10/18/19	Fan Configuration	Fan A&C
Testers	ZDH/LCE	Fan Setting	NA Hz
Stack Dia.	60 in.	Stack Temp	63.90 deg F
Stack X-Area	2827.4 in.2	Start/End Time	9:06 9:14
Test Port	1	Center 2/3 from	5.51 to: 54.49
Distance to disturbance	56.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (310 deg from N)				Side2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	58.1	3,618.6	3,551.8	3,596.5	3,589.0	3,640.6	3,618.6	3,662.4	3,640.5
2	53.7	4,016.0	4,094.8	4,016.0	4,042.2	3,976.0	3,935.7	3,996.1	3,969.3
3	48.4	4,133.5	4,035.8	4,094.8	4,088.0	4,114.2	4,133.5	4,152.8	4,133.5
4	40.6	4,191.1	4,152.8	4,229.0	4,191.0	4,210.1	4,055.6	4,114.2	4,126.7
Center	30.0	4,035.8	4,075.2	4,152.8	4,087.9	4,075.2	4,094.8	4,094.8	4,088.2
5	19.4	4,191.1	4,094.8	4,229.0	4,171.6	4,016.0	4,152.8	4,075.2	4,081.3
6	11.6	4,114.2	4,229.0	4,114.2	4,152.5	4,114.2	4,094.8	4,094.8	4,101.2
7	6.3	3,976.0	4,094.8	3,935.7	4,002.1	4,075.2	4,055.6	3,935.7	4,022.2
8	1.9	3,596.5	3,640.6	3,618.6	3,618.5	3,483.7	3,596.5	3,791.0	3,623.7
Averages ---------->		3,985.9	3,996.6	3,998.5	3,993.7	3,967.2	3,970.9	3,990.8	3,976.3

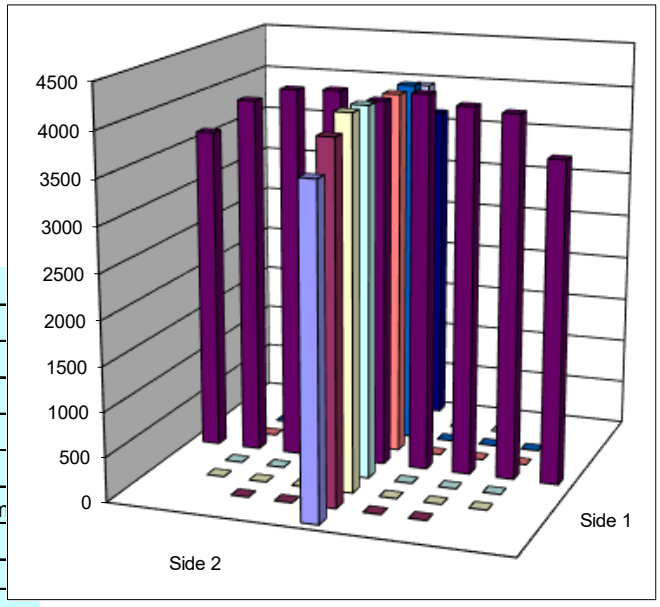
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	3985.0		Mean	4105.1	4074.6	4089.8
Min Point	3589.0	-9.9%	Std. Dev.	69.7	59.1	64.1
Max Point	4191.0	5.2%	COV as %	1.7	1.5	**1.6**

Flow w/o C-Pt 77992 cfm

Vel Avg w/o C-Pt 3972 fpm

	Start	Finish	
Stack temp	64.1	63.7	F
Equipment temp	53.1	51.8	F
Ambient temp	53.1	51.8	F
Stack static	2.9	2.4	mbars
Ambient pressure	985.8	985.8	mbars
Total Stack pressure	988.7	988.2	mbars
Ambient humidity	44%	45%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST8, 8ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

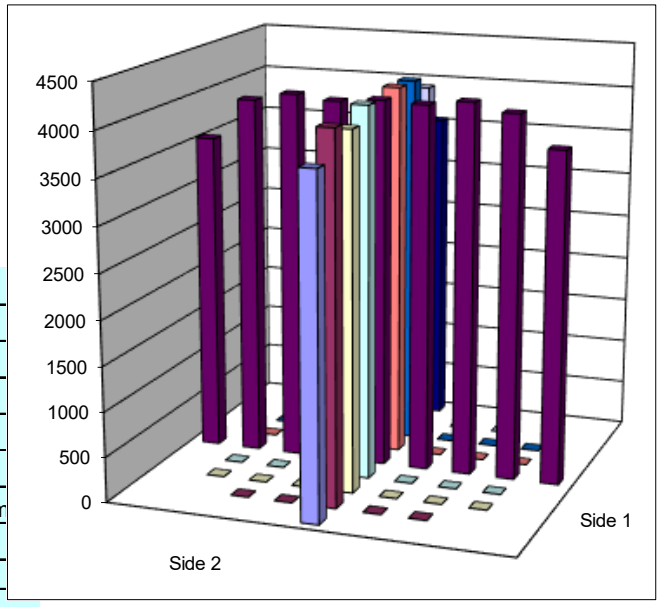
Stack	LB-S1	Run No.	VT-13
Date	10/18/19	Fan Configuration	Fan A&C
Testers	ZDH/LCE	Fan Setting	NA Hz
Stack Dia.	60 in.	Stack Temp	66.5 deg F
Stack X-Area	2827.4 in.2	Start/End Time	10:15 10:22
Test Port	1	Center 2/3 from	5.51 to: 54.49
Distance to disturbance	56.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (310 deg from N)				Side2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	58.1	3,756.6	3,692.1	3,626.3	3,691.7	3,713.7	3,692.1	3,735.3	3,713.7
2	53.7	3,984.5	4,083.9	4,064.2	4,044.2	4,024.6	4,024.6	4,044.4	4,031.2
3	48.4	4,044.4	4,238.0	4,122.9	4,135.1	3,923.7	3,923.7	3,944.1	3,930.5
4	40.6	4,103.5	4,064.2	4,064.2	4,077.3	4,044.4	4,238.0	4,004.6	4,095.7
Center	30.0	4,083.9	4,122.9	4,083.9	4,096.9	4,044.4	4,083.9	4,064.2	4,064.2
5	19.4	4,122.9	4,044.4	4,004.6	4,057.3	4,161.7	4,103.5	4,103.5	4,122.9
6	11.6	4,004.6	4,161.7	4,142.4	4,102.9	4,142.4	4,161.7	4,044.4	4,116.2
7	6.3	4,024.6	4,044.4	3,964.3	4,011.1	3,923.7	4,004.6	3,964.3	3,964.2
8	1.9	3,514.0	3,559.4	3,581.8	3,551.7	3,491.1	3,491.1	3,536.8	3,506.3
Averages ---------->		3,959.9	4,001.2	3,961.6	3,974.2	3,941.1	3,969.2	3,938.0	3,949.4

All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	3961.8		Mean	4075.0	4046.4	4060.7
Min Point	3506.3	-11.5%	Std. Dev.	41.3	75.1	60.1
Max Point	4135.1	4.4%	COV as %	1.0	1.9	**1.5**

Flow w/o C-Pt	77499 cfm	**Instuments Used:**	Cal Due
Vel Avg w/o C-Pt	3947 fpm	Standard pitot (ID: BST8, 8ft)	Post-test inspection
		Digi-sense 20250-13 Manometer	9/15/2020
		Workhorse Thermometer	Verified prior to each field use

	Start	Finish	
Stack temp	67	66	F
Equipment temp	56.6	57.2	F
Ambient temp	56.6	57.2	F
Stack static	2.9	2.4	mbars
Ambient pressure	985.8	985.8	mbars
Total Stack pressure	988.7	988.2	mbars
Ambient humidity	37%	35%	RH



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

Stack	LB-S1	Run No.	VT-14
Date	10/19/19	Fan Configuration	Fan A & B
Testers	ZDH/LCE	Fan Setting	NA Hz
Stack Dia.	60 in.	Stack Temp	61.75 deg F
Stack X-Area	2827.4 in.2	Start/End Time	9:17 9:24
Test Port	1	Center 2/3 from	5.51 to: 54.49
Distance to disturbance	56.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (310 deg from N)				Side2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	58.1	3,949.1	4,029.8	4,009.7	3,996.2	4,029.8	4,108.8	3,989.6	4,042.7
2	53.7	4,089.1	4,167.0	4,069.4	4,108.5	4,089.1	4,167.0	4,205.5	4,153.9
3	48.4	4,049.6	4,029.8	3,989.6	4,023.0	4,167.0	4,128.2	4,167.0	4,154.1
4	40.6	3,969.5	3,949.1	4,029.8	3,982.8	4,029.8	3,949.1	4,009.7	3,996.2
Center	30.0	3,969.5	3,989.6	3,969.5	3,976.2	4,089.1	4,009.7	4,009.7	4,036.2
5	19.4	4,108.8	4,108.8	4,089.1	4,102.2	4,049.6	4,167.0	4,147.7	4,121.5
6	11.6	4,243.4	4,147.7	4,167.0	4,186.1	4,224.5	4,029.8	3,949.1	4,067.8
7	6.3	4,281.2	3,803.9	3,866.8	3,984.0	4,089.1	4,108.8	3,908.1	4,035.3
8	1.9	3,825.0	3,866.8	3,908.1	3,866.7	3,740.1	3,782.8	3,653.0	3,725.3
Averages ---------->		4,053.9	4,010.3	4,011.0	4,025.1	4,056.4	4,050.1	4,004.4	4,037.0

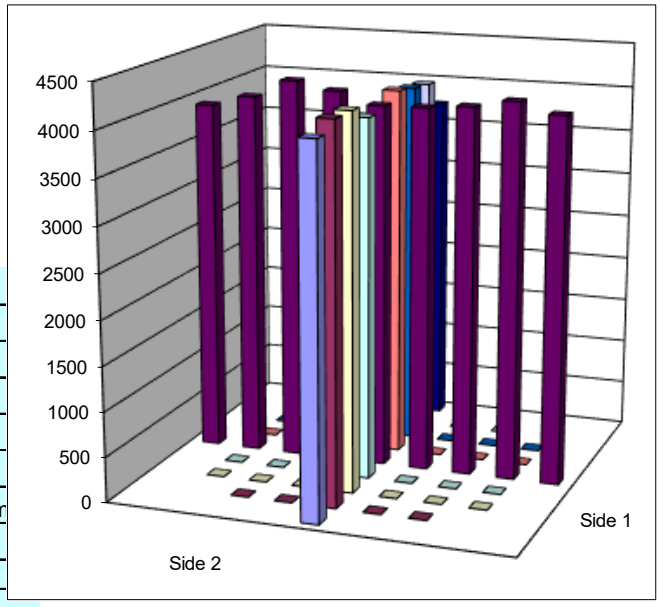
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4031.0		Mean	4051.8	4080.7	4066.3
Min Point	3725.3	-7.6%	Std. Dev.	81.3	62.9	71.4
Max Point	4186.1	3.8%	COV as %	2.0	1.5	**1.8**

Flow w/o C-Pt 79210 cfm

Vel Avg w/o C-Pt 4034 fpm

	Start	Finish	
Stack temp	61.70	61.80	F
Equipment temp	40.90	48.70	F
Ambient temp	40.90	48.70	F
Stack static	2.39	2.09	mbars
Ambient pressure	975.28	975.62	mbars
Total Stack pressure	977.67	977.71	mbars
Ambient humidity	80%	79%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST8, 8ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

Appendix C – LB-S2 Stack Verification Data Sheets

C.1 Flow Angle Data Forms

FLOW ANGLE DATA FORM

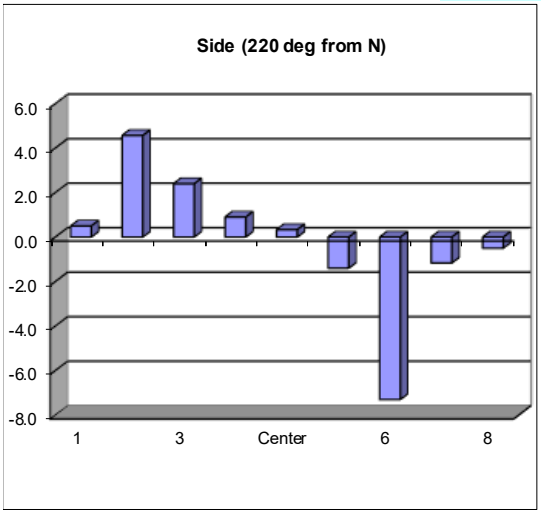
Stack	LB-S2	Run No.	FA-1
Date	10/15/2019	Fan Setting	N/A Hz
Start/End Time	14:15 14:30	Fan Configuration	Fan A
Testers	ZDH/LCE	Stack Temp	68 deg F
Stack Dia.	28 in		
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

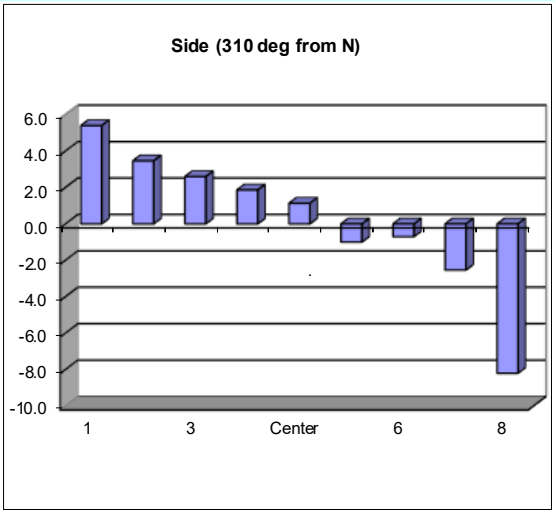
Order -->		First				Second			
Traverse-->		Side 1 (220 deg from N)				Side 2 (310 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	27.1	1.2	0.2	0.1	0.5	5.5	5.6	5.1	5.4
2	25.1	4.3	4.3	5.1	4.6	3.5	2.7	4.2	3.5
3	22.6	2.0	2.7	2.5	2.4	1.7	2.8	3.3	2.6
4	19.0	1.3	0.6	0.8	0.9	2.2	1.6	1.8	1.9
Center	14.0	0.6	0.2	0.2	0.3	1.1	0.5	1.8	1.1
5	9.0	-1.6	-1.4	-1.2	-1.4	-2.0	-0.8	-0.2	-1.0
6	5.4	-7.5	-7.3	-7.1	-7.3	-0.2	-1.4	-0.5	-0.7
7	2.9	-1.2	-1.1	-1.2	-1.2	-4.0	-1.7	-1.9	-2.5
8	0.9	-0.2	-0.5	-0.8	-0.5	-9.7	-6.7	-8.2	-8.2
Mean of absolute values:					2.1				3.0
" " w/o points by wall:					2.6				1.9
								Grand mean ABS	2.6
								Grand mean ABS w/o wall pts	2.2

Instuments Used:		Cal. Due
S-type pitot (ID: 7A, 7ft)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuracy check prior to each use; filed recalibration as necessar
Fluid Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle.
Approx. air velocity was derived from all points on the Velocity Traverse Forms





FLOW ANGLE DATA FORM

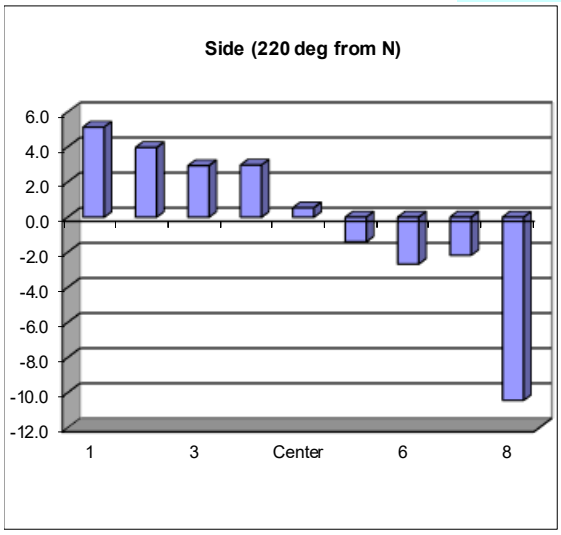
Stack	LB-S2	Run No.	FA-2
Date	10/15/2019	Fan Setting	N/A Hz
Start/End Time	15:55 16:04	Fan Configuration	Fan A
Testers	ZDH/LCE	Stack Temp	68.9 deg F
Stack Dia.	28 in		
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

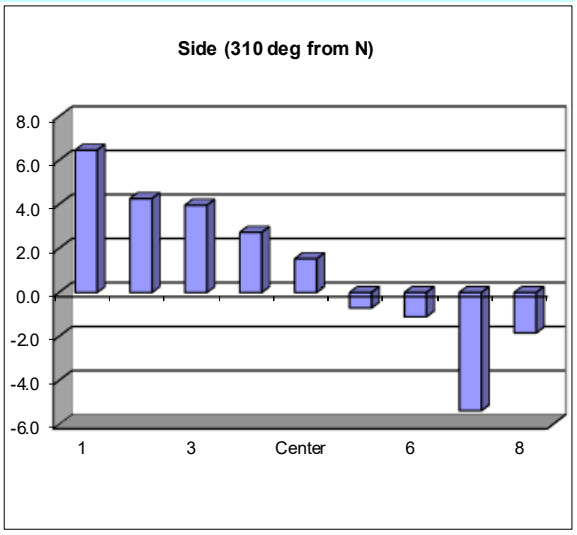
Order -->	First				Second			
Traverse-->	Side 1 (220 deg from N)				Side 2 (310 deg from N)			
Trial ---->	1	2	3	Mean	1	2	3	Mean
Point / Depth, in.	deg. cw				deg. cw			
1 / 27.1	4.6	5.7	5.1	5.1	6.4	7.8	5.2	6.5
2 / 25.1	3.9	4.5	3.5	4.0	3.4	4.7	4.7	4.3
3 / 22.6	3.1	2.7	3.0	2.9	5.3	1.9	4.7	4.0
4 / 19.0	2.6	3.4	2.9	3.0	2.7	3.2	2.3	2.7
Center / 14.0	0.0	1.2	0.4	0.5	2.2	1.1	1.3	1.5
5 / 9.0	-2.0	-1.3	-0.9	-1.4	-0.3	-0.8	-1.0	-0.7
6 / 5.4	-2.5	-2.8	-2.7	-2.7	-1.4	-1.2	-0.7	-1.1
7 / 2.9	-2.6	-2.8	-1.1	-2.2	-5.8	-5.5	-4.8	-5.4
8 / 0.9	-10.8	-10.2	-10.3	-10.4	-3.4	-1.6	-0.5	-1.8
Mean of absolute values:				3.6				3.1
" " w/o points by wall:				2.4				2.8
							Grand mean ABS	3.3
							Grand mean ABS w/o wall pts	2.6

Instuments Used:		Cal. Due
S-type pitot (ID: 7A, 7ft)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuracy check prior to each use; filed recalibration as necessar
Fluid Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle.
Approx. air velocity was derived from all points on the Velocity Traverse Forms





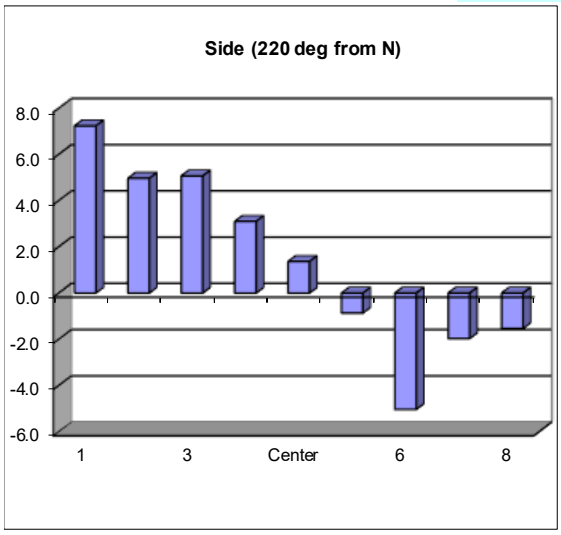
FLOW ANGLE DATA FORM

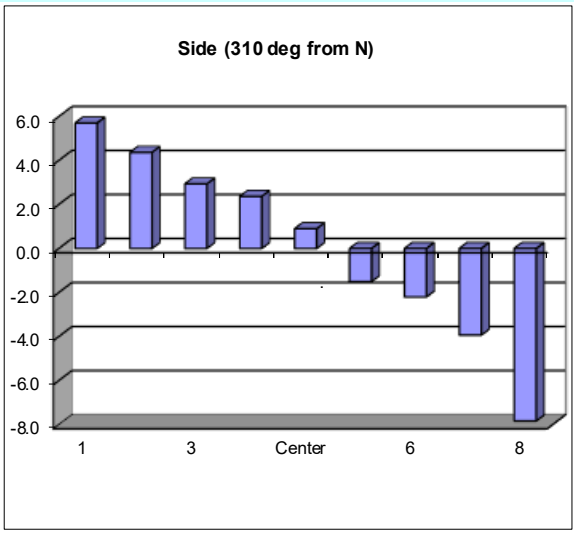
Stack	LB-S2	Run No.	FA-3
Date	10/16/2019	Fan Setting	N/A Hz
Start/End Time	9:52 10:01	Fan Configuration	Fan A
Testers	ZDH/LCE	Stack Temp	66.8 deg F
Stack Dia.	28 in		
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

Order -->	First				Second				
Traverse-->	Side 1 (220 deg from N)				Side 2 (310 deg from N)				
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	27.1	8.0	7.1	6.6	7.2	6.3	4.7	6.1	5.7
2	25.1	5.9	4.8	4.2	5.0	4.5	4.3	4.3	4.4
3	22.6	5.3	5.1	4.8	5.1	4.0	2.6	2.2	2.9
4	19.0	3.6	3.3	2.4	3.1	2.1	2.3	2.7	2.4
Center	14.0	0.8	1.6	1.7	1.4	1.0	0.9	0.8	0.9
5	9.0	-1.6	-0.7	-0.3	-0.9	-1.6	-1.4	-1.5	-1.5
6	5.4	-5.2	-4.9	-5.0	-5.0	-2.6	-2.1	-1.9	-2.2
7	2.9	-1.8	-1.9	-2.2	-2.0	-4.0	-3.8	-4.0	-3.9
8	0.9	-2.3	-1.2	-1.1	-1.5	-7.9	-8.1	-7.5	-7.8
Mean of absolute values:					3.5				3.5
" " w/o points by wall:					3.2				2.6
								Grand mean ABS	3.5
Instuments Used:					**Cal. Due**			Grand mean ABS w/o wall pts	2.9
S-type pitot (ID: 7A, 7ft)					Post-test				
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)				Accuracy check prior to each use; filed recalibration as necessar				
Fluid Manometer	5D				Primary standard				

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle.
Approx. air velocity was derived from all points on the Velocity Traverse Forms





FLOW ANGLE DATA FORM

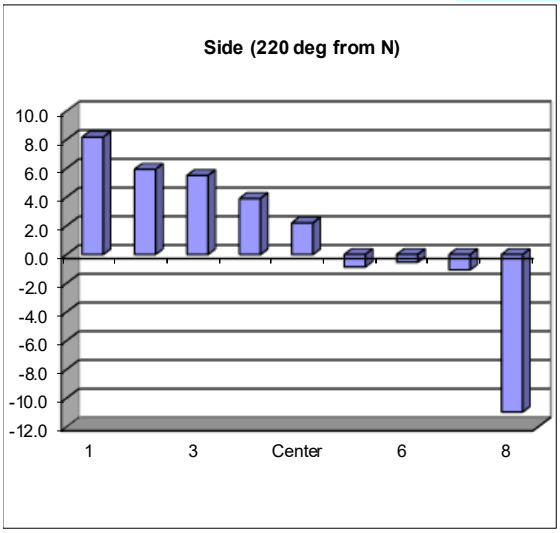
Stack	LB-S2	Run No.	FA-4
Date	10/16/2019	Fan Setting	N/A Hz
Start/End Time	11:21 11:29	Fan Configuration	Fan A
Testers	ZDH/LCE	Stack Temp	68.3 deg F
Stack Dia.	28 in		
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

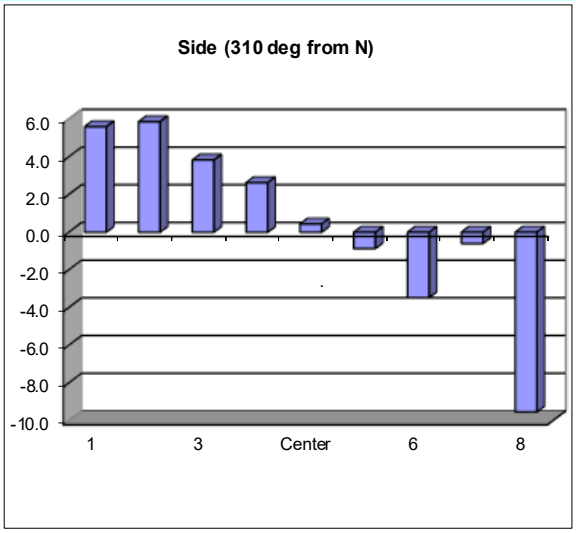
Order -->	First				Second				
Traverse-->	Side 1 (220 deg from N)				Side 2 (310 deg from N)				
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	27.1	7.9	9.7	6.9	8.2	4.6	5.9	6.3	5.6
2	25.1	5.9	5.9	6.0	5.9	6.5	6.0	5.1	5.9
3	22.6	5.7	5.2	5.6	5.5	4.4	3.6	3.5	3.8
4	19.0	3.1	4.4	4.2	3.9	2.8	2.6	2.5	2.6
Center	14.0	2.3	2.4	1.9	2.2	0.1	0.4	0.8	0.4
5	9.0	-1.2	-0.8	-0.6	-0.9	-0.9	-1.3	-0.4	-0.9
6	5.4	-1.0	-0.5	-0.1	-0.5	-4.2	-4.9	-1.3	-3.5
7	2.9	-1.1	-0.7	-1.4	-1.1	-0.6	-0.5	-0.7	-0.6
8	0.9	-11.2	-11.5	-10.2	-11.0	-9.5	-9.3	-9.8	-9.5
Mean of absolute values:					4.3				3.6
" " w/o points by wall:					2.9				2.5
								Grand mean ABS	4.0
								Grand mean ABS w/o wall pts	2.7

Instuments Used:		Cal. Due
S-type pitot (ID: 7A, 7ft)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuracy check prior to each use; filed recalibration as necessar
Fluid Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle.
Approx. air velocity was derived from all points on the Velocity Traverse Forms





FLOW ANGLE DATA FORM

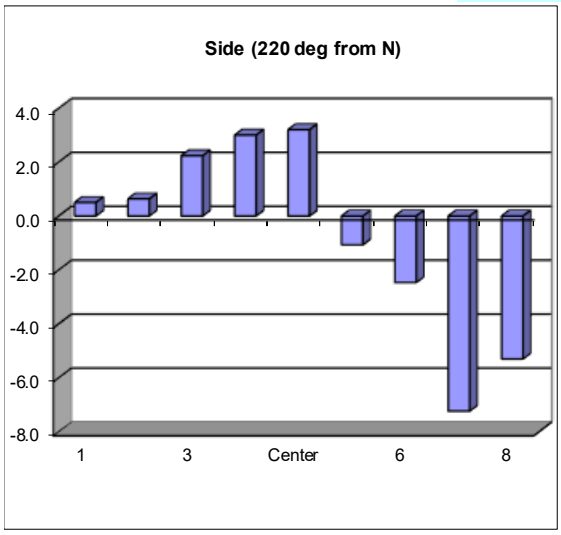
Stack	LB-S2	Run No.	FA-5
Date	10/16/2019	Fan Setting	N/A Hz
Start/End Time	13:27 13:33	Fan Configuration	Fan A
Testers	ZDH/LCE	Stack Temp	68.7 deg F
Stack Dia.	28 in		
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

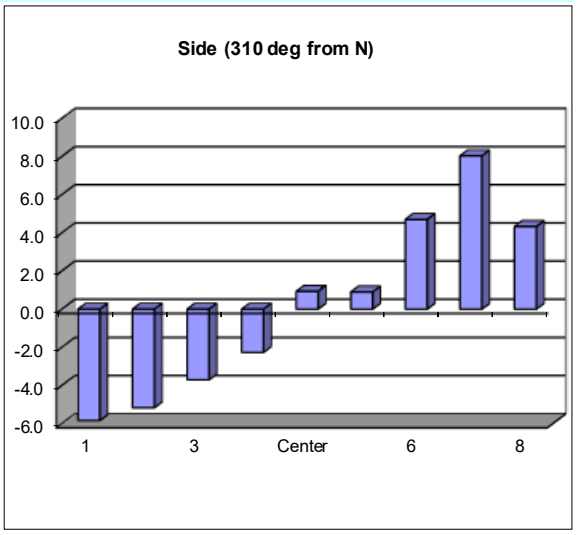
Order -->		First				Second			
Traverse-->		Side 1 (220 deg from N)				Side 2 (310 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	27.1	0.5	0.5	0.5	0.5	-7.1	-5.4	-5.0	-5.8
2	25.1	0.7	0.6	0.6	0.6	-3.4	-6.1	-6.0	-5.2
3	22.6	0.7	3.3	2.7	2.2	-3.2	-3.7	-4.2	-3.7
4	19.0	3.2	3.0	2.8	3.0	-2.4	-1.8	-2.6	-2.3
Center	14.0	3.2	2.8	3.6	3.2	1.5	0.8	0.5	0.9
5	9.0	-0.9	-1.0	-1.3	-1.1	0.2	1.5	1.0	0.9
6	5.4	-5.0	-0.9	-1.5	-2.5	4.8	4.7	4.6	4.7
7	2.9	-7.2	-7.7	-6.8	-7.2	8.1	8.8	7.2	8.0
8	0.9	-6.9	-5.8	-3.2	-5.3	4.8	3.4	4.8	4.3
Mean of absolute values:					2.8				4.0
" " w/o points by wall:					2.8				3.7
								Grand mean ABS	3.4
								Grand mean ABS w/o wall pts	3.3

Instuments Used:		Cal. Due
S-type pitot (ID: 7A, 7ft)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuracy check prior to each use; filed recalibration as necessar
Fluid Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle.
Approx. air velocity was derived from all points on the Velocity Traverse Forms





FLOW ANGLE DATA FORM

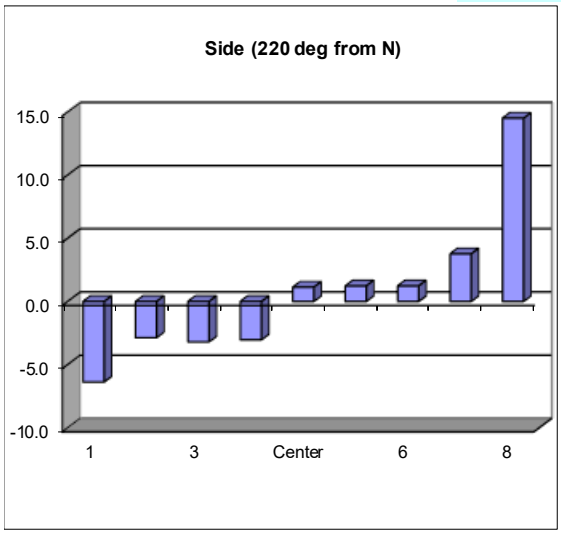
Stack	LB-S2	Run No.	FA-6
Date	10/16/2019	Fan Setting	N/A Hz
Start/End Time	14:34 14:40	Fan Configuration	Fan A
Testers	ZDH/LCE	Stack Temp	69.1 deg F
Stack Dia.	28 in		
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

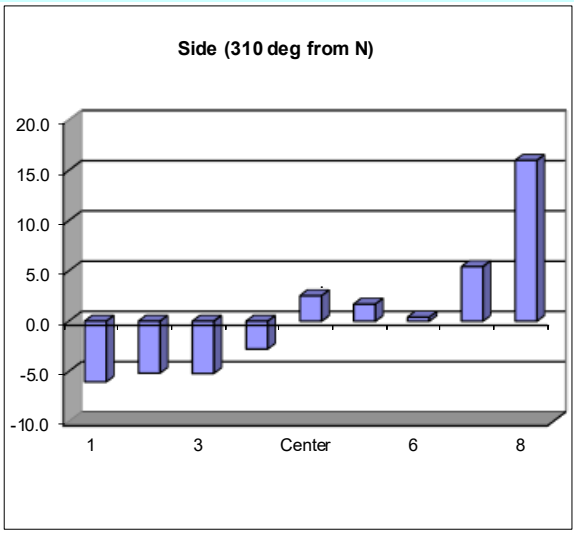
Order -->	First				Second			
Traverse-->	Side 1 (220 deg from N)				Side 2 (310 deg from N)			
Trial ---->	1	2	3	Mean	1	2	3	Mean
Point / Depth, in.	deg. cw				deg. cw			
1 / 27.1	-4.0	-7.7	-7.4	-6.4	-6.3	-5.8	-6.0	-6.0
2 / 25.1	-3.0	-2.7	-2.9	-2.9	-5.4	-5.0	-5.1	-5.2
3 / 22.6	-2.8	-3.3	-3.5	-3.2	-5.6	-4.9	-5.1	-5.2
4 / 19.0	-3.4	-2.7	-3.0	-3.0	-3.0	-2.6	-2.7	-2.8
Center / 14.0	0.8	1.2	1.4	1.1	2.7	2.4	2.5	2.5
5 / 9.0	1.4	1.2	1.1	1.2	1.1	1.4	2.6	1.7
6 / 5.4	1.1	1.0	1.6	1.2	0.1	0.4	0.7	0.4
7 / 2.9	3.6	3.7	4.0	3.8	6.2	5.7	4.4	5.4
8 / 0.9	14.5	14.9	14.1	14.5	15.2	16.5	16.3	16.0
Mean of absolute values:				4.1				5.0
" " w/o points by wall:				2.4				3.3
							Grand mean ABS	4.6
							Grand mean ABS w/o wall pts	2.8

Instuments Used:		Cal. Due
S-type pitot (ID: 7A, 7ft)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuracy check prior to each use; filed recalibration as necessar
Fluid Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle.
Approx. air velocity was derived from all points on the Velocity Traverse Forms





FLOW ANGLE DATA FORM

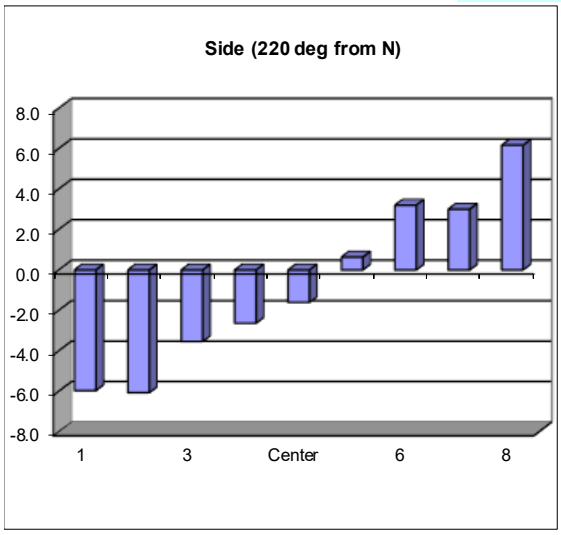
Stack	LB-S2	Run No.	FA-7
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	9:43 9:51	Fan Configuration	Fan A
Testers	ZDH/LCE	Stack Temp	69.2 deg F
Stack Dia.	28 in		
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		
Order -->	First	Second	

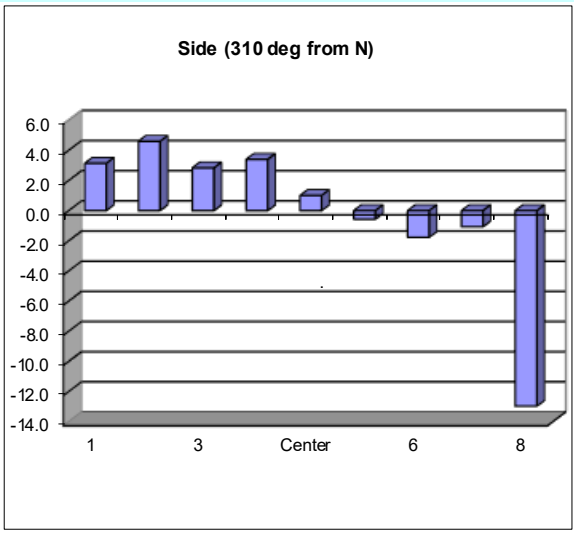
Traverse-->		Side 1 (220 deg from N)				Side 2 (310 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	27.1	-5.9	-5.4	-6.6	-6.0	3.2	3.1	3.1	3.1
2	25.1	-6.1	-5.8	-6.3	-6.1	4.6	5.0	4.2	4.6
3	22.6	-4.2	-3.8	-2.6	-3.5	2.5	3.2	2.8	2.8
4	19.0	-3.3	-2.3	-2.3	-2.6	4.2	3.3	2.7	3.4
Center	14.0	-1.7	-1.1	-2.0	-1.6	0.9	0.9	1.2	1.0
5	9.0	0.8	0.3	0.8	0.6	-0.1	-1.1	-0.5	-0.6
6	5.4	1.6	2.5	5.5	3.2	-1.8	-1.6	-1.9	-1.8
7	2.9	4.0	2.3	2.7	3.0	-0.7	-1.1	-1.4	-1.1
8	0.9	6.2	6.5	5.8	6.2	-13.9	-12.7	-12.3	-13.0
Mean of absolute values:					3.6				3.5
" " w/o points by wall:					3.0				2.2
								Grand mean ABS	3.6
								Grand mean ABS w/o wall pts	2.6

Instuments Used:		Cal. Due
S-type pitot (ID: 7A, 7ft)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuracy check prior to each use; filed recalibration as necessar
Fluid Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle.
Approx. air velocity was derived from all points on the Velocity Traverse Forms





FLOW ANGLE DATA FORM

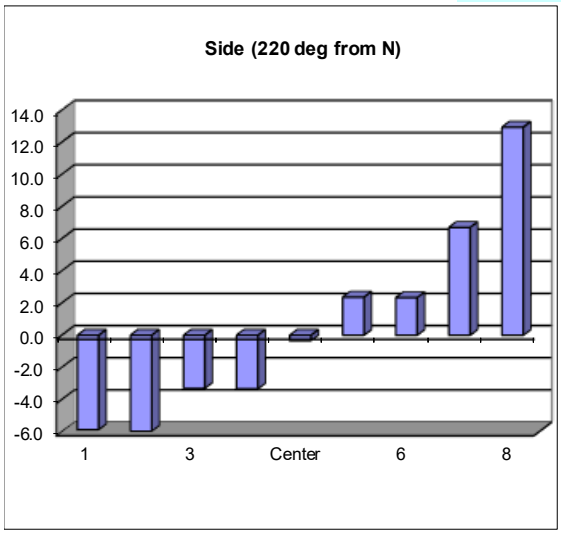
Stack	LB-S2	Run No.	FA-8
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	10:52 11:00	Fan Configuration	Fan B Only
Testers	ZDH/LCE	Stack Temp	69.2 deg F
Stack Dia.	28 in		
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

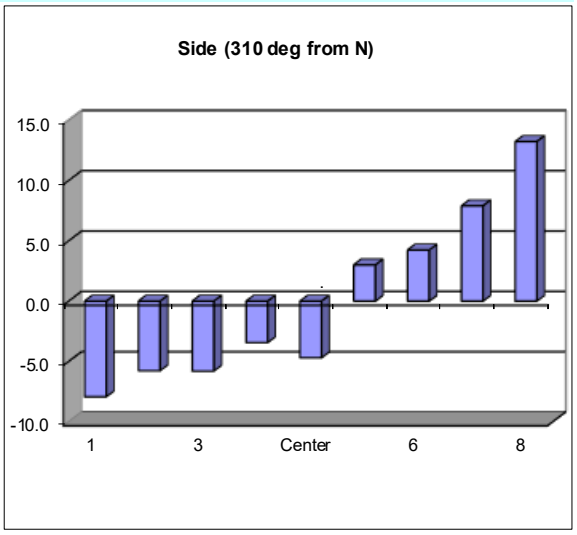
Order -->		First				Second			
Traverse-->		Side 1 (220 deg from N)				Side 2 (310 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	27.1	-7.6	-4.3	-5.7	-5.9	-8.2	-7.9	-7.7	-7.9
2	25.1	-5.7	-6.5	-5.7	-6.0	-6.7	-5.3	-5.3	-5.8
3	22.6	-5.4	-3.2	-1.3	-3.3	-6.3	-5.8	-5.3	-5.8
4	19.0	-2.9	-5.4	-1.7	-3.3	-4.8	-2.8	-2.7	-3.4
Center	14.0	-0.2	-0.7	-0.1	-0.3	-5.2	-4.7	-4.2	-4.7
5	9.0	3.1	2.8	1.2	2.4	4.8	2.0	2.2	3.0
6	5.4	2.8	2.0	2.2	2.3	4.4	4.3	4.0	4.2
7	2.9	6.9	6.5	6.7	6.7	7.4	8.1	8.2	7.9
8	0.9	13.4	13.0	12.4	12.9	13.8	12.5	13.4	13.2
Mean of absolute values:					4.8				6.2
" " w/o points by wall:					3.5				5.0
								Grand mean ABS	5.5
								Grand mean ABS w/o wall pts	4.2

Instuments Used:		Cal. Due
S-type pitot (ID: 7A, 7ft)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuracy check prior to each use; filed recalibration as necessar
Fluid Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle.
Approx. air velocity was derived from all points on the Velocity Traverse Forms





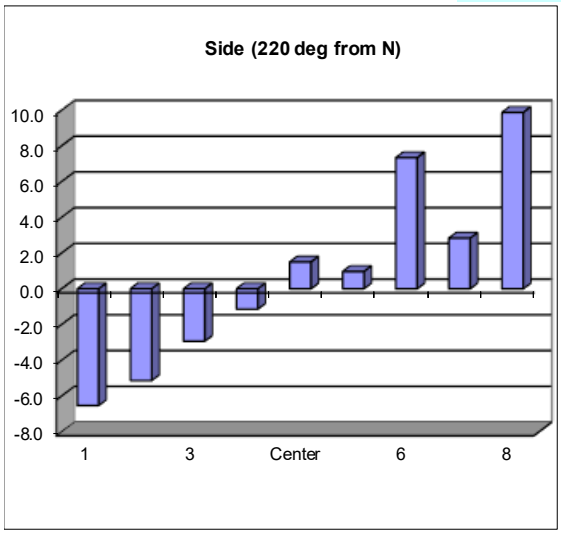
FLOW ANGLE DATA FORM

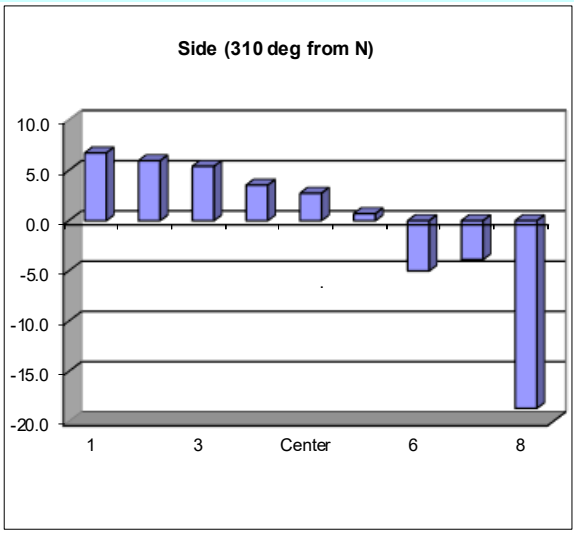
Stack	LB-S2	Run No.	FA-9
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	13:20 13:27	Fan Configuration	Fan B Only
Testers	ZDH/LCE	Stack Temp	70.6 deg F
Stack Dia.	28 in		
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

Order -->	First				Second				
Traverse-->	Side 1 (220 deg from N)				Side 2 (310 deg from N)				
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	27.1	-6.6	-6.8	-6.2	-6.5	6.4	7.5	6.3	6.7
2	25.1	-5.1	-5.6	-4.7	-5.1	6.1	5.8	6.0	6.0
3	22.6	-2.7	-2.8	-3.3	-2.9	5.5	5.8	4.9	5.4
4	19.0	-0.9	-1.3	-1.2	-1.1	3.5	3.3	3.8	3.5
Center	14.0	1.8	1.1	1.6	1.5	2.4	2.9	2.9	2.7
5	9.0	1.0	0.7	1.2	1.0	0.6	1.0	0.5	0.7
6	5.4	7.6	7.3	7.1	7.3	-4.9	-5.0	-5.1	-5.0
7	2.9	2.5	3.3	2.7	2.8	-3.9	-4.2	-3.5	-3.9
8	0.9	9.2	10.0	10.4	9.9	-18.2	-18.7	-19.1	-18.7
Mean of absolute values:					4.2				5.8
" " w/o points by wall:					3.1				3.9
								Grand mean ABS	5.0
Instuments Used:					**Cal. Due**			Grand mean ABS w/o wall pts	3.5
S-type pitot (ID: 7A, 7ft)					Post-test				
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)				Accuracy check prior to each use; filed recalibration as necessar				
Fluid Manometer	5D				Primary standard				

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle.
Approx. air velocity was derived from all points on the Velocity Traverse Forms





FLOW ANGLE DATA FORM

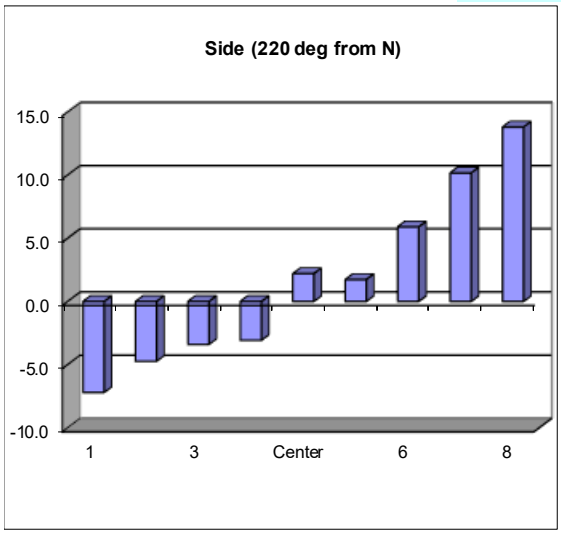
Stack	LB-S2	Run No.	FA-10
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	14:45 14:52	Fan Configuration	Fan B
Testers	ZDH/LCE	Stack Temp	70.2 deg F
Stack Dia.	28 in		
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

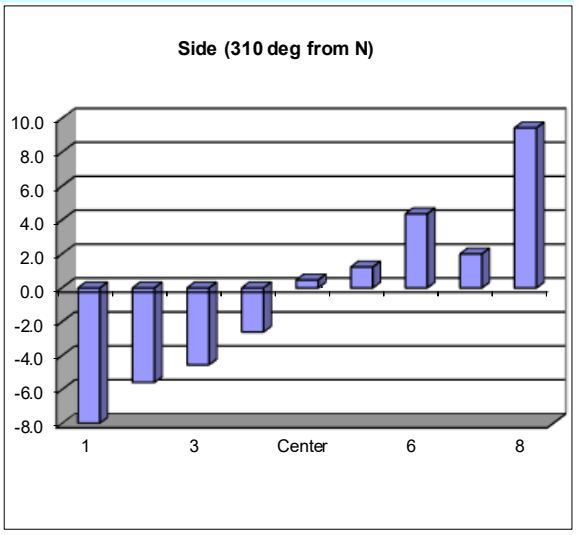
Order -->	First				Second				
Traverse-->	Side 1 (220 deg from N)				Side 2 (310 deg from N)				
Trial ---->	1	2	3	Mean	1	2	3	Mean	
Point	Depth, in.	deg. cw				deg. cw			
1	27.1	-8.4	-6.6	-6.6	-7.2	-8.4	-7.4	-8.1	-8.0
2	25.1	-5.7	-4.2	-4.3	-4.7	-6.1	-4.5	-6.1	-5.6
3	22.6	-3.4	-3.9	-2.9	-3.4	-4.6	-4.9	-4.1	-4.5
4	19.0	-2.9	-3.1	-3.2	-3.1	-2.5	-3.5	-1.8	-2.6
Center	14.0	2.6	2.5	1.5	2.2	0.8	0.5	0.1	0.5
5	9.0	1.2	2.2	1.8	1.7	2.0	1.2	0.5	1.2
6	5.4	5.3	6.1	6.3	5.9	4.1	4.8	4.2	4.4
7	2.9	11.7	9.3	9.5	10.2	2.1	1.9	2.0	2.0
8	0.9	14.2	13.5	13.7	13.8	10.0	9.8	8.5	9.4
Mean of absolute values:					5.8				4.2
" " w/o points by wall:					4.5				3.0
								Grand mean ABS	5.0
								Grand mean ABS w/o wall pts	3.7

Instuments Used:		Cal. Due
S-type pitot (ID: 7A, 7ft)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuracy check prior to each use; filed recalibration as necessar
Fluid Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle.
Approx. air velocity was derived from all points on the Velocity Traverse Forms





FLOW ANGLE DATA FORM

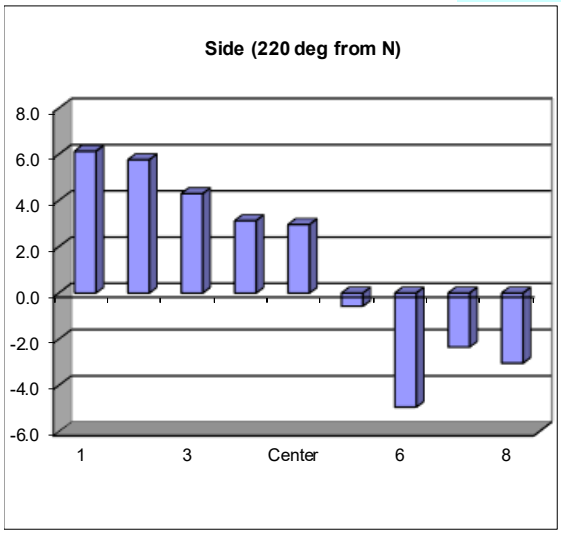
Stack	LB-S2	Run No.	FA-11
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	15:52 15:57	Fan Configuration	Fan B
Testers	ZDH/LCE	Stack Temp	70.4 deg F
Stack Dia.	28 in		
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

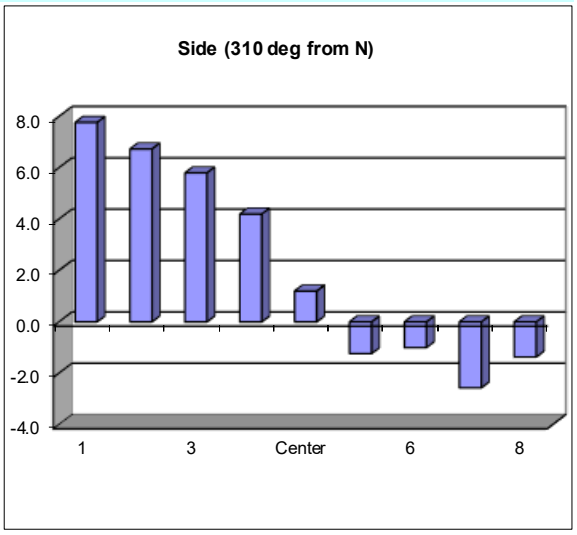
Order -->	First				Second				
Traverse-->	Side 1 (220 deg from N)				Side 2 (310 deg from N)				
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	27.1	6.4	6.1	5.9	6.1	8.3	7.4	7.6	7.8
2	25.1	5.5	5.8	6.0	5.8	6.7	6.9	6.6	6.7
3	22.6	4.0	4.6	4.3	4.3	6.4	5.4	5.6	5.8
4	19.0	4.1	2.7	2.6	3.1	3.4	4.8	4.4	4.2
Center	14.0	2.6	3.1	3.2	3.0	1.3	1.2	1.1	1.2
5	9.0	-0.8	-0.6	-0.3	-0.6	-0.9	-1.3	-1.5	-1.2
6	5.4	-4.8	-5.1	-4.9	-4.9	-0.8	-1.2	-1.0	-1.0
7	2.9	-2.2	-2.3	-2.5	-2.3	-2.4	-2.6	-2.7	-2.6
8	0.9	-3.6	-2.8	-2.7	-3.0	-0.6	-1.8	-1.7	-1.4
Mean of absolute values:					3.7				3.5
" " w/o points by wall:					3.4				3.2
								Grand mean ABS	3.6
								Grand mean ABS w/o wall pts	3.3

Instuments Used:		Cal. Due
S-type pitot (ID: 7A, 7ft)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuracy check prior to each use; filed recalibration as necessar
Fluid Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle.
Approx. air velocity was derived from all points on the Velocity Traverse Forms





FLOW ANGLE DATA FORM

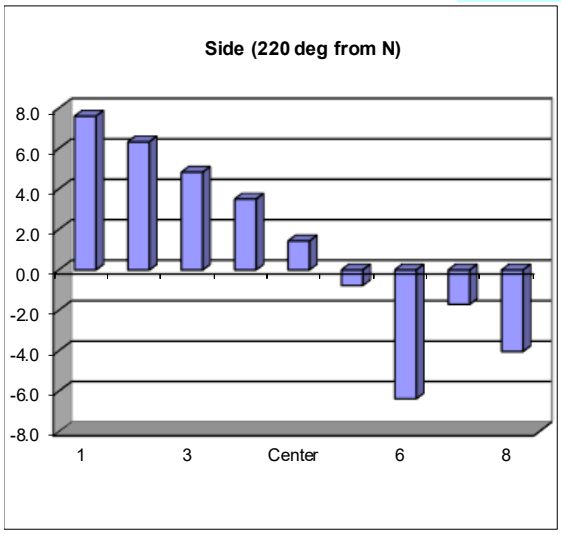
Stack	LB-S2	Run No.	FA-12
Date	10/18/2019	Fan Setting	N/A Hz
Start/End Time	9:31 9:37	Fan Configuration	Fan B
Testers	ZDH/LCE	Stack Temp	67.8 deg F
Stack Dia.	28 in		
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

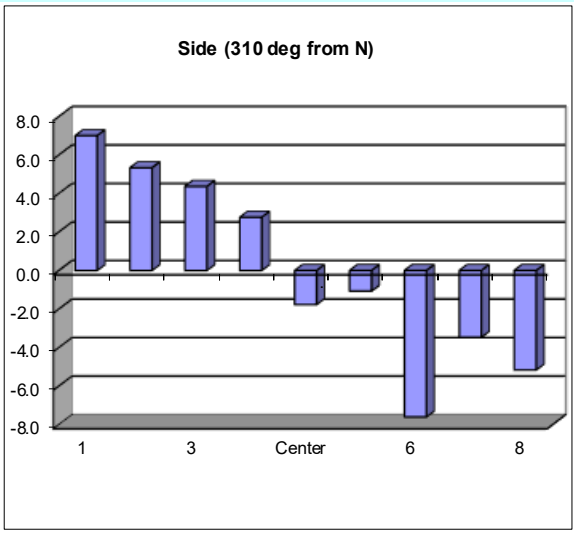
Order -->	First				Second				
Traverse-->	Side 1 (220 deg from N)				Side 2 (310 deg from N)				
Trial ---->	1	2	3	Mean	1	2	3	Mean	
Point	Depth, in.	deg. cw				deg. cw			
1	27.1	7.7	7.6	7.5	7.6	7.6	6.9	6.5	7.0
2	25.1	7.1	5.2	6.7	6.3	5.6	5.0	5.4	5.3
3	22.6	5.3	4.6	4.6	4.8	4.6	4.1	4.4	4.4
4	19.0	3.5	3.1	3.9	3.5	2.4	3.1	2.8	2.8
Center	14.0	1.8	1.0	1.5	1.4	-2.1	-2.2	-1.0	-1.8
5	9.0	-1.3	-0.7	-0.3	-0.8	-1.3	-0.8	-1.1	-1.1
6	5.4	-7.1	-6.2	-5.8	-6.4	-7.4	-7.9	-7.5	-7.6
7	2.9	-1.2	-1.1	-2.8	-1.7	-3.1	-3.4	-3.9	-3.5
8	0.9	-4.1	-4.5	-3.5	-4.0	-4.5	-6.2	-4.8	-5.2
Mean of absolute values:					4.1				4.3
" " w/o points by wall:					3.6				3.8
								Grand mean ABS	4.2
								Grand mean ABS w/o wall pts	3.7

Instuments Used:		Cal. Due
S-type pitot (ID: 7A, 7ft)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuracy check prior to each use; filed recalibration as necessar
Fluid Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle.
Approx. air velocity was derived from all points on the Velocity Traverse Forms





FLOW ANGLE DATA FORM

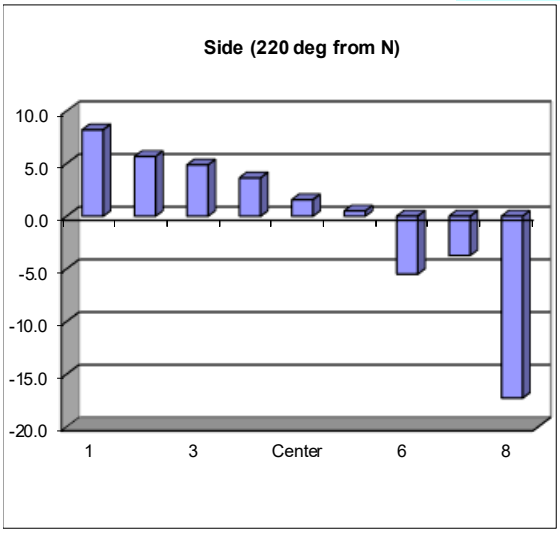
Stack	LB-S2	Run No.	FA-13
Date	10/18/2019	Fan Setting	N/A Hz
Start/End Time	10:39 19:46	Fan Configuration	Fan B
Testers	ZDH/LCE	Stack Temp	67.7 deg F
Stack Dia.	28 in		
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

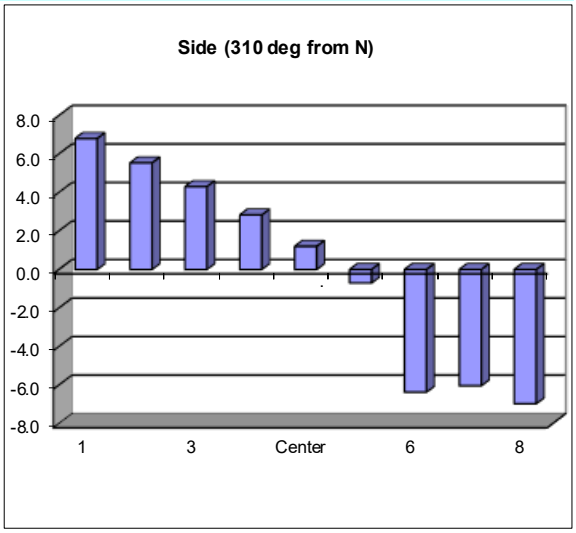
Order -->	First				Second			
Traverse-->	Side 1 (220 deg from N)				Side 2 (310 deg from N)			
Trial ---->	1	2	3	Mean	1	2	3	Mean
Point / Depth, in.	deg. cw				deg. cw			
1 / 27.1	8.8	7.7	8.1	8.2	7.4	6.8	6.2	6.8
2 / 25.1	5.5	5.8	5.7	5.7	5.7	5.4	5.5	5.5
3 / 22.6	4.5	5.2	4.9	4.9	4.4	4.3	4.2	4.3
4 / 19.0	3.6	3.9	3.4	3.6	2.8	3.1	2.6	2.8
Center / 14.0	1.6	1.3	1.8	1.6	0.5	1.4	1.7	1.2
5 / 9.0	0.7	0.5	0.3	0.5	-0.5	-0.7	-0.9	-0.7
6 / 5.4	-6.4	-5.5	-4.6	-5.5	-6.5	-6.2	-6.4	-6.4
7 / 2.9	-4.2	-3.8	-3.2	-3.7	-6.3	-6.0	-5.8	-6.0
8 / 0.9	-17.0	-18.1	-16.7	-17.3	-7.8	-6.5	-6.6	-7.0
Mean of absolute values:				5.7				4.5
" " w/o points by wall:				3.6				3.9
							Grand mean ABS	5.1
							Grand mean ABS w/o wall pts	3.7

Instuments Used:		Cal. Due
S-type pitot (ID: 7A, 7ft)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuracy check prior to each use; filed recalibration as necessar
Fluid Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle.
Approx. air velocity was derived from all points on the Velocity Traverse Forms





FLOW ANGLE DATA FORM

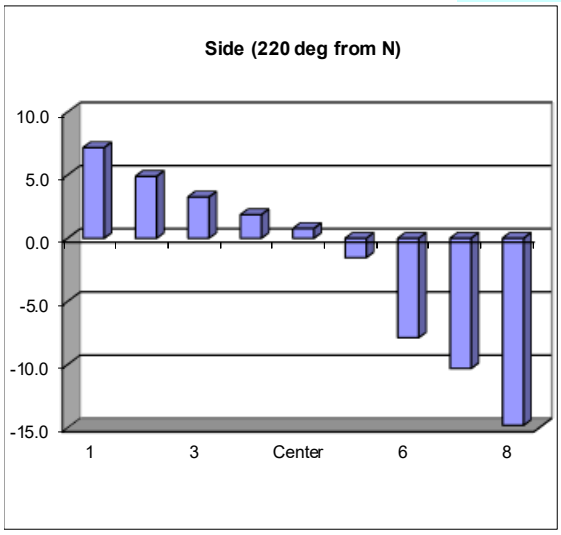
Stack	LB-S2	Run No.	FA-14
Date	10/19/2019	Fan Setting	N/A Hz
Start/End Time	9:45 9:51	Fan Configuration	Fan B
Testers	ZDH/LCE	Stack Temp	66.6 deg F
Stack Dia.	28 in		
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

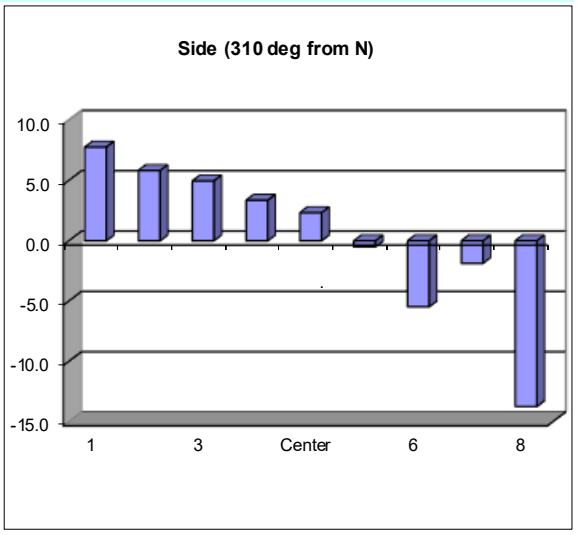
		Side 1 (220 deg from N)				Side 2 (310 deg from N)			
Order -->		First				Second			
Traverse-->									
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	27.1	6.7	7.0	7.8	7.2	8.2	7.8	7.3	7.8
2	25.1	4.4	5.7	4.6	4.9	6.2	5.6	5.7	5.8
3	22.6	3.2	3.7	2.9	3.3	4.8	5.0	5.1	5.0
4	19.0	2.3	2.1	1.2	1.9	3.4	3.4	3.3	3.4
Center	14.0	0.0	1.1	1.2	0.8	2.5	2.2	2.3	2.3
5	9.0	-1.7	-1.5	-1.4	-1.5	-0.5	-0.7	-0.3	-0.5
6	5.4	-7.6	-8.1	-7.9	-7.9	-5.8	-5.4	-5.2	-5.5
7	2.9	-10.3	-10.1	-10.5	-10.3	-2.2	-1.7	-1.7	-1.9
8	0.9	-14.5	-14.7	-15.2	-14.8	-13.5	-13.9	-13.8	-13.7
Mean of absolute values:					5.8				5.1
" " w/o points by wall:					4.4				3.5
								Grand mean ABS	5.5
								Grand mean ABS w/o wall pts	3.9

Instuments Used:		Cal. Due
S-type pitot (ID: 7A, 7ft)		Post-test
Angle indicator	SPI Tronic PRO 360 (SN 31-038-3)	Accuracy check prior to each use; filed recalibration as necessar
Fluid Manometer	5D	Primary standard

Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:
Traverse point depth = the distance from inside stack wall to each point
Sign of flow angle indicates which direction the pitot was turned to achieve null angle.
Approx. air velocity was derived from all points on the Velocity Traverse Forms





C.2 Velocity Transverse Data Forms

VELOCITY TRAVERSE DATA FORM

Stack	**LB-S2**	Run No.	**VT-1**
Date	**10/15/19**	Fan Configuration	**Fan A**
Testers	ZDH/LCE	Fan Setting	**N/A** **Hz**
Stack Dia.	28 in.	Stack Temp	67.90 deg F
Stack X-Area	615.8 in.2	Start/End Time	14:07 14:13
Test Port	2	Center 2/3 from	2.57 to: 25.43
Distance to disturbance	57.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (XX deg from N)				Side2 (YY deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	27.1	3,820.2	3,799.2	3,862.0	3,827.1	3,326.6	3,203.7	3,444.9	3,325.1
2	25.1	4,123.1	3,984.6	4,004.7	4,037.5	3,882.7	3,923.8	4,044.5	3,950.3
3	22.6	4,350.3	4,219.2	4,350.3	4,306.6	4,161.8	4,200.2	4,064.3	4,142.1
4	19.0	4,387.0	4,405.2	4,275.8	4,356.0	4,331.7	4,350.3	4,275.8	4,319.3
Center	14.0	4,387.0	4,368.7	4,350.3	4,368.6	4,387.0	4,313.2	4,350.3	4,350.2
5	9.0	4,294.5	4,275.8	4,294.5	4,288.3	4,350.3	4,200.2	4,350.3	4,300.2
6	5.4	4,181.0	4,238.2	4,219.2	4,212.8	4,064.3	3,882.7	4,142.5	4,029.8
7	2.9	3,984.6	4,064.3	3,903.3	3,984.1	3,964.4	4,024.7	4,004.7	3,998.0
8	0.9	3,713.8	3,735.3	3,626.4	3,691.9	3,491.2	3,514.1	3,559.4	3,521.6
Averages ---------->		4,138.0	4,121.2	4,098.5	4,119.2	3,995.6	3,957.0	4,026.3	3,993.0

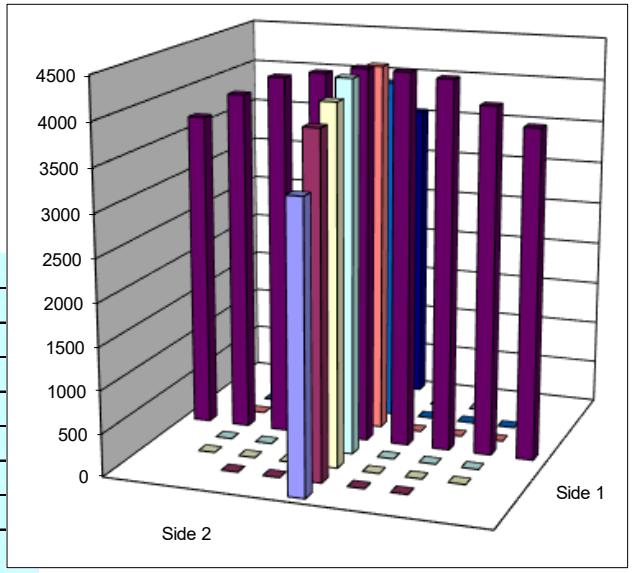
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4056.1		Mean	4222.0	4155.7	4188.8
Min Point	3325.1	-18.0%	Std. Dev.	153.7	167.6	158.3
Max Point	4368.6	7.7%	COV as %	3.6	4.0	**3.8**

Flow w/o C-Pt 17182 cfm

Vel Avg w/o C-Pt 4018 fpm

	Start	Finish	
Stack temp	67.70	68.10	F
Equipment temp	73.70	68.10	F
Ambient temp	73.70	69.60	F
Stack static	0.50	0.50	mbars
Ambient pressure	991.20	991.20	mbars
Total Stack pressure	991.7	991.7	mbars
Ambient humidity	25%	27%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST3, 3ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm) (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

Stack	LB-S2	Run No.	VT-2
Date	10/15/19	Fan Configuration	Fan A
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	28 in.	Stack Temp	68.65 deg F
Stack X-Area	615.8 in.2	Start/End Time	15:46 15:52
Test Port	2	Center 2/3 from	2.57 to: 25.43
Distance to disturbance	57.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (XX deg from N)				Side2 (YY deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	27.1	3,323.4	3,441.7	3,323.4	3,362.8	3,578.5	3,556.1	3,600.8	3,578.5
2	25.1	3,920.0	4,020.8	4,157.8	4,032.9	4,080.1	4,099.7	4,157.8	4,112.5
3	22.6	4,327.7	4,271.8	4,253.0	4,284.1	4,080.1	4,253.0	4,290.5	4,207.9
4	19.0	4,364.4	4,309.1	4,346.0	4,339.9	4,437.2	4,327.7	4,346.0	4,370.3
Center	14.0	4,419.2	4,364.4	4,401.0	4,394.8	4,346.0	4,437.2	4,419.2	4,400.8
5	9.0	4,382.8	4,364.4	4,327.7	4,358.3	4,327.7	4,382.8	4,364.4	4,358.3
6	5.4	4,099.7	4,234.1	4,271.8	4,201.8	4,234.1	4,177.0	4,271.8	4,227.6
7	2.9	4,080.1	4,000.9	3,899.6	3,993.5	4,020.8	3,980.8	4,099.7	4,033.8
8	0.9	3,600.8	3,441.7	3,533.5	3,525.3	3,533.5	3,510.7	3,578.5	3,540.9
Averages ---------->		4,057.6	4,049.9	4,057.1	4,054.8	4,070.9	4,080.6	4,125.4	4,092.3

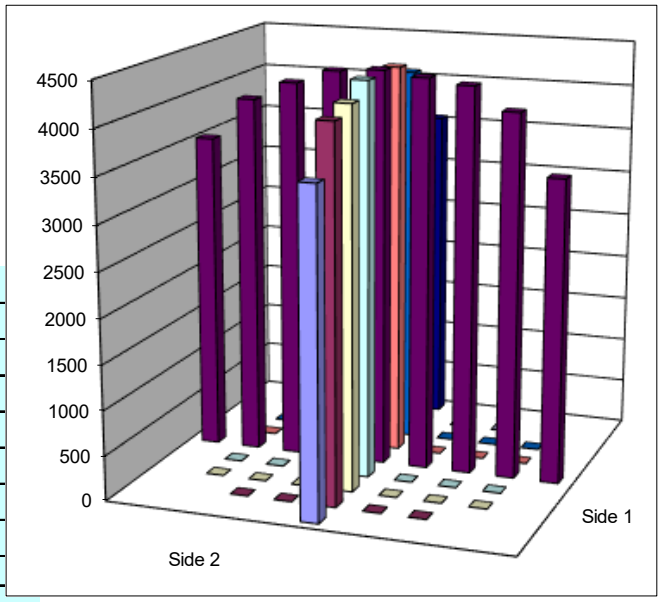
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4073.6		Mean	4229.3	4244.5	4236.9
Min Point	3362.8	-17.4%	Std. Dev.	160.3	139.4	144.6
Max Point	4400.8	8.0%	COV as %	3.8	3.3	**3.4**

Flow w/o C-Pt 17245 cfm

Vel Avg w/o C-Pt 4033 fpm

	Start	Finish	
Stack temp	68.40	68.90	F
Equipment temp	64.10	68.90	F
Ambient temp	64.10	63.10	F
Stack static	4.58	4.03	mbars
Ambient pressure	990.86	990.52	mbars
Total Stack pressure	995.4	994.6	mbars
Ambient humidity	32%	33%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST3, 3ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm) (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

Stack	LB-S2	Run No.	VT-3
Date	10/16/19	Fan Configuration	Fan A
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	28 in.	Stack Temp	66.85 deg F
Stack X-Area	615.8 in.2	Start/End Time	9:45 9:51
Test Port	2	Center 2/3 from	2.57 to: 25.43
Distance to disturbance	57.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (XX deg from N)				Side2 (YY deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	27.1	3,303.2	3,375.3	3,351.4	3,343.3	3,560.3	3,515.0	3,605.1	3,560.1
2	25.1	3,945.2	4,104.6	3,904.3	3,984.7	3,965.5	3,863.0	3,985.6	3,938.0
3	22.6	4,295.7	4,351.3	4,351.3	4,332.8	4,220.3	4,162.9	4,065.3	4,149.5
4	19.0	4,332.8	4,351.3	4,369.7	4,351.3	4,295.7	4,314.3	4,295.7	4,301.9
Center	14.0	4,388.1	4,406.2	4,332.8	4,375.7	4,406.2	4,351.3	4,351.3	4,369.6
5	9.0	4,351.3	4,239.3	4,276.9	4,289.2	4,276.9	4,369.7	4,276.9	4,307.8
6	5.4	4,201.2	4,201.2	4,162.9	4,188.4	4,258.1	4,295.7	4,182.0	4,245.3
7	2.9	4,025.7	3,985.6	3,904.3	3,971.9	4,065.3	3,924.7	3,985.6	3,991.9
8	0.9	3,649.4	3,492.1	3,515.0	3,552.1	3,515.0	3,515.0	3,582.9	3,537.6
Averages ---------->		4,054.7	4,056.3	4,018.7	4,043.3	4,062.6	4,034.6	4,036.7	4,044.6

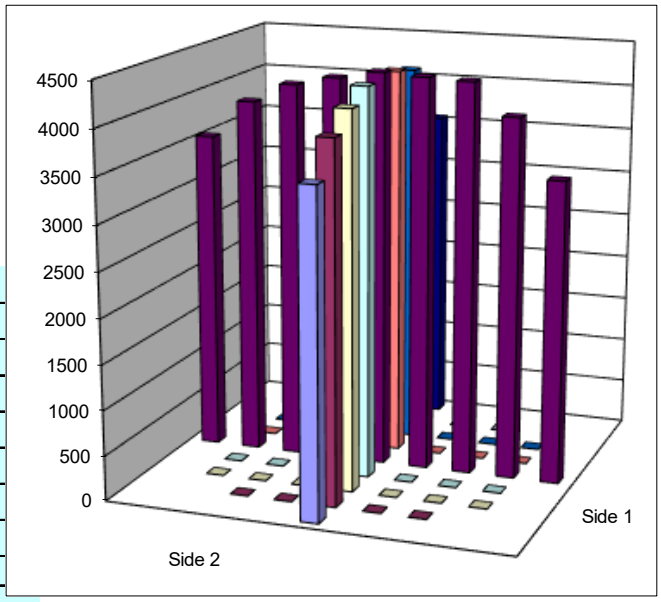
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4043.9		Mean	4213.4	4186.3	4199.9
Min Point	3343.3	-17.3%	Std. Dev.	171.6	166.3	162.9
Max Point	4375.7	8.2%	COV as %	4.1	4.0	**3.9**

Flow w/o C-Pt 17116 cfm

Vel Avg w/o C-Pt 4003 fpm

	Start	Finish	
Stack temp	66.90	66.80	F
Equipment temp	56.40	66.80	F
Ambient temp	56.40	57.80	F
Stack static	4.58	3.34	mbars
Ambient pressure	985.44	985.10	mbars
Total Stack pressure	990.0	988.4	mbars
Ambient humidity	48%	46%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST3, 3ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm) (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

Stack	LB-S2	Run No.	VT-4
Date	10/16/19	Fan Configuration	Fan A
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	28 in.	Stack Temp	67.95 deg F
Stack X-Area	615.8 in.2	Start/End Time	11:14 11:20
Test Port	2	Center 2/3 from	2.57 to: 25.43
Distance to disturbance	57.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (XX deg from N)				Side2 (YY deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	27.1	3,607.4	3,540.0	3,517.3	3,554.9	3,353.6	3,280.9	3,353.6	3,329.4
2	25.1	4,048.2	3,927.2	4,087.7	4,021.0	3,906.8	3,947.7	3,823.7	3,892.7
3	22.6	4,223.0	4,298.4	4,184.7	4,235.4	4,203.9	4,223.0	4,241.9	4,222.9
4	19.0	4,354.1	4,298.4	4,298.4	4,317.0	4,279.6	4,409.1	4,260.9	4,316.5
Center	14.0	4,390.8	4,354.1	4,223.0	4,322.6	4,317.0	4,390.8	4,335.6	4,347.8
5	9.0	4,241.9	4,317.0	4,279.6	4,279.5	4,317.0	4,372.5	4,354.1	4,347.9
6	5.4	4,165.5	4,260.9	4,241.9	4,222.8	4,223.0	4,317.0	4,372.5	4,304.2
7	2.9	4,008.3	4,048.2	4,087.7	4,048.1	4,107.2	4,028.2	3,906.8	4,014.1
8	0.9	3,448.1	3,585.1	3,494.3	3,509.2	3,717.1	3,585.1	3,607.4	3,636.6
Averages ---------->		4,054.1	4,069.9	4,046.1	4,056.7	4,047.3	4,061.6	4,028.5	4,045.8

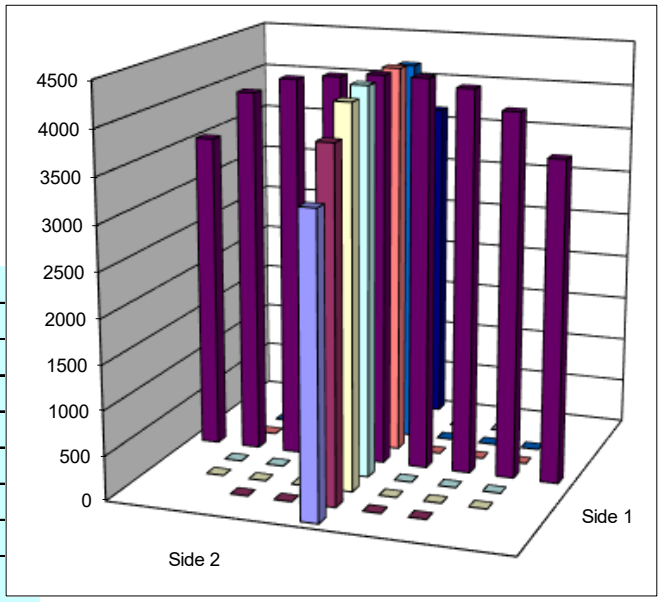
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4051.2		Mean	4206.6	4206.6	4206.6
Min Point	3329.4	-17.8%	Std. Dev.	123.6	181.4	149.1
Max Point	4347.9	7.3%	COV as %	2.9	4.3	**3.5**

Flow w/o C-Pt 17172 cfm

Vel Avg w/o C-Pt 4016 fpm

	Start	Finish	
Stack temp	67.60	68.30	F
Equipment temp	66.40	68.30	F
Ambient temp	66.40	66.90	F
Stack static	6.40	4.13	mbars
Ambient pressure	984.76	984.76	mbars
Total Stack pressure	991.2	988.9	mbars
Ambient humidity	38%	37%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST3, 3ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm) (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

Stack	LB-S2	Run No.	VT-5
Date	10/16/19	Fan Configuration	Fan A
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	28 in.	Stack Temp	69.00 deg F
Stack X-Area	615.8 in.2	Start/End Time	13:21 13:27
Test Port	2	Center 2/3 from	2.57 to: 25.43
Distance to disturbance	57.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (XX deg from N)				Side2 (YY deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	27.1	4,016.8	3,478.7	3,592.8	3,696.1	3,312.3	3,312.3	3,287.9	3,304.2
2	25.1	4,016.8	3,996.7	4,056.8	4,023.4	3,915.1	4,016.8	3,996.7	3,976.2
3	22.6	4,251.0	4,269.9	4,174.4	4,231.8	4,251.0	4,135.6	4,193.6	4,193.4
4	19.0	4,307.5	4,326.2	4,269.9	4,301.2	4,251.0	4,307.5	4,326.2	4,294.9
Center	14.0	4,288.8	4,381.8	4,344.9	4,338.5	4,307.5	4,326.2	4,363.3	4,332.4
5	9.0	4,174.4	4,135.6	4,212.9	4,174.3	4,251.0	4,193.6	4,096.3	4,180.3
6	5.4	4,076.6	3,976.4	4,155.0	4,069.3	4,251.0	4,212.9	4,232.0	4,232.0
7	2.9	3,956.1	4,096.3	3,956.1	4,002.8	3,873.7	3,935.6	3,956.1	3,921.8
8	0.9	3,431.9	3,524.7	3,570.2	3,509.0	3,810.7	3,659.5	3,703.3	3,724.5
Averages ---------->		4,057.8	4,020.7	4,037.0	4,038.5	4,024.8	4,011.1	4,017.3	4,017.7

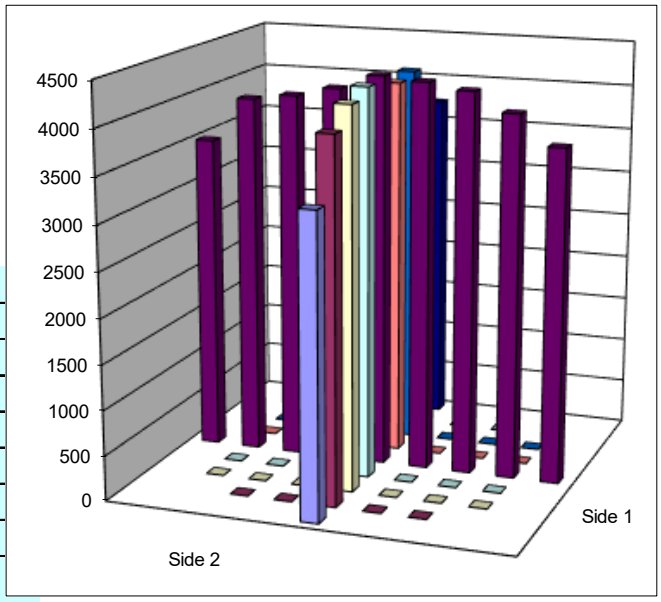
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4028.1		Mean	4163.0	4161.6	4162.3
Min Point	3304.2	-18.0%	Std. Dev.	134.6	155.5	139.7
Max Point	4338.5	7.7%	COV as %	3.2	3.7	**3.4**

Flow w/o C-Pt 17060 cfm

Vel Avg w/o C-Pt 3990 fpm

	Start	Finish	
Stack temp	69.30	68.70	F
Equipment temp	67.70	68.70	F
Ambient temp	67.70	67.50	F
Stack static	4.08	4.66	mbars
Ambient pressure	983.41	983.41	mbars
Total Stack pressure	987.5	988.1	mbars
Ambient humidity	34%	34%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST3, 3ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm) (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

Stack	LB-S2	Run No.	VT-6
Date	10/16/19	Fan Configuration	Fan A
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	28 in.	Stack Temp	69.60 deg F
Stack X-Area	615.8 in.2	Start/End Time	14:27 14:33
Test Port	2	Center 2/3 from	2.57 to: 25.43
Distance to disturbance	57.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (XX deg from N)				Side2 (YY deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	27.1	3,113.9	3,241.0	3,481.4	3,278.8	3,216.0	3,363.3	3,387.3	3,322.2
2	25.1	3,999.8	3,999.8	3,959.2	3,986.3	4,756.5	3,897.5	3,979.6	4,211.2
3	22.6	4,158.4	4,292.2	4,254.4	4,235.0	4,235.4	4,216.2	4,254.4	4,235.3
4	19.0	4,273.3	4,366.9	4,273.3	4,304.5	4,348.3	4,311.0	4,348.3	4,335.9
Center	14.0	4,348.3	4,292.2	4,292.2	4,310.9	4,385.3	4,403.7	4,329.7	4,372.9
5	9.0	4,329.7	4,311.0	4,348.3	4,329.7	4,216.2	4,235.4	4,254.4	4,235.3
6	5.4	4,216.2	4,177.7	4,329.7	4,241.2	4,216.2	4,079.9	4,040.1	4,112.1
7	2.9	3,918.3	3,979.6	3,938.8	3,945.6	4,158.4	3,999.8	3,897.5	4,018.6
8	0.9	3,434.7	3,387.3	3,363.3	3,395.1	3,527.5	3,550.4	3,411.1	3,496.4
Averages ---------->		3,977.0	4,005.3	4,026.8	4,003.0	4,117.8	4,006.4	3,989.2	4,037.8

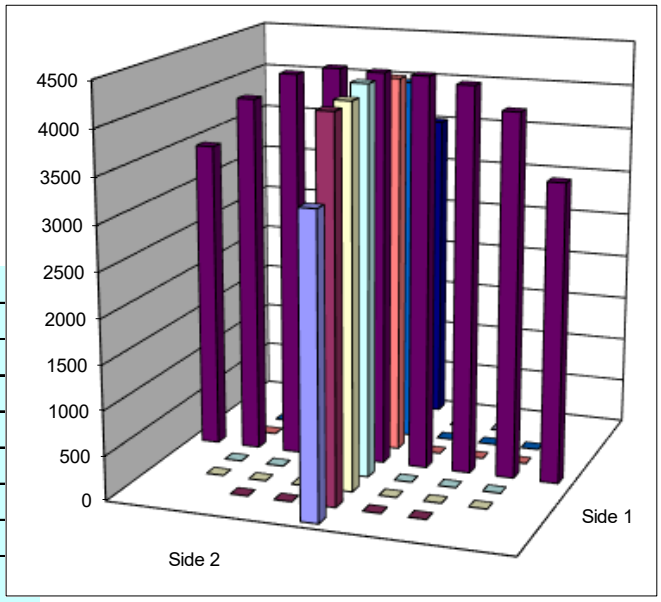
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4020.4		Mean	4193.3	4217.3	4205.3
Min Point	3278.8	-18.4%	Std. Dev.	159.7	122.2	137.2
Max Point	4372.9	8.8%	COV as %	3.8	2.9	**3.3**

Flow w/o C-Pt 17020 cfm

Vel Avg w/o C-Pt 3980 fpm

	Start	Finish	
Stack temp	70.10	69.10	F
Equipment temp	63.80	69.10	F
Ambient temp	63.80	64.60	F
Stack static	5.68	5.30	mbars
Ambient pressure	982.39	982.39	mbars
Total Stack pressure	988.1	987.7	mbars
Ambient humidity	37%	35%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST3, 3ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm) (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

Stack	LB-S2	Run No.	VT-7
Date	10/17/19	Fan Configuration	Fan A
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	28 in.	Stack Temp	68.95 deg F
Stack X-Area	615.8 in.2	Start/End Time	9:36 9:43
Test Port	2	Center 2/3 from	2.57 to: 25.43
Distance to disturbance	57.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (XX deg from N)				Side2 (YY deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	27.1	3,508.5	3,577.1	3,508.5	3,531.4	3,414.9	3,391.1	3,391.1	3,399.0
2	25.1	4,201.7	4,064.6	4,004.3	4,090.2	3,943.2	4,084.4	4,004.3	4,010.6
3	22.6	4,278.1	4,371.8	4,240.1	4,296.6	4,240.1	4,240.1	4,371.8	4,284.0
4	19.0	4,371.8	4,426.9	4,353.2	4,384.0	4,297.0	4,390.2	4,297.0	4,328.1
Center	14.0	4,390.2	4,390.2	4,426.9	4,402.5	4,408.6	4,371.8	4,371.8	4,384.1
5	9.0	4,201.7	4,220.9	4,334.5	4,252.4	4,390.2	4,315.7	4,334.5	4,346.8
6	5.4	4,143.4	4,220.9	4,084.4	4,149.6	4,143.4	4,297.0	4,163.0	4,201.1
7	2.9	3,943.2	3,984.1	3,881.1	3,936.1	4,064.6	4,278.1	4,104.2	4,149.0
8	0.9	3,367.1	3,531.4	3,367.1	3,421.9	3,485.3	3,508.5	3,462.0	3,485.3
Averages ---------->		4,045.1	4,087.5	4,022.2	4,051.6	4,043.0	4,097.4	4,055.5	4,065.3

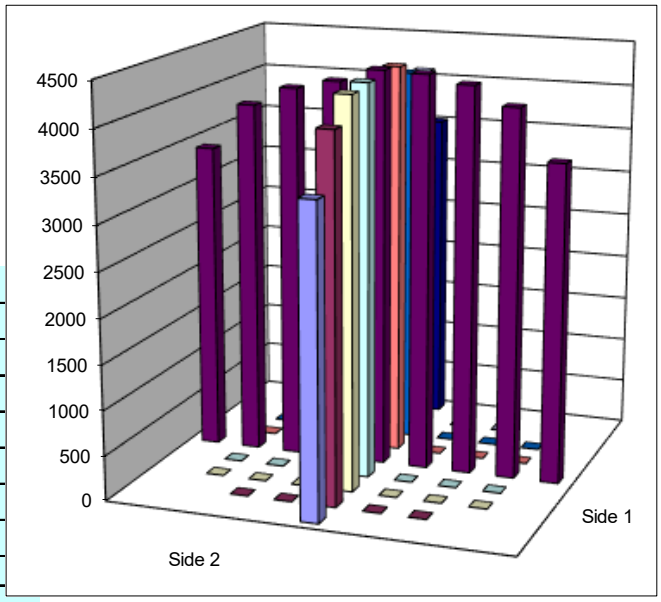
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4058.5		Mean	4215.9	4243.4	4229.6
Min Point	3399.0	-16.2%	Std. Dev.	168.0	131.8	145.8
Max Point	4402.5	8.5%	COV as %	4.0	3.1	**3.4**

Flow w/o C-Pt 17175 cfm

Vel Avg w/o C-Pt 4017 fpm

	Start	Finish	
Stack temp	68.70	69.20	F
Equipment temp	57.10	69.20	F
Ambient temp	57.10	57.10	F
Stack static	3.64	4.16	mbars
Ambient pressure	980.02	980.02	mbars
Total Stack pressure	983.7	984.2	mbars
Ambient humidity	47%	47%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST3, 3ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm) (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

Stack	LB-S2	Run No.	VT-8
Date	10/17/19	Fan Configuration	Fan B only
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	28 in.	Stack Temp	69.45 deg F
Stack X-Area	615.8 in.2	Start/End Time	10:45 10:50
Test Port	2	Center 2/3 from	2.57 to: 25.43
Distance to disturbance	57.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (XX deg from N)				Side2 (YY deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	27.1	3,369.0	3,487.3	3,533.5	3,463.3	3,690.6	3,668.6	3,579.0	3,646.1
2	25.1	4,261.5	4,204.0	4,026.7	4,164.1	4,355.6	4,336.9	4,299.4	4,330.7
3	22.6	4,355.6	4,223.3	4,318.3	4,299.1	4,447.7	4,502.1	4,538.0	4,495.9
4	19.0	4,608.8	4,465.9	4,447.7	4,507.5	4,591.2	4,643.9	4,555.8	4,597.0
Center	14.0	4,520.0	4,447.7	4,538.0	4,501.9	4,573.5	4,502.1	4,538.0	4,537.9
5	9.0	4,411.1	4,392.7	4,429.4	4,411.1	4,465.9	4,392.7	4,429.4	4,429.3
6	5.4	4,411.1	4,374.2	4,411.1	4,398.8	4,336.9	4,242.5	4,318.3	4,299.2
7	2.9	4,280.5	4,280.5	4,242.5	4,267.8	4,145.8	4,261.5	3,924.8	4,110.7
8	0.9	3,862.4	3,904.1	3,986.3	3,917.6	3,777.5	3,579.0	3,601.7	3,652.7
Averages ---------->		4,231.1	4,197.7	4,214.8	4,214.6	4,265.0	4,236.6	4,198.3	4,233.3

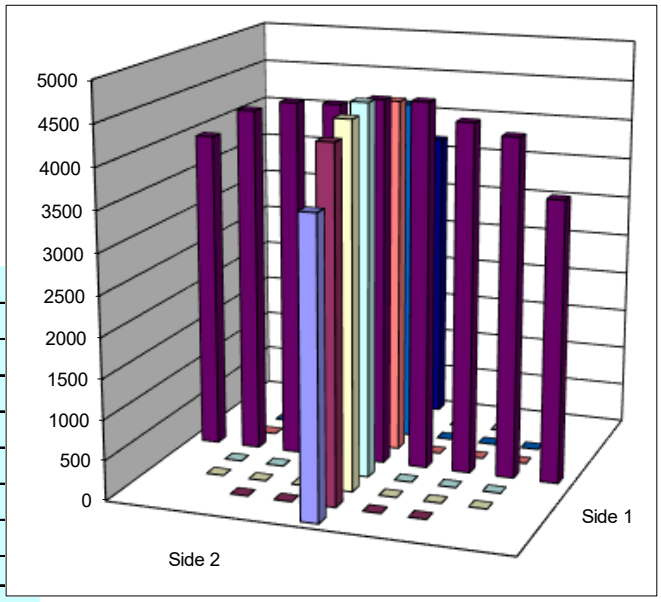
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4223.9		Mean	4364.3	4400.1	4382.2
Min Point	3463.3	-18.0%	Std. Dev.	126.8	166.6	143.4
Max Point	4597.0	8.8%	COV as %	2.9	3.8	**3.3**

Flow w/o C-Pt 17904 cfm

Vel Avg w/o C-Pt 4187 fpm

	Start	Finish	
Stack temp	69.70	69.20	F
Equipment temp	59.10	69.20	F
Ambient temp	59.10	58.60	F
Stack static	3.04	3.39	mbars
Ambient pressure	980.36	980.70	mbars
Total Stack pressure	983.4	984.1	mbars
Ambient humidity	42%	43%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST3, 3ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm) (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

Stack	**LB-S2**	Run No.	**VT-9**
Date	**10/17/19**	Fan Configuration	**Fan B**
Testers	ZDH/LCE	Fan Setting	**N/A** Hz
Stack Dia.	28 in.	Stack Temp	70.95 deg F
Stack X-Area	615.8 in.2	Start/End Time	13:13 13:19
Test Port	2	Center 2/3 from	2.57 to: 25.43
Distance to disturbance	57.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (XX deg from N)				Side2 (YY deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	27.1	3,468.0	3,491.4	3,583.2	3,514.2	3,845.8	4,011.3	3,950.0	3,935.7
2	25.1	3,991.0	4,170.2	4,209.0	4,123.4	4,228.2	4,051.6	4,189.6	4,156.5
3	22.6	4,397.8	4,434.7	4,507.3	4,446.6	4,304.4	4,525.3	4,247.4	4,359.0
4	19.0	4,489.2	4,507.3	4,507.3	4,501.3	4,397.8	4,452.9	4,525.3	4,458.7
Center	14.0	4,452.9	4,543.3	4,561.1	4,519.1	4,416.3	4,471.1	4,471.1	4,452.8
5	9.0	4,489.2	4,434.7	4,379.3	4,434.4	4,507.3	4,416.3	4,379.3	4,434.3
6	5.4	4,170.2	4,247.4	4,342.1	4,253.2	4,304.4	4,507.3	4,379.3	4,397.0
7	2.9	4,051.6	4,150.6	5,644.1	4,615.4	4,304.4	4,342.1	4,111.3	4,252.6
8	0.9	3,672.8	3,694.9	3,628.4	3,665.4	3,950.0	3,824.6	3,824.6	3,866.4
Averages ---------->		4,131.4	4,186.0	4,373.5	4,230.3	4,251.0	4,289.2	4,230.9	4,257.0

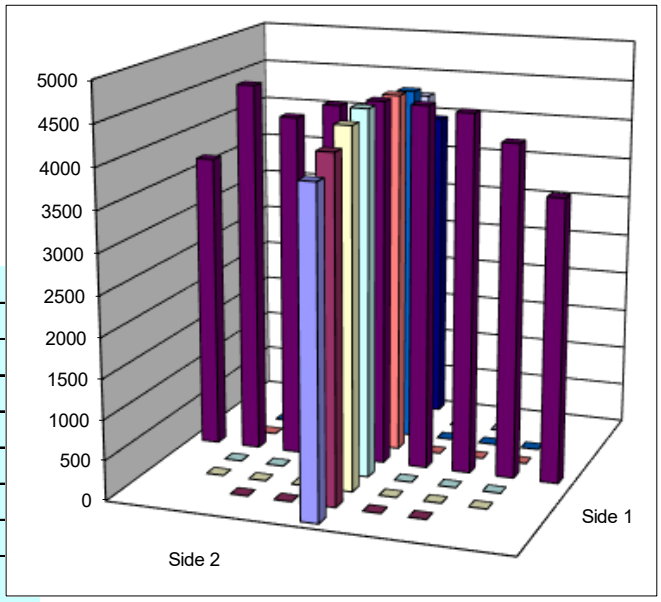
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4243.7		Mean	4413.3	4358.7	4386.0
Min Point	3514.2	-17.2%	Std. Dev.	168.8	114.2	141.3
Max Point	4615.4	8.8%	COV as %	3.8	2.6	**3.2**

Flow w/o C-Pt 18017 cfm

Vel Avg w/o C-Pt 4213 fpm

	Start	Finish	
Stack temp	71.3	70.6	F
Equipment temp	61.8	62.1	F
Ambient temp	61.8	62.1	F
Stack static	3.4	3.7	mbars
Ambient pressure	980.7	980.7	mbars
Total Stack pressure	984.1	984.4	mbars
Ambient humidity	42%	41%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST3, 3ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm) (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

Stack	LB-S2	Run No.	VT-10
Date	10/17/19	Fan Configuration	Fan B
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	28 in.	Stack Temp	70.30 deg F
Stack X-Area	615.8 in.2	Start/End Time	14:38 14:44
Test Port	2	Center 2/3 from	2.57 to: 25.43
Distance to disturbance	57.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (XX deg from N)				Side2 (YY deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	27.1	3,120.5	3,041.6	3,068.2	3,076.8	3,692.3	3,603.3	3,580.7	3,625.4
2	25.1	4,282.5	4,167.3	4,320.2	4,256.7	4,128.1	4,167.3	4,225.3	4,173.6
3	22.6	4,301.4	4,339.0	4,467.9	4,369.5	4,486.1	4,263.5	4,431.5	4,393.7
4	19.0	4,504.1	4,449.8	4,522.1	4,492.0	4,449.8	4,394.7	4,557.9	4,467.5
Center	14.0	4,467.9	4,486.1	4,486.1	4,480.1	4,540.1	4,467.9	4,504.1	4,504.0
5	9.0	4,449.8	4,320.2	4,431.5	4,400.5	4,449.8	4,413.1	4,413.1	4,425.3
6	5.4	4,244.4	4,376.3	4,263.5	4,294.7	4,413.1	4,376.3	4,449.8	4,413.0
7	2.9	4,206.0	4,225.3	4,048.7	4,160.0	4,244.4	4,263.5	4,147.7	4,218.5
8	0.9	3,648.1	3,625.8	3,714.2	3,662.7	3,714.2	3,736.0	3,757.7	3,736.0
Averages ---------->		4,136.1	4,114.6	4,146.9	4,132.5	4,235.3	4,187.3	4,229.7	4,217.5

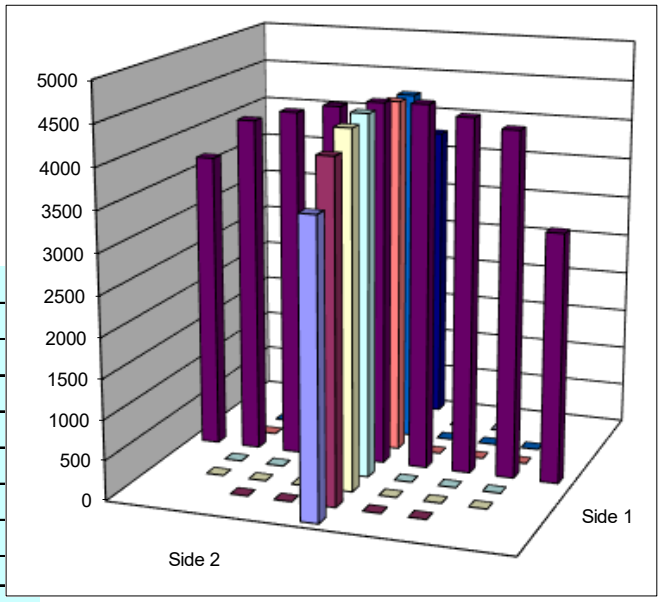
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4175.0		Mean	4350.5	4370.8	4360.6
Min Point	3076.8	-26.3%	Std. Dev.	121.0	125.5	118.9
Max Point	4504.0	7.9%	COV as %	2.8	2.9	**2.7**

Flow w/o C-Pt 17683 cfm

Vel Avg w/o C-Pt 4135 fpm

	Start	Finish	
Stack temp	70.4	70.2	F
Equipment temp	61.6	70.2	F
Ambient temp	61.1	61.7	F
Stack static	3.7	3.4	mbars
Ambient pressure	980.7	981.0	mbars
Total Stack pressure	984.4	984.4	mbars
Ambient humidity	42%	42%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST3, 3ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm) (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

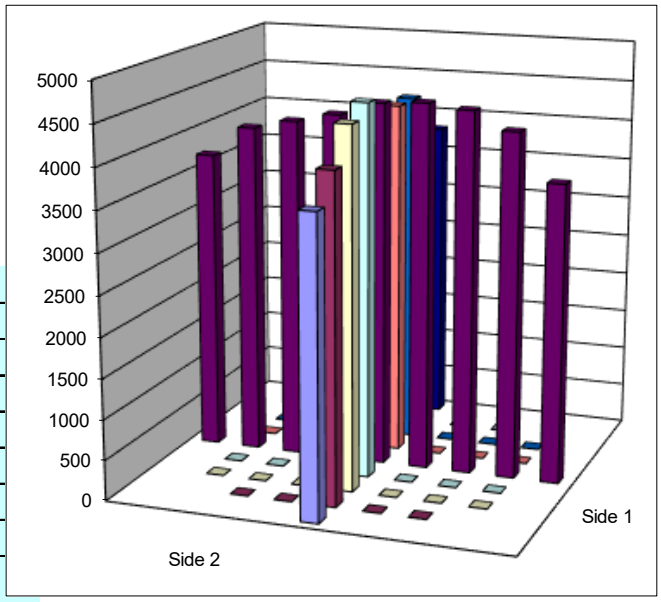
Stack	LB-S2	Run No.	VT-11
Date	10/17/19	Fan Configuration	Fan B
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	28 in.	Stack Temp	70.75 deg F
Stack X-Area	615.8 in.2	Start/End Time	15:45 15:51
Test Port	2	Center 2/3 from	2.57 to: 25.43
Distance to disturbance	57.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (XX deg from N)				Side2 (YY deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	27.1	3,627.5	3,759.4	3,649.8	3,678.9	3,694.0	3,627.5	3,627.5	3,649.6
2	25.1	4,359.6	4,246.3	4,169.2	4,258.4	4,010.3	4,010.3	3,989.9	4,003.5
3	22.6	4,451.8	4,470.0	4,506.2	4,476.0	4,524.2	4,396.7	4,359.6	4,426.8
4	19.0	4,524.2	4,577.8	4,488.1	4,530.0	4,613.0	4,577.8	4,560.0	4,583.6
Center	14.0	4,470.0	4,506.2	4,506.2	4,494.1	4,470.0	4,524.2	4,451.8	4,482.0
5	9.0	4,265.4	4,415.1	4,284.5	4,321.7	4,303.4	4,359.6	4,415.1	4,359.4
6	5.4	4,070.5	4,284.5	4,265.4	4,206.8	4,378.2	4,322.2	4,378.2	4,359.5
7	2.9	4,169.2	4,090.5	4,010.3	4,090.0	4,130.0	4,265.4	4,188.5	4,194.7
8	0.9	3,780.9	3,759.4	3,604.9	3,715.1	3,737.7	3,802.4	3,802.4	3,780.8
Averages ---------->		4,191.0	4,234.3	4,165.0	4,196.8	4,206.7	4,209.6	4,197.0	4,204.4

All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4200.6		Mean	4339.6	4344.2	4341.9
Min Point	3649.6	-13.1%	Std. Dev.	166.1	192.4	172.7
Max Point	4583.6	9.1%	COV as %	3.8	4.4	**4.0**

Flow w/o C-Pt	17808 cfm	**Instuments Used:**	Cal Due
Vel Avg w/o C-Pt	4165 fpm	Standard pitot (ID: BST3, 3ft)	Post-test inspection
		Digi-sense 20250-13 Manometer	9/15/2020
		Workhorse Thermometer	Verified prior to each field use

	Start	Finish	
Stack temp	71.1	70.4	F
Equipment temp	60.7	70.4	F
Ambient temp	60.7	60.9	F
Stack static	3.8	3.5	mbars
Ambient pressure	980.7	980.7	mbars
Total Stack pressure	984.5	984.2	mbars
Ambient humidity	43%	43%	RH



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm) (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

Stack	LB-S2	Run No.	VT-12
Date	10/18/19	Fan Configuration	Fan B
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	28 in.	Stack Temp	67.75 deg F
Stack X-Area	615.8 in.2	Start/End Time	9:24 9:31
Test Port	2	Center 2/3 from	2.57 to: 25.43
Distance to disturbance	57.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (XX deg from N)				Side2 (YY deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	27.1	3,673.5	3,673.5	3,607.3	3,651.4	3,517.0	3,494.1	3,280.8	3,430.6
2	25.1	4,146.0	4,165.3	4,067.7	4,126.3	4,316.8	4,390.6	4,298.2	4,335.2
3	22.6	4,427.0	4,241.8	4,184.5	4,284.5	4,516.9	4,427.0	4,445.1	4,463.0
4	19.0	4,499.1	4,516.9	4,390.6	4,468.8	4,569.9	4,587.4	4,552.2	4,569.9
Center	14.0	4,516.9	4,427.0	4,499.1	4,481.0	4,499.1	4,587.4	4,463.2	4,516.6
5	9.0	4,481.1	4,390.6	4,463.2	4,445.0	4,279.4	4,408.9	4,372.3	4,353.5
6	5.4	4,372.3	4,390.6	4,372.3	4,378.4	4,335.3	4,260.6	4,260.6	4,285.5
7	2.9	4,372.3	4,107.1	4,184.5	4,221.3	4,222.8	4,165.3	4,203.7	4,197.3
8	0.9	3,844.4	3,947.5	3,865.3	3,885.7	3,695.3	3,695.3	3,651.5	3,680.7
Averages ---------->		4,259.2	4,206.7	4,181.6	4,215.8	4,216.9	4,224.1	4,169.7	4,203.6

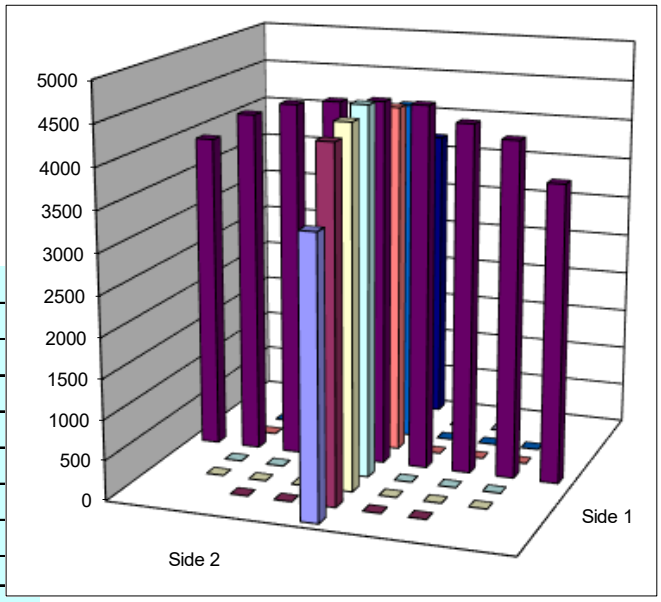
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4209.7		Mean	4343.6	4388.7	4366.2
Min Point	3430.6	-18.5%	Std. Dev.	136.4	133.0	131.5
Max Point	4569.9	8.6%	COV as %	3.1	3.0	**3.0**

Flow w/o C-Pt 17846 cfm

Vel Avg w/o C-Pt 4174 fpm

	Start	Finish	
Stack temp	67.70	67.80	F
Equipment temp	51.90	52.30	F
Ambient temp	51.90	52.30	F
Stack static	3.61	3.66	mbars
Ambient pressure	986.12	986.12	mbars
Total Stack pressure	989.7	989.8	mbars
Ambient humidity	45%	44%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST3, 3ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm) (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

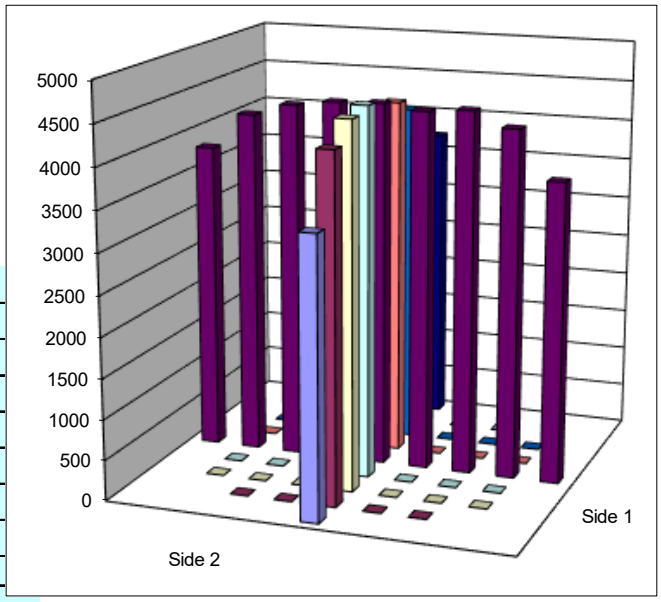
Stack	LB-S2	Run No.	VT-13
Date	10/18/19	Fan Configuration	Fan B
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	28 in.	Stack Temp	67.8 deg F
Stack X-Area	615.8 in.2	Start/End Time	10:33 10:38
Test Port	2	Center 2/3 from	2.57 to: 25.43
Distance to disturbance	57.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (XX deg from N)				Side2 (YY deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	27.1	3,715.1	3,627.7	3,671.6	3,671.5	3,204.9	3,538.1	3,492.4	3,411.8
2	25.1	4,277.3	4,406.7	4,085.4	4,256.5	4,163.3	4,333.2	4,239.7	4,245.4
3	22.6	4,479.0	4,424.9	4,406.7	4,436.9	4,550.1	4,461.0	4,479.0	4,496.7
4	19.0	4,479.0	4,406.7	4,296.1	4,393.9	4,567.7	4,550.1	4,567.7	4,561.8
Center	14.0	4,532.4	4,370.2	4,461.0	4,454.5	4,479.0	4,479.0	4,514.6	4,490.8
5	9.0	4,388.5	4,424.9	4,496.8	4,436.7	4,333.2	4,461.0	4,443.0	4,412.4
6	5.4	4,443.0	4,351.7	4,314.7	4,369.8	4,239.7	4,201.6	4,258.5	4,233.3
7	2.9	4,314.7	4,163.3	4,182.4	4,220.2	4,085.4	4,220.7	4,065.8	4,124.0
8	0.9	3,842.5	3,821.6	3,671.6	3,778.6	3,671.6	3,736.6	3,715.1	3,707.8
Averages ---------->		4,274.6	4,222.0	4,176.3	4,224.3	4,143.9	4,220.1	4,197.3	4,187.1

All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4205.7		Mean	4366.9	4366.3	4366.6
Min Point	3411.8	-18.9%	Std. Dev.	93.0	165.3	128.8
Max Point	4561.8	8.5%	COV as %	2.1	3.8	**3.0**

Flow w/o C-Pt	17841 cfm	**Instuments Used:**	Cal Due
Vel Avg w/o C-Pt	4172 fpm	Standard pitot (ID: BST3, 3ft)	Post-test inspection
		Digi-sense 20250-13 Manometer	9/15/2020
		Workhorse Thermometer	Verified prior to each field use

	Start	Finish	
Stack temp	67.7	67.8	F
Equipment temp	51.9	52.30 F	F
Ambient temp	51.9	52.3	F
Stack static	3.7	3.8	mbars
Ambient pressure	986.8	987.1	mbars
Total Stack pressure	990.5	991.0	mbars
Ambient humidity	45%	44%	RH



Notes:

Traverse point depth = the distance from inside stack wall to each point.

Side 1 port was always measured first.

Direct measurements of differential pressure (in. H20) were recorded using a digital manometer. Differential pressures were converted to the stack gas velocities (afpm) (shown here) in a separate datasheet based on recorded total stack pressure, stack temperature and density of air for each run.

VELOCITY TRAVERSE DATA FORM

Stack	LB-S2	Run No.	VT-14
Date	10/19/19	Fan Configuration	Fan B
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	28 in.	Stack Temp	67.95 deg F
Stack X-Area	615.8 in.2	Start/End Time	9:39 9:44
Test Port	2	Center 2/3 from	2.57 to: 25.43
Distance to disturbance	57.5 ft	Points in Center 2/3	2 to: 7
Velocity units	ft/min		

Order -->		First port				Second port			
Traverse-->		Side1 (XX deg from N)				Side2 (YY deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	27.1	2,988.9	3,249.3	3,147.7	3,128.7	3,844.7	3,780.8	3,715.7	3,780.4
2	25.1	4,303.2	4,207.7	4,265.3	4,258.7	4,322.0	4,149.4	4,265.3	4,245.6
3	22.6	4,396.6	4,524.0	4,541.9	4,487.5	4,451.6	4,340.7	4,284.2	4,358.9
4	19.0	4,524.0	4,612.9	4,506.0	4,547.6	4,524.0	4,488.0	4,559.7	4,523.9
Center	14.0	4,524.0	4,541.9	4,541.9	4,535.9	4,541.9	4,524.0	4,559.7	4,541.9
5	9.0	4,524.0	4,340.7	4,359.4	4,408.0	4,451.6	4,415.0	4,469.8	4,445.5
6	5.4	4,169.0	4,303.2	4,246.2	4,239.5	4,415.0	4,359.4	4,396.6	4,390.3
7	2.9	4,129.9	4,050.4	3,989.7	4,056.7	4,227.0	4,303.2	4,188.4	4,239.5
8	0.9	3,802.2	3,693.8	3,490.3	3,662.1	3,627.3	3,671.8	3,693.8	3,664.3
Averages ---------->		4,151.3	4,169.3	4,120.9	4,147.2	4,267.2	4,225.8	4,237.0	4,243.4

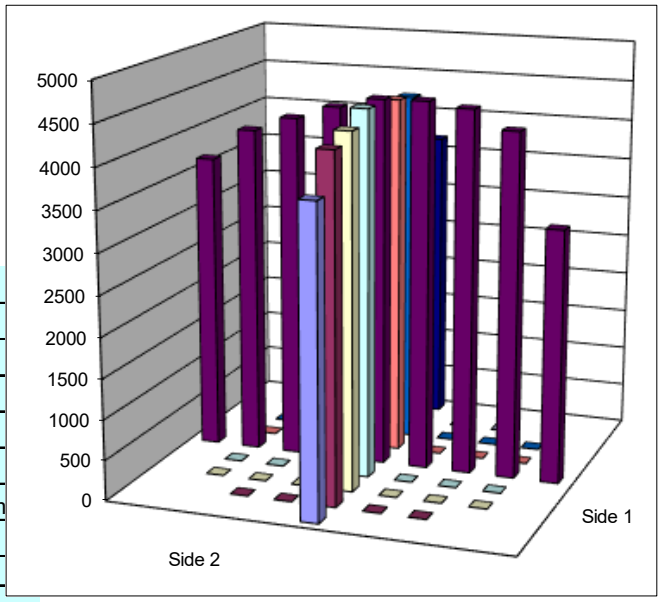
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4195.3		Mean	4362.0	4392.2	4377.1
Min Point	3128.7	-25.4%	Std. Dev.	183.2	121.5	150.2
Max Point	4547.6	8.4%	COV as %	4.2	2.8	**3.4**

Flow w/o C-Pt 17756 cfm

Vel Avg w/o C-Pt 4152 fpm

	Start	Finish	
Stack temp	69.30	66.60	F
Equipment temp	47.30	46.80	F
Ambient temp	47.30	46.80	F
Stack static	3.66	3.56	mbars
Ambient pressure	975.62	975.62	mbars
Total Stack pressure	979.28	979.18	mbars
Ambient humidity	84%	86%	RH

Instuments Used:	Cal Due
Standard pitot (ID: BST3, 3ft)	Post-test inspection
Digi-sense 20250-13 Manometer	9/15/2020
Workhorse Thermometer	Verified prior to each field use



Notes:

Traverse point depth = the distance from inside stack wall to each point.

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Appendix D – LAB Stack Verification Document Summary

The following table provides a summary of the documents produced by Pacific Northwest National Laboratory (PNNL) during LAB Verification Test activities.

Document Title	Document Number	Notes
LAB Verification Test Input Document	Attachment to WTP/RPP-MOA-PNNL-00970, Rev 0	Test input document to provide information to Bison Engineering (Bison) and Waste Treatment Completion Company (WTCC) concerning the verification tests. Transmitted as an attachment to a memo.
WTP LAB Stack Verification Tests of Velocity Uniformity and Flow Angle provided by WTCC	TDP-WTPSP-958	Test Data Package to contain the data sheets collected by Bison
Qualification of LAB Stack Verification Testing Data collected by Bison	DQP-WTPSP-0003, Rev 1	Data Qualification Plan to describe the qualification of the data from WTCC
Qualification of LAB Stack Verification Testing Data Collected by Bison	N/A	Data Qualification Evaluation to assess whether the data from WTCC are acceptable
Qualification of LAB Stack Verification Testing Data collected by Bison	DQR-WTPSP-0003, Rev 1	Data Qualification Report to document the results of the data evaluation(s)
WTP LAB Stack Verification Tests of Velocity Uniformity and Flow Angle transcribed by PNNL	TDP-WTPSP-959	Test Data Package to contain the data that were input into PNNL spreadsheets from the Bison sheets
Determine Air Velocity Uniformity of LB-C2, LB-S1, and LB-S2 Stacks	CCP-WTPSP-1374, Rev 1	Calculation package to document and review equations and calculations performed to determine velocity uniformity
Determine Flow Angle in LB-C2, LB-S1, and LB-S2 Stacks	CCP-WTPSP-1375, Rev 0	Calculation package to document and review equations and calculations performed to determine flow angle
Determine the product of the hydraulic diameter and the mean velocity of LAB Stacks	CCP-WTPSP-1385, Rev 0	Calculation package to document and review the equations and calculations performed to determine the DV values from the scale model stack tests and the verification tests.

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