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PNNL-31230, Rev 0
WTP-RPT-249, Rev 0

Hanford Waste Treatment Plant LAB Facility Stack Effluent Monitoring

Sampling Probe Location Qualification Evaluation

July 2021

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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Richland, Washington 99354

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 625 to 47,237 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	1,191–2,506	199	15,036
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.

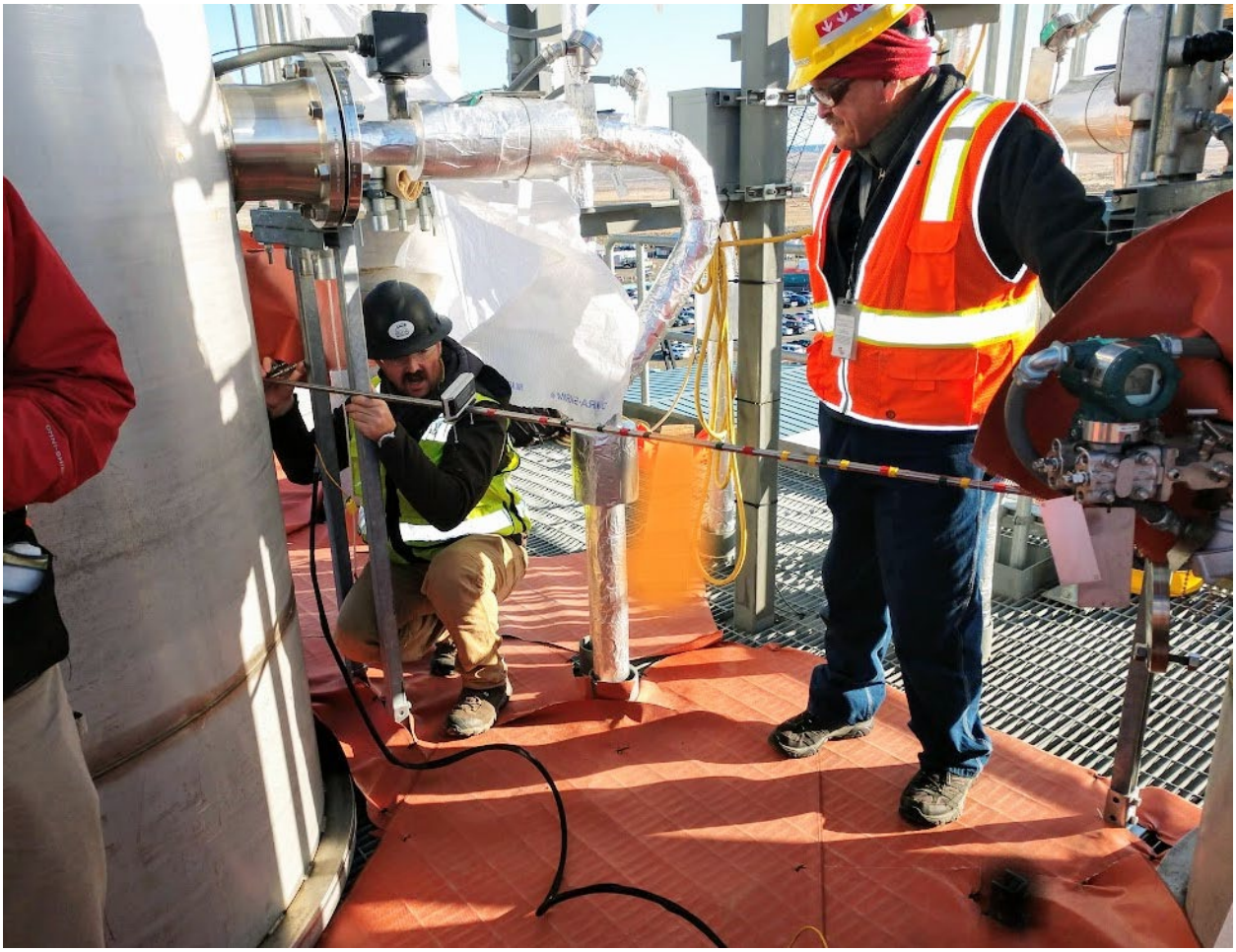


Figure 2. Flow Angle Testing on the LB-C2 Stack, with Probe Maneuvered around the LB-S1 Pitot Support

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 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	35,191	2.6	11,200
	2	18.0	35,061	3.0	11,160
	3	16.6	34,070	3.9	10,844
	4	19.0	34,295	1.9	10,916
	14	17.3	37,160	2.4	11,828
Fan B Only	5	5.8	33,633	2.4	10,704
	6	4.0	33,764	3.5	10,748
	7	5.2	34,569	2.0	11,004
	8	5.6	34,818	2.0	11,084
	9	5.4	34,464	1.7	10,972
Fans A and B	10	3.1	37,165	1.9	11,832
	11	2.8	37,331	1.8	11,884
	12	3.6	37,331	1.6	11,884
	13	2.8	37,337	1.2	11,884

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	77,305	2.1	19,685
	2	9.6	77,921	2.0	19,840
	3	9.3	77,199	2.2	19,660
	4	9.4	76,150	2.8	19,390
	14	9.5	80,109	1.8	20,400
Fans B and C	5	5.4	75,750	2.7	19,290
	6	4.4	75,682	2.4	19,270
	7	4.9	76,283	1.5	19,425
	8	5.4	76,818	1.8	19,560
	9	4.8	76,316	1.8	19,435
Fans A and C	10	2.1	78,427	2.0	19,970
	11	3.6	78,310	1.3	19,940
	12	3.3	78,886	1.6	20,090
	13	1.3	78,388	1.5	19,960

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	17,360	3.8	9,473
	2	2.6	17,456	3.4	9,525
	3	2.9	17,323	3.9	9,452
	4	2.7	17,391	3.5	9,490
	5	3.3	17,271	3.4	9,424
	6	2.8	17,239	3.3	9,408
	7	2.6	17,383	3.4	9,485
Fan B	8	4.2	18,116	3.3	9,886
	9	3.5	18,231	3.2	9,949
	10	3.7	17,895	2.7	9,765
	11	3.3	18,022	4.0	9,835
	12	3.7	18,060	3.0	9,854
	13	3.7	18,057	3.0	9,854
	14	3.9	17,968	3.4	9,805

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	2,820	11,280	1191–2506	7,149–15,036
LB-S1	60	3,510	17,550	3,942	19,710	2602–4377	15,612–26,262
LB-S2	28	3,300	7,700	4,139	9,658	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	1271	7625^{N}	4.6	4.3	≤9.3
		Min	VT-7	1277	7664^{N}	4.2		
		Min	VT-9	1289	7733^{N}	4.1		
	2	Min	VT-8	1302	7810^{N}	3.6	3.6	≤8.6
	3	Min	VT-10	1297	7781^{N}	1.3	1.3	≤6.3
B	1	Min	VT-12	1235	7408^{N}	1.9	1.9	≤6.9
	2	Min	VT-13	1275	7649^{N}	2.4	2.4	≤7.4
		Min	VT-16	1191	7149^{N}	1.9	2.0	≤7.0
	3	Min	VT-15	1247	7481^{N}	2.5		
		Min	VT-14	1284	7703^{N}	1.6		
A and B	1	Max	VT-2	2506	$15036^{D/B}$	3.4	3.4	≤8.4
	2	Max	VT-3	2325	$13951^{D/B}$	3.1	3.5	≤8.5
		Max	VT-17	2342	$14055^{D/B}$	4.2		
		Max	VT-5	2465	$14790^{D/B}$	3.3		
		Max	VT-6	2482	$14890^{D/B}$	3.2		
	3	Max	VT-4	2485	$14909^{D/B}$	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]	5.2	4.8	≤9.8
		Max	VT-8	1,531	9,186[D]	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)	35,297	77,396	17,698
Verification Test Average DV (ft^2/min)	11,280	19,710	9,658
Minimum Allowable DV (1/6DV, ft^2/min)[a]	199	434	255
Maximum Allowable DV (6DV, ft^2/min)[b]	15,036	26,262	9,870
Minimum Qualified Stack Velocity (sfpm)	50	87	109
Maximum Qualified Stack Velocity (sfpm)	3759	5252	4,230
Minimum Qualified Stack Flow (scfm)	625	1,704	467
Maximum Qualified Stack Flow (scfm)	47,237	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.

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

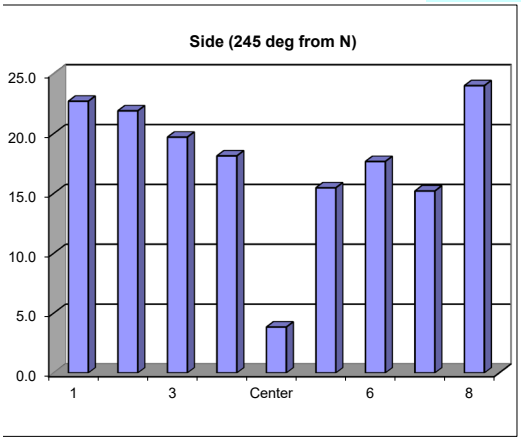
Stack	LB-C2	Run No.	FA-1
Date	10/15/2019	Fan Setting	N/A Hz
Start/End Time	11:20 11:50	Fan Configuration	Fan A only
Testers	ZDH/LCE	Stack Temp	61 deg F
Stack Dia.	48 in	Approx. air vel.	2812 afpm at point > Mean All
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

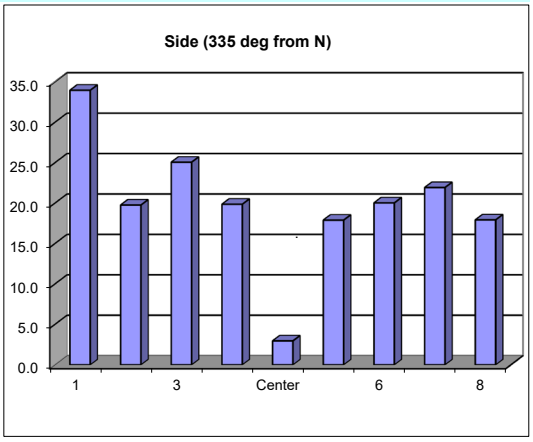
Order -->	First				Second			
Traverse-->	Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Trial ---->	1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw			deg. cw			
1	46.46	24.7	20.1	23.3	22.7	33.3	34.4	34.2	34.0
2	42.96	29.3	18.5	17.9	21.9	20.8	21.6	16.9	19.8
3	38.69	19.7	19.9	19.5	19.7	27.3	23.9	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 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.
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.





Data Transcribed by:	Ernest Antonio	Data Entered by:	Ernest Antonio	Transciption Review performed by:	Jennifer Yac
Signature/date	3/4/2020	Signature/date	3/5/2020	Signature/date	3/18/2020

FLOW ANGLE DATA FORM

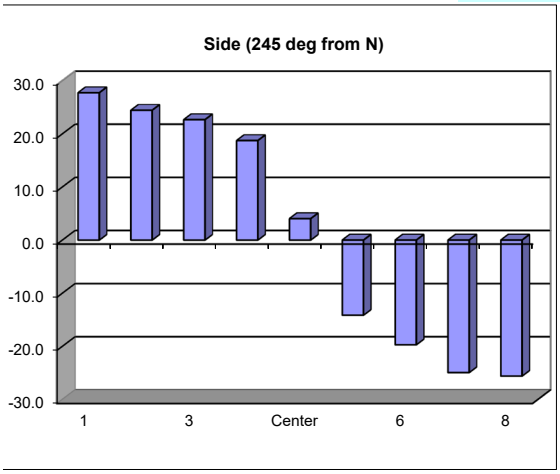
Stack	LB-C2	Run No.	FA-2
Date	10/15/2019	Fan Setting	N/A Hz
Start/End Time	14:57 15:10	Fan Configuration	Fan A only
Testers	ZDH/LCE	Stack Temp	66.6 deg F
Stack Dia.	48 in	Approx. air vel.	2809 afpm at point > All
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

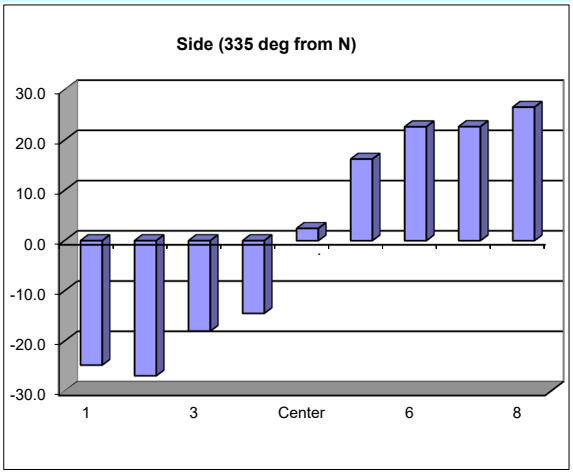
Order -->		First				Second			
Traverse-->		Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	46.46	28.1	27.7	27.4	27.7	-26.9	-24.3	-23.1	-24.8
2	42.96	25.5	23.0	24.8	24.4	-27.0	-26.8	-26.9	-26.9
3	38.69	21.7	23.4	22.9	22.7	-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 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 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 wall values





Data Transcribed by:	Ernest Antonio	Data Entered by:	Ernest Antonio	Transciption Review performed by:	Jennifer Yac
Signature/date	3/4/2020	Signature/date	3/5/2020	Signature/date	3/18/2020

FLOW ANGLE DATA FORM

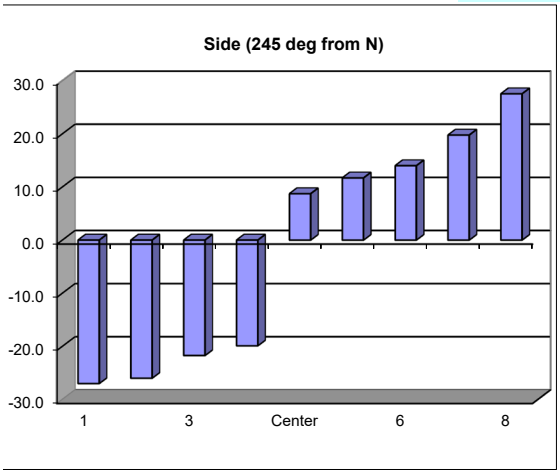
Stack	LB-C2	Run No.	FA-3
Date	10/16/2019	Fan Setting	N/A Hz
Start/End Time	9:04 9:17	Fan Configuration	Fan A only
Testers	ZDH/LCE	Stack Temp	63.7 deg F
Stack Dia.	48 in	Approx. air vel.	2735 afpm at point > Mean All
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

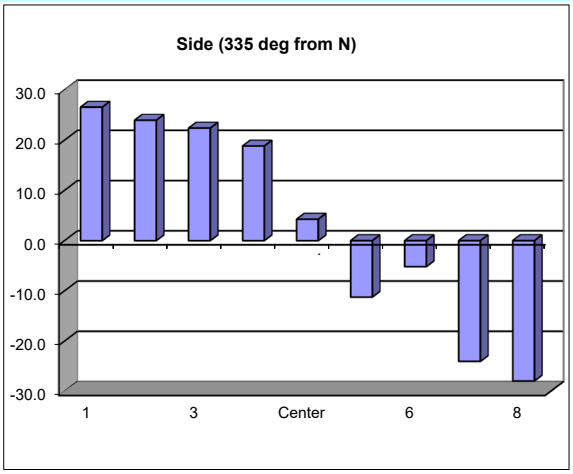
Order -->		First				Second			
Traverse-->		Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	46.46	-28.6	-26.5	-25.9	-27.0	25.3	26.8	27.6	26.6
2	42.96	-24.2	-27.5	-26.3	-26.0	26.5	22.2	23.2	24.0
3	38.69	-21.8	-21.9	-21.5	-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 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





Data Transcribed by:	Ernest Antonio	Data Entered by:	Ernest Antonio	Transciption Review performed by:	Jennifer Yac
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FLOW ANGLE DATA FORM

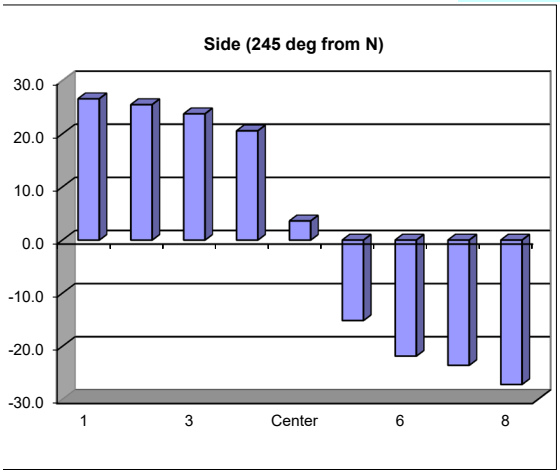
Stack	LB-C2	Run No.	FA-4
Date	10/16/2019	Fan Setting	N/A Hz
Start/End Time	10:24 10:35	Fan Configuration	Fan A only
Testers	ZDH/LCE	Stack Temp	65.4 deg F
Stack Dia.	48 in	Approx. air vel.	2741 afpm at point > Mean All
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

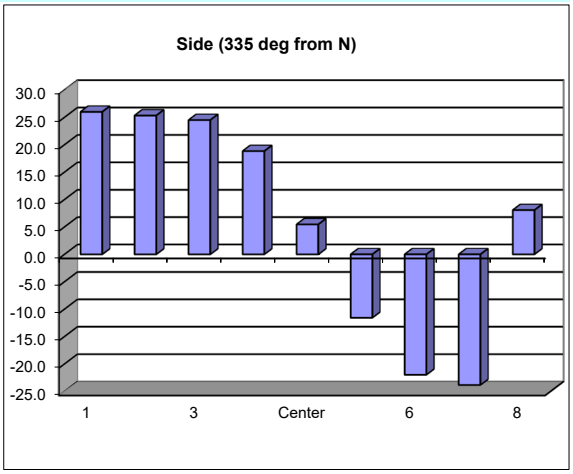
Order -->		First				Second			
Traverse-->		Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	46.46	26.7	26.5	26.6	26.6	26.5	25.7	25.8	26.0
2	42.96	25.7	25.9	24.9	25.5	24.8	25.3	25.9	25.3
3	38.69	24.7	23.6	23.0	23.8	24.5	24.4	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 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





Data Transcribed by:	Ernest Antonio	Data Entered by:	Ernest Antonio	Transciption Review performed by:	Jennifer Yac
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FLOW ANGLE DATA FORM

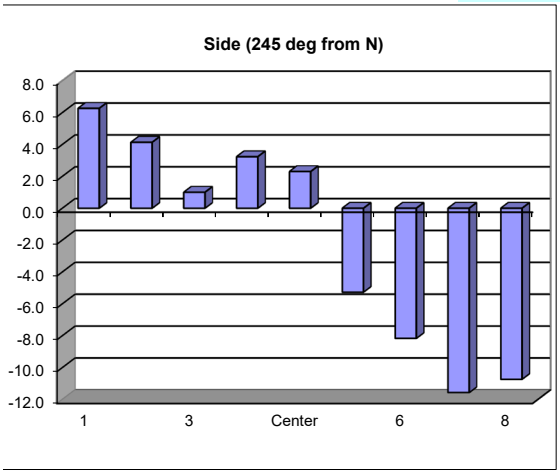
Stack	LB-C2	Run No.	FA-5
Date	10/16/2019	Fan Setting	N/A Hz
Start/End Time	12:49 12:58	Fan Configuration	Fan B only
Testers	ZDH/LCE	Stack Temp	68.5 deg F
Stack Dia.	48 in	Approx. air vel.	2688 afpm at point > Mean All
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

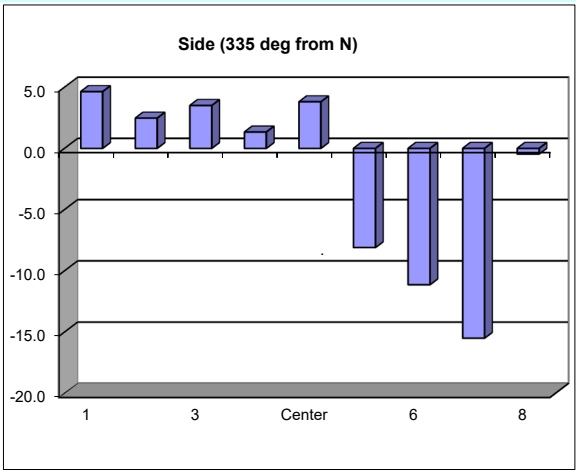
Order -->		First				Second			
Traverse-->		Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	46.46	6.9	6.5	5.4	6.3	5.1	4.3	4.5	4.6
2	42.96	3.0	4.0	5.4	4.1	3.6	1.2	2.6	2.5
3	38.69	1.6	0.8	0.6	1.0	3.8	3.5	3.2	3.5
4	32.50	3.4	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





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FLOW ANGLE DATA FORM

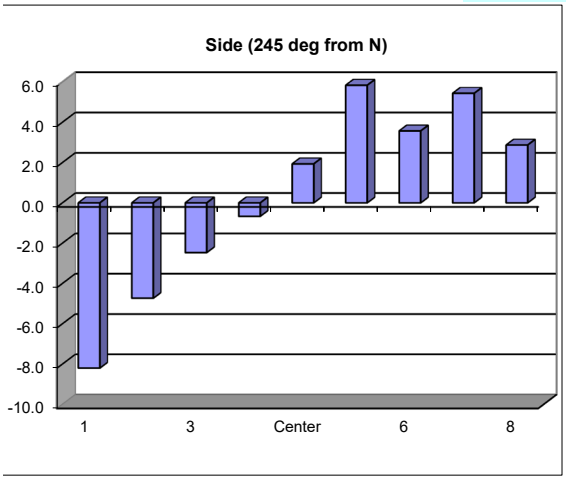
Stack	LB-C2	Run No.	FA-6
Date	10/16/2019	Fan Setting	N/A Hz
Start/End Time	13:55 14:00	Fan Configuration	Fan B only
Testers	ZDH/LCE	Stack Temp	68.5 deg F
Stack Dia.	48 in	Approx. air vel.	2697 afpm at point > Mean All
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

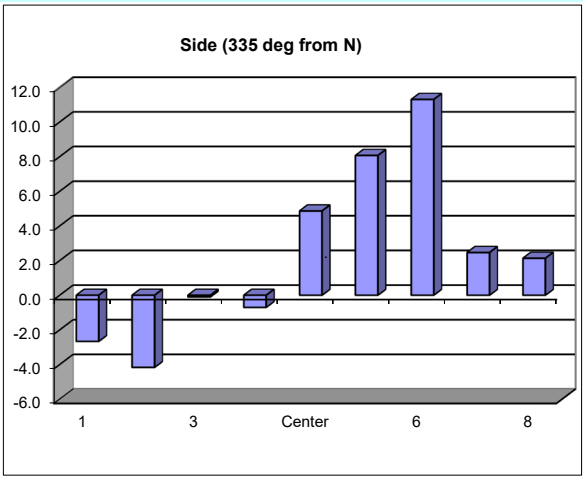
Order -->		First				Second			
Traverse-->		Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	46.46	-7.4	-8.8	-8.4	-8.2	-3.0	-2.9	-2.1	-2.7
2	42.96	-4.3	-4.6	-5.3	-4.7	-7.8	-2.4	-2.3	-4.2
3	38.69	-2.7	-2.4	-2.3	-2.5	-0.3	0.0	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





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FLOW ANGLE DATA FORM

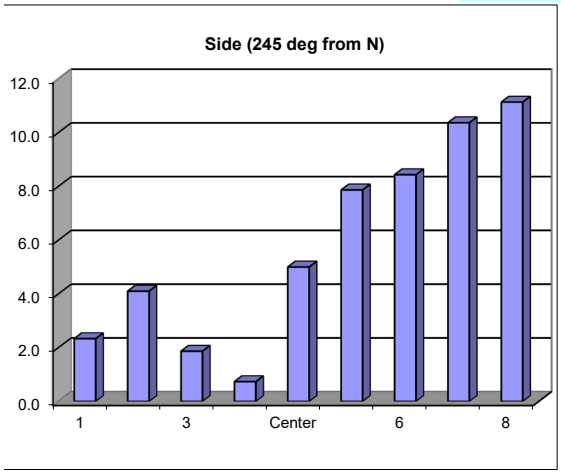
Stack	LB-C2	Run No.	FA-7
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	9:00 9:10	Fan Configuration	Fan B only
Testers	ZDH/LCE	Stack Temp	66.5 deg F
Stack Dia.	48 in	Approx. air vel.	2763 afpm at point > Mean All
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

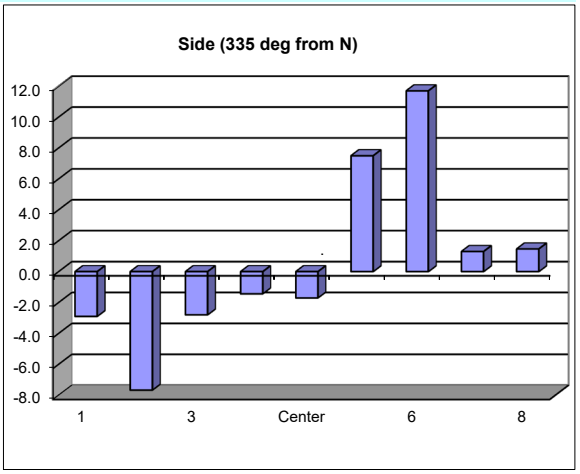
		Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Order -->		First				Second			
Traverse-->									
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	46.46	1.4	2.8	2.8	2.3	-2.5	-3.3	-2.9	-2.9
2	42.96	5.6	4.5	2.2	4.1	-10.7	-6.5	-5.8	-7.7
3	38.69	2.7	2.1	0.8	1.9	-3.6	-3.1	-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





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Signature/date	3/4/2020	Signature/date	3/5/2020	Signature/date	3/18/2020

FLOW ANGLE DATA FORM

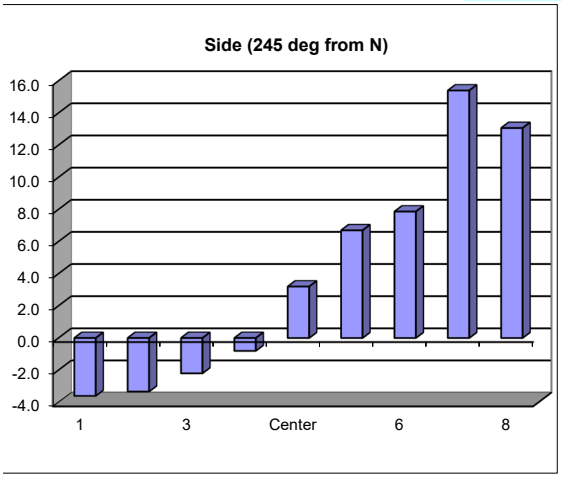
Stack	LB-C2	Run No.	FA-8
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	10:05 10:17	Fan Configuration	Fan B only
Testers	ZDH/LCE	Stack Temp	68.4 deg F
Stack Dia.	48 in	Approx. air vel.	2785 afpm at point > Mean All
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

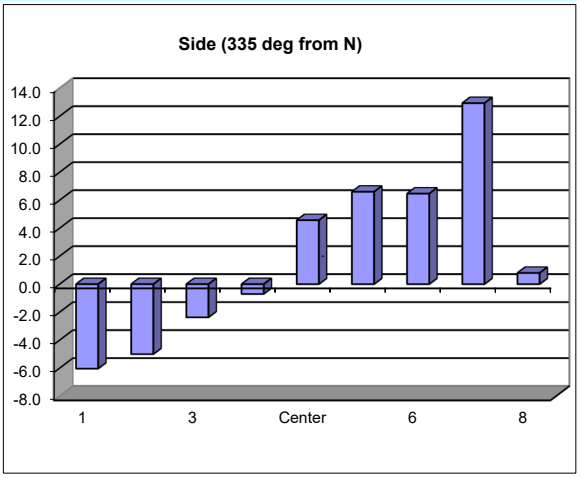
Order -->		First				Second			
Traverse-->		Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	46.46	-3.8	-3.4	-3.6	-3.6	-6.9	-5.5	-5.7	-6.0
2	42.96	-3.7	-3.9	-2.4	-3.3	-5.5	-4.2	-5.3	-5.0
3	38.69	-2.5	-2.4	-1.7	-2.2	-2.9	-2.0	-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





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Signature/date	3/4/2020	Signature/date	3/5/2020	Signature/date	3/18/2020

FLOW ANGLE DATA FORM

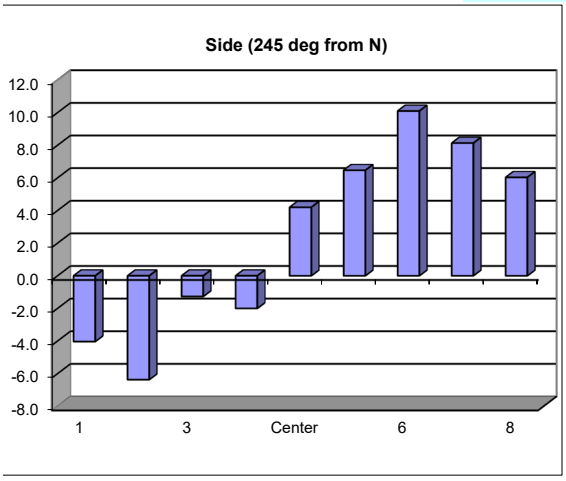
Stack	LB-C2	Run No.	FA-9
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	11:13 11:20	Fan Configuration	Fan B only
Testers	ZDH/LCE	Stack Temp	71.4 deg F
Stack Dia.	48 in	Approx. air vel.	2754 afpm at point > Mean All
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

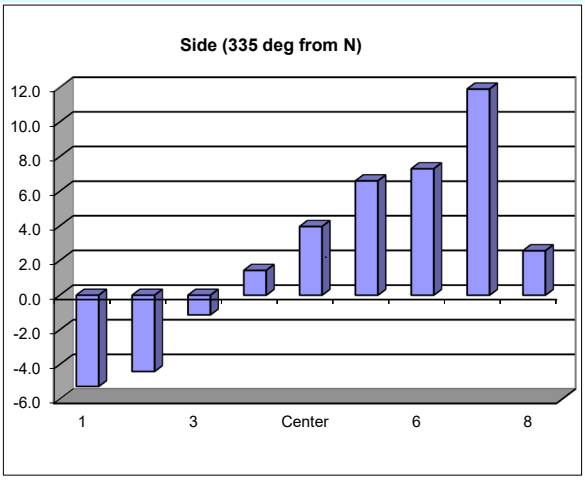
Order -->		First				Second			
Traverse-->		Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	46.46	-5.3	-3.2	-3.6	-4.0	-6.4	-4.3	-5.1	-5.3
2	42.96	-6.9	-6.1	-6.1	-6.4	-5.4	-4.9	-2.9	-4.4
3	38.69	-0.7	-0.5	-2.6	-1.3	-0.9	-1.1	-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





Data Transcribed by:	Ernest Antonio	Data Entered by:	Ernest Antonio	Transciption Review performed by:	Jennifer Yao
Signature/date	3/4/2020	Signature/date	3/5/2020	Signature/date	3/18/2020

FLOW ANGLE DATA FORM

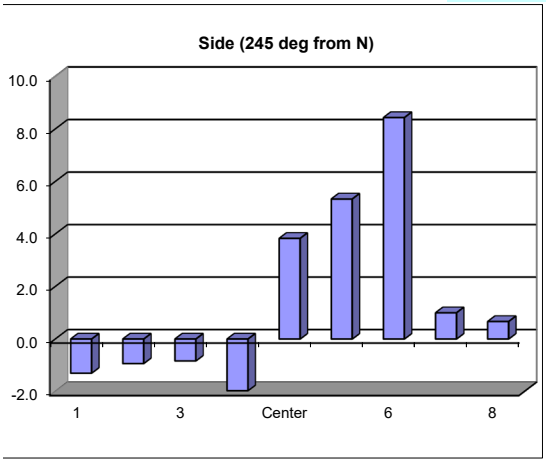
Stack	LB-C2	Run No.	FA-10
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	14:09 14:16	Fan Configuration	Fans A & B
Testers	ZDH/LCE	Stack Temp	68.1 deg F
Stack Dia.	48 in	Approx. air vel.	2972 afpm at point > Mean All
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

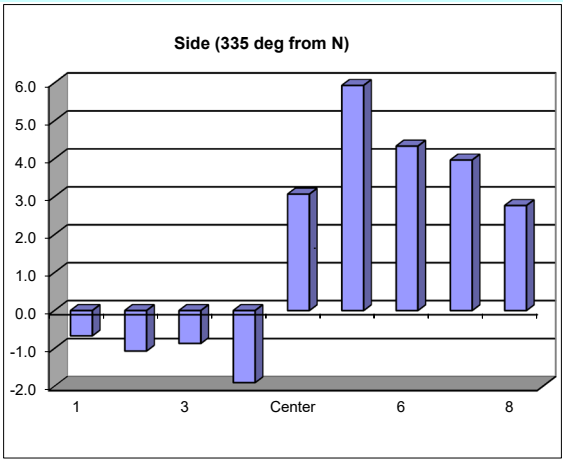
Order -->	First				Second			
Traverse-->	Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Trial ---->	1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw			deg. cw			
1	46.46	-1.0	-2.2	-0.7	-1.3	-0.4	-1.2	-0.4	-0.7
2	42.96	-0.5	-1.1	-1.2	-0.9	-1.1	-0.9	-1.2	-1.1
3	38.69	-1.0	-0.7	-0.8	-0.8	-1.3	-0.6	-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





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Signature/date	3/4/2020	Signature/date	3/5/2020	Signature/date	3/18/2020

FLOW ANGLE DATA FORM

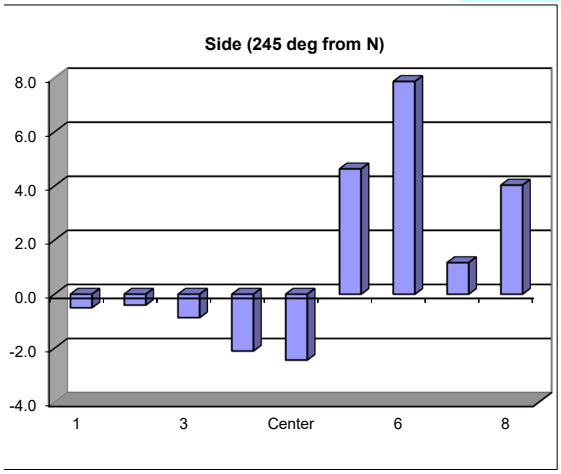
Stack	LB-C2	Run No.	FA-11
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	15:15 15:21	Fan Configuration	Fans A & B
Testers	ZDH/LCE	Stack Temp	68.9 deg F
Stack Dia.	48 in	Approx. air vel.	2987 afpm at point > Mean All
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

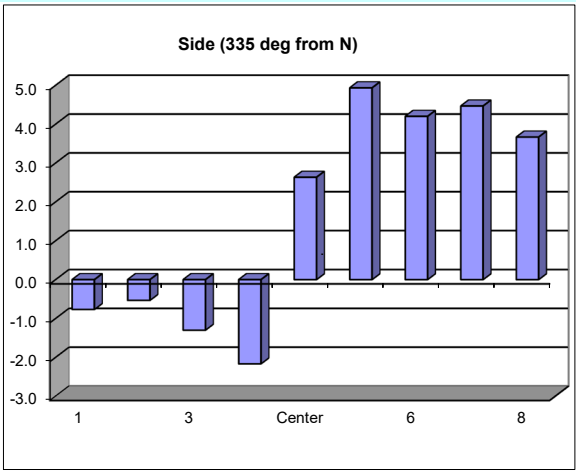
Order -->	First				Second			
Traverse-->	Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Trial ---->	1	2	3	Mean	1	2	3	Mean
Point / Depth, in.	deg. cw				deg. cw			
1 / 46.46	-1.0	-0.2	-0.3	-0.5	-0.8	-0.7	-0.8	-0.8
2 / 42.96	-0.1	-0.5	-0.6	-0.4	-0.7	-0.3	-0.6	-0.5
3 / 38.69	-1.9	-0.4	-0.3	-0.9	-1.1	-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





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FLOW ANGLE DATA FORM

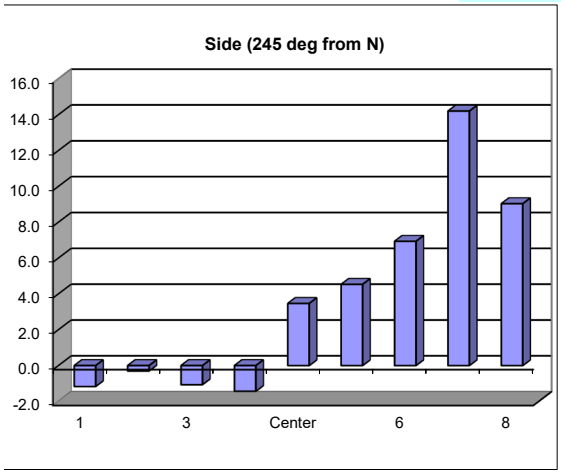
Stack	LB-C2	Run No.	FA-12
Date	10/18/2019	Fan Setting	N/A Hz
Start/End Time	8:56 9:04	Fan Configuration	Fans A & B
Testers	ZDH/LCE	Stack Temp	62.8 deg F
Stack Dia.	48 in	Approx. air vel.	2987 afpm at point > Mean All
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

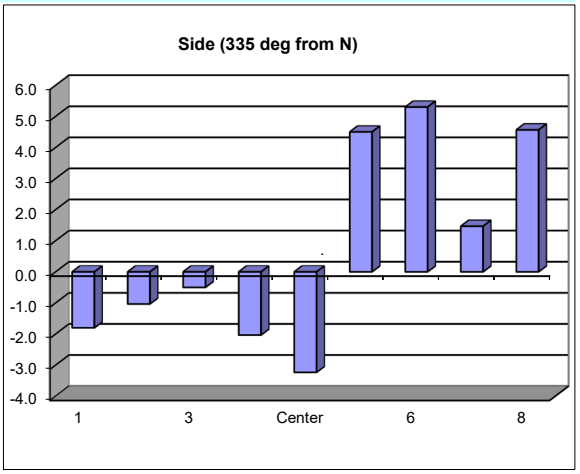
		Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Order -->		First				Second			
Traverse-->									
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	46.46	-1.6	-0.6	-1.3	-1.2	-2.7	-2.0	-0.7	-1.8
2	42.96	0.0	-0.5	-0.4	-0.3	-1.1	-1.0	-1.0	-1.0
3	38.69	-0.9	-1.2	-1.1	-1.1	-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





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Signature/date	3/4/2020	Signature/date	3/5/2020	Signature/date	3/18/2020

FLOW ANGLE DATA FORM

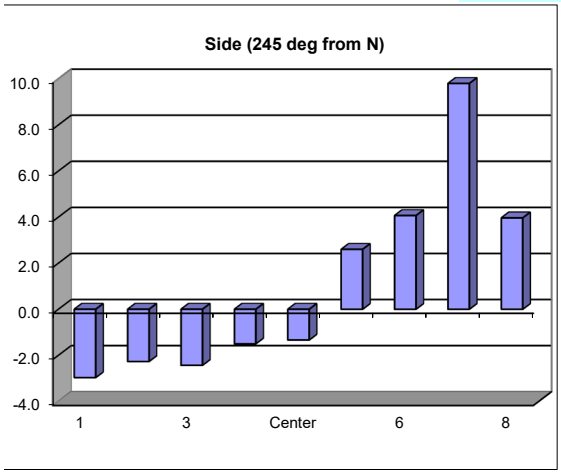
Stack	LB-C2	Run No.	FA-13
Date	10/18/2019	Fan Setting	N/A Hz
Start/End Time	10:02 10:10	Fan Configuration	Fans A & B
Testers	ZDH/LCE	Stack Temp	64.9 deg F
Stack Dia.	48 in	Approx. air vel.	2982 afpm at point > Mean All
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

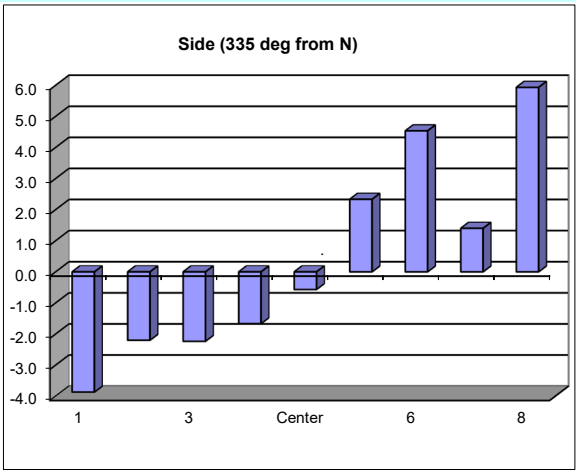
Order -->	First				Second			
Traverse-->	Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Trial ---->	1	2	3	Mean	1	2	3	Mean
Point / Depth, in.	deg. cw				deg. cw			
1 / 46.46	-2.6	-3.4	-2.9	-3.0	-4.6	-3.6	-3.4	-3.9
2 / 42.96	-1.5	-1.8	-3.5	-2.3	-2.2	-2.3	-2.1	-2.2
3 / 38.69	-2.4	-2.2	-2.7	-2.4	-2.8	-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





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FLOW ANGLE DATA FORM

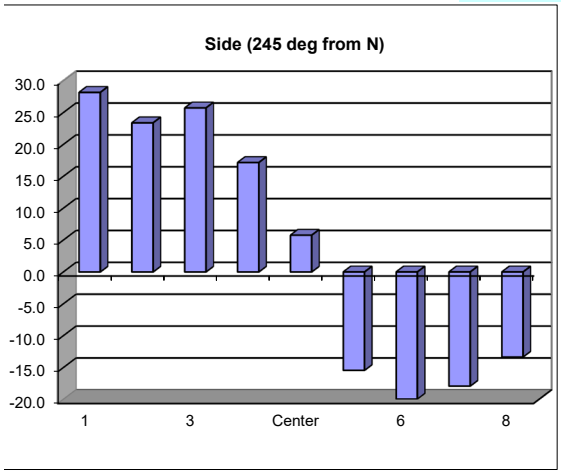
Stack	LB-C2	Run No.	FA-14
Date	10/19/2019	Fan Setting	N/A Hz
Start/End Time	9:06 9:15	Fan Configuration	Fan A
Testers	ZDH/LCE	Stack Temp	61.9 deg F
Stack Dia.	48 in	Approx. air vel.	2963 afpm at point > Mean All
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

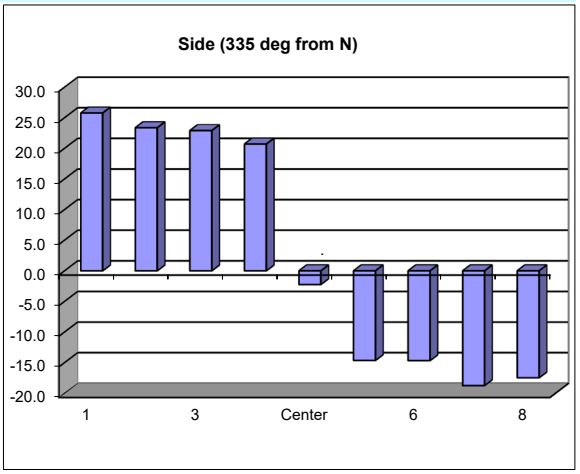
Order -->	First				Second			
Traverse-->	Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Trial ---->	1	2	3	Mean	1	2	3	Mean
Point / Depth, in.	deg. cw				deg. cw			
1 / 46.46	27.6	28.2	28.7	28.2	26.5	26.0	24.8	25.8
2 / 42.96	23.3	23.3	23.6	23.4	23.6	23.0	23.5	23.4
3 / 38.69	26.0	25.7	25.5	25.7	23.1	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





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Signature/date	3/4/2020	Signature/date	3/5/2020	Signature/date	3/18/2020

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	2,665.3	2,572.8	2,604.0	2,614.0	2,725.2	2,572.8	2,634.8	2,644.3
2	42.96	2,841.2	2,841.2	2,869.5	2,850.6	2,925.2	2,783.8	2,754.6	2,821.2
3	38.69	2,897.5	2,869.5	2,952.7	2,906.6	2,925.2	2,897.5	2,897.5	2,906.7
4	32.50	3,006.8	2,979.9	3,006.8	2,997.8	2,869.5	2,925.2	2,952.7	2,915.8
Center	24.00	2,925.2	2,869.5	2,841.2	2,878.6	3,033.6	2,952.7	2,812.6	2,933.0
5	15.50	2,952.7	2,783.8	2,841.2	2,859.2	2,841.2	2,897.5	2,841.2	2,860.0
6	9.31	2,869.5	2,783.8	2,869.5	2,840.9	2,869.5	2,841.2	2,812.6	2,841.1
7	5.04	2,754.6	2,725.2	2,695.4	2,725.1	2,754.6	2,783.8	2,604.0	2,714.1
8	1.54	2,695.4	2,665.3	2,604.0	2,654.9	2,695.4	2,541.2	2,725.2	2,653.9
Averages ---------->		2,845.4	2,787.9	2,809.4	2,814.2	2,848.8	2,799.5	2,781.7	2,810.0

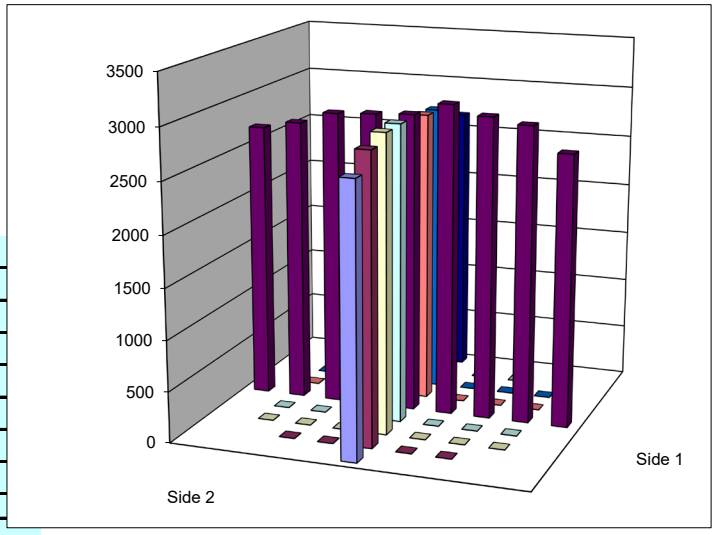
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	2812.1		Mean	2865.6	2856.0	2860.8
Min Point	2614.0	-7.0%	Std. Dev.	81.6	74.9	75.4
Max Point	2997.8	6.6%	COV as %	2.8	2.6	**2.6**

Flow w/o C-Pt 35191 cfm

Vel Avg w/o C-Pt 2800 fpm

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

	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	17.61	17.95	mbars
Ambient pressure	992.55	992.21	mbars
Total Stack pressure	1010.2	1010.2	mbars
Ambient humidity	40%	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/9/2020	Signature/date	3/9/2020	Signature/date	3/17/2020

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	2,771.0	2,650.4	2,800.3	2,740.6	2,650.4	2,681.1	2,711.4	2,681.0
2	42.96	2,771.0	2,829.3	2,886.5	2,828.9	2,800.3	2,711.4	2,771.0	2,760.9
3	38.69	2,997.5	2,886.5	2,800.3	2,894.8	2,858.0	2,800.3	2,829.3	2,829.2
4	32.50	2,942.5	2,914.6	3,024.7	2,960.6	2,970.2	2,997.5	2,829.3	2,932.3
Center	24.00	3,130.8	2,942.5	2,886.5	2,986.6	3,024.7	2,914.6	2,886.5	2,941.9
5	15.50	2,858.0	2,771.0	2,800.3	2,809.8	2,942.5	2,858.0	3,051.6	2,950.7
6	9.31	2,711.4	2,858.0	2,829.3	2,799.6	2,914.6	2,858.0	2,886.5	2,886.4
7	5.04	2,741.3	2,829.3	2,741.3	2,770.6	2,711.4	2,681.1	2,741.3	2,711.3
8	1.54	2,619.4	2,681.1	2,619.4	2,640.0	2,286.4	2,556.3	2,491.6	2,444.8
Averages ---------->		2,838.1	2,818.1	2,821.0	2,825.7	2,795.4	2,784.3	2,799.8	2,793.2

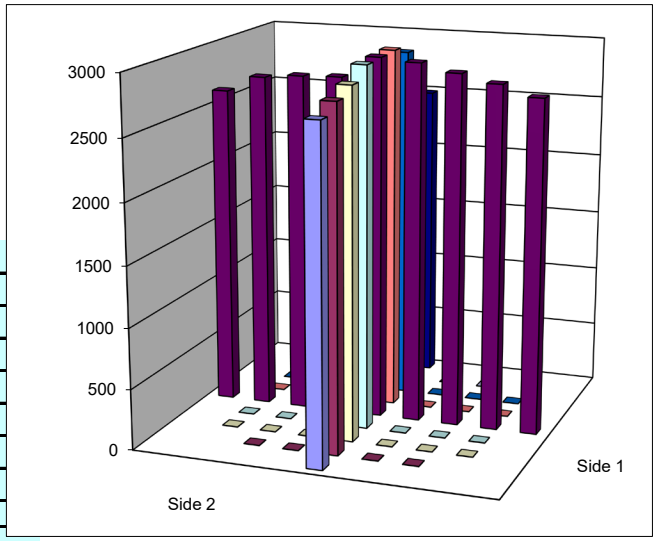
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	2809.4		Mean	2864.4	2859.0	2861.7
Min Point	2444.8	-13.0%	Std. Dev.	84.0	94.6	86.0
Max Point	2986.6	6.3%	COV as %	2.9	3.3	**3.0**

Flow w/o C-Pt 35061 cfm

Vel Avg w/o C-Pt 2790 fpm

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

	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	27.77	74.16	mbars
Ambient pressure	992.55	990.86	mbars
Total Stack pressure	1020.32	1065.02	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/9/2020	Signature/date	3/9/2020	Signature/date	3/17/2020

VELOCITY TRAVERSE DATA FORM

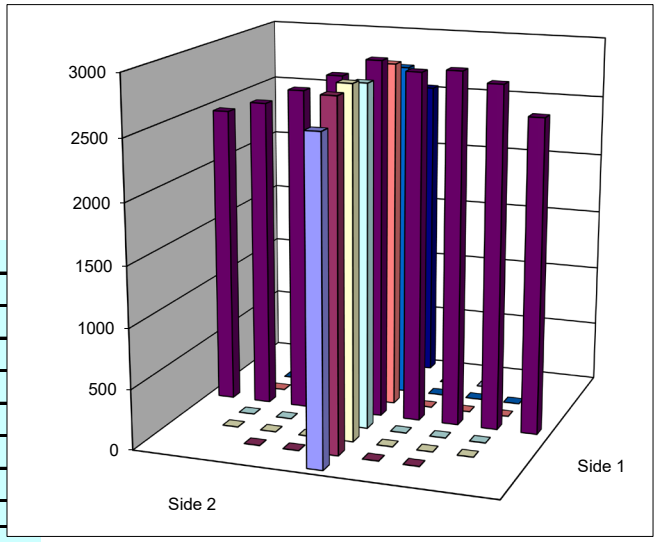
Stack	LB-C2	Run No.	VT-3
Date	10/16/19	Fan Configuration	Fan A only
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	48 in.	Stack Temp	63.75 deg F
Stack X-Area	1809.6 in.2	Start/End Time	8:53 9:00
Test Port	2	Center 2/3 from	4.40 to: 43.60
Distance to disturbance	53.3 ft	Points in Center 2/3	2 to: 7
Velocity 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	2,588.6	2,556.8	2,620.0	2588.5	2,524.7	2,620.0	2,588.6	2,577.8
2	42.96	2,771.5	2,829.9	2,887.1	2829.5	2,771.5	2,771.5	2,800.9	2,781.3
3	38.69	2,858.6	2,943.1	2,943.1	2914.9	2,771.5	2,887.1	2,800.9	2,819.8
4	32.50	2,915.2	2,829.9	2,915.2	2886.8	2,681.6	2,800.9	2,829.9	2,770.8
Center	24.00	2,970.8	2,943.1	2,970.8	2961.6	2,829.9	2,998.1	2,858.6	2,895.5
5	15.50	2,887.1	2,800.9	2,771.5	2819.8	2,771.5	2,915.2	2,771.5	2,819.4
6	9.31	2,711.9	2,681.6	2,651.0	2681.5	2,741.9	2,771.5	2,711.9	2,741.8
7	5.04	2,524.7	2,588.6	2,556.8	2556.7	2,620.0	2,681.6	2,651.0	2,650.9
8	1.54	2,492.1	2,391.7	2,524.7	2469.5	2,492.1	2,425.6	2,492.1	2,469.9
Averages ---------->		2,746.7	2,729.5	2,760.0	2,745.4	2,689.4	2,763.5	2,722.8	2,725.2

All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	2735.3		Mean	2807.3	2782.8	2795.0
Min Point	2469.5	-9.7%	Std. Dev.	142.0	76.0	110.1
Max Point	2961.6	8.3%	COV as %	5.1	2.7	**3.9**

Flow w/o C-Pt	34070 cfm	**Instuments Used:**	Cal Due
Vel Avg w/o C-Pt	2711 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	23.03	30.14	mbars
Ambient pressure	985.10	985.10	mbars
Total Stack pressure	1008.1	1015.2	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/9/2020	Signature/date	3/9/2020	Signature/date	3/17/2020

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	2,560.2	2,623.5	2,560.2	2,581.3	2,325.4	2,394.9	2,495.4	2,405.2
2	42.96	2,833.7	2,833.7	2,890.9	2,852.8	2,890.9	2,775.2	2,833.7	2,833.3
3	38.69	2,862.4	2,833.7	2,804.6	2,833.6	2,833.7	2,862.4	2,833.7	2,843.3
4	32.50	2,862.4	2,804.6	2,862.4	2,843.1	2,919.1	2,804.6	2,833.7	2,852.5
Center	24.00	2,775.2	2,919.1	2,833.7	2,842.7	2,833.7	2,745.5	2,919.1	2,832.8
5	15.50	2,715.5	2,833.7	2,890.9	2,813.4	2,919.1	2,862.4	2,833.7	2,871.7
6	9.31	2,804.6	2,592.0	2,745.5	2,714.0	2,804.6	2,833.7	2,833.7	2,824.0
7	5.04	2,654.5	2,715.5	2,715.5	2,695.2	2,745.5	2,715.5	2,775.2	2,745.4
8	1.54	2,428.9	2,495.4	2,528.0	2,484.1	2,560.2	2,428.9	2,428.9	2,472.7
Averages ---------->		2,721.9	2,739.0	2,759.1	2,740.0	2,759.1	2,713.7	2,754.1	2,742.3

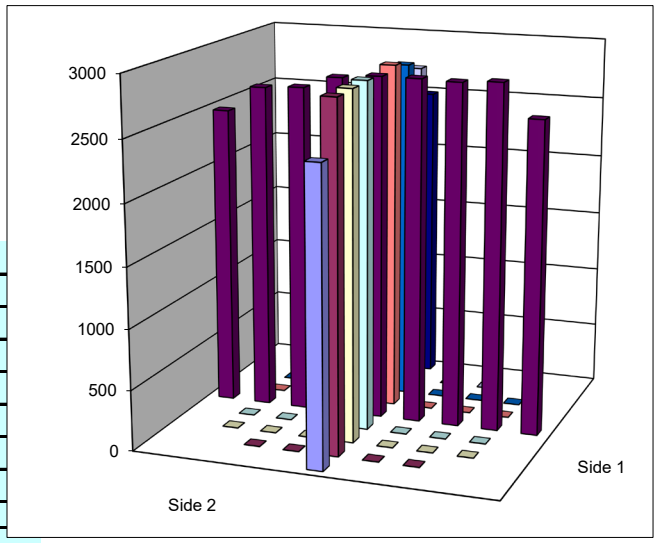
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	2741.2		Mean	2799.2	2829.0	2814.1
Min Point	2405.2	-12.3%	Std. Dev.	66.0	40.1	54.7
Max Point	2871.7	4.8%	COV as %	2.4	1.4	**1.9**

Flow w/o C-Pt 34295 cfm

Vel Avg w/o C-Pt 2729 fpm

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

	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	26.75	28.78	mbars
Ambient pressure	985.10	984.76	mbars
Total Stack pressure	1011.9	1013.5	mbars
Ambient humidity	44%	40%	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/9/2020	Signature/date	3/9/2020	Signature/date	3/17/2020

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	2,471.6	2,569.8	2,438.0	2,493.1	2,403.9	2,298.5	2,225.5	2,309.3
2	42.96	2,695.3	2,633.3	2,504.8	2,611.1	2,725.7	2,873.2	2,569.8	2,722.9
3	38.69	2,930.1	2,785.6	2,844.3	2,853.3	2,785.6	2,901.8	2,471.6	2,719.7
4	32.50	2,725.7	2,785.6	2,844.3	2,785.2	2,725.7	2,873.2	2,785.6	2,794.8
Center	24.00	2,844.3	2,755.8	2,873.2	2,824.4	2,633.3	2,815.1	2,785.6	2,744.7
5	15.50	2,785.6	2,873.2	2,901.8	2,853.5	2,873.2	2,695.3	2,873.2	2,813.9
6	9.31	2,844.3	2,901.8	2,471.6	2,739.2	2,785.6	2,725.7	2,755.8	2,755.7
7	5.04	2,755.8	2,664.5	2,725.7	2,715.3	2,695.3	2,664.5	2,815.1	2,725.0
8	1.54	2,369.3	2,471.6	2,438.0	2,426.3	2,471.6	2,471.6	2,569.8	2,504.3
Averages ---------->		2,713.6	2,715.7	2,671.3	2,700.2	2,677.8	2,702.1	2,650.2	2,676.7

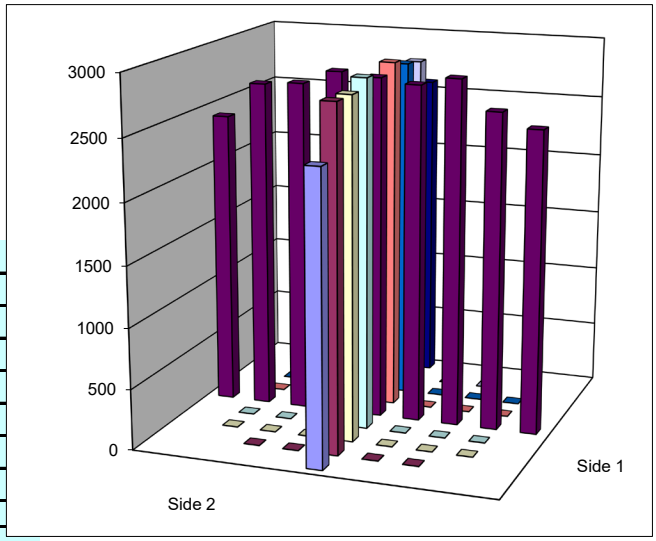
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	2688.4		Mean	2768.9	2753.8	2761.3
Min Point	2309.3	-14.1%	Std. Dev.	87.8	37.3	65.3
Max Point	2853.5	6.1%	COV as %	3.2	1.4	**2.4**

Flow w/o C-Pt 33633 cfm

Vel Avg w/o C-Pt 2676 fpm

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

	Start	Finish	
Stack temp	68.60	68.50	F
Equipment temp	62.30	68.50	F
Ambient temp	62.30	66.30	F
Stack static	34.88	40.98	mbars
Ambient pressure	984.08	984.08	mbars
Total Stack pressure	1019.0	1025.1	mbars
Ambient humidity	42%	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/9/2020	Signature/date	3/9/2020	Signature/date	3/17/2020

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	2,604.4	2,507.3	2,540.1	2,550.6	2,440.4	2,406.3	2,440.4	2,429.0
2	42.96	2,817.9	2,788.4	2,728.5	2,778.3	2,336.5	2,406.3	2,604.4	2,449.1
3	38.69	2,728.5	2,758.6	2,788.4	2,758.5	2,604.4	2,758.6	2,817.9	2,727.0
4	32.50	2,758.6	2,817.9	2,667.1	2,747.9	2,667.1	2,847.1	2,788.4	2,767.5
Center	24.00	2,876.1	2,758.6	2,847.1	2,827.3	2,817.9	2,758.6	2,604.4	2,727.0
5	15.50	2,728.5	2,635.9	2,847.1	2,737.2	2,817.9	2,847.1	2,847.1	2,837.4
6	9.31	2,788.4	2,817.9	2,904.7	2,837.0	2,788.4	2,788.4	2,728.5	2,768.4
7	5.04	2,788.4	2,728.5	2,635.9	2,717.6	2,728.5	2,728.5	2,604.4	2,687.1
8	1.54	2,507.3	2,336.5	2,440.4	2,428.1	2,728.5	2,788.4	2,788.4	2,768.4
Averages ---------->		2,733.1	2,683.3	2,711.0	2,709.1	2,658.8	2,703.3	2,691.5	2,684.5

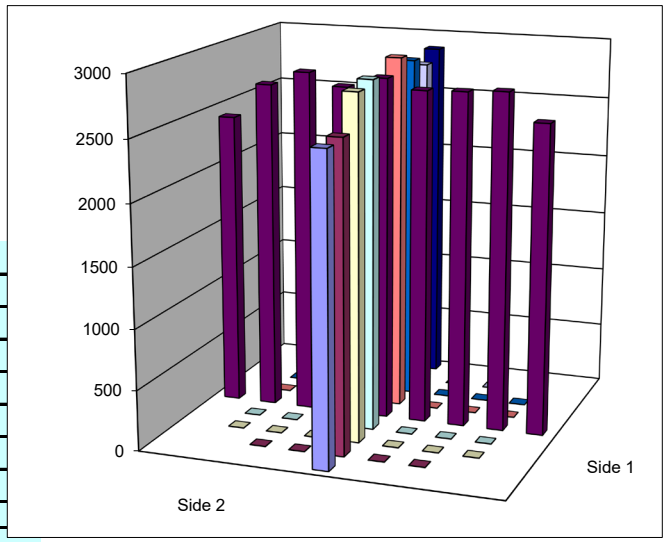
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	2696.8		Mean	2772.0	2709.1	2740.5
Min Point	2428.1	-10.0%	Std. Dev.	45.2	123.9	95.4
Max Point	2837.4	5.2%	COV as %	1.6	4.6	**3.5**

Flow w/o C-Pt 33764 cfm

Vel Avg w/o C-Pt 2687 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	42.67	16.25	mbars
Ambient pressure	983.41	983.41	mbars
Total Stack pressure	1026.1	999.7	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/9/2020	Signature/date	3/9/2020	Signature/date	3/17/2020

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	2,369.6	2,369.6	2,438.3	2,392.5	2,664.8	2,756.2	2,404.2	2,608.4
2	42.96	2,902.1	2,786.0	2,815.5	2,834.5	2,873.5	2,844.6	2,815.5	2,844.5
3	38.69	2,844.6	2,815.5	2,786.0	2,815.4	2,844.6	2,844.6	2,815.5	2,834.9
4	32.50	2,902.1	2,902.1	2,873.5	2,892.6	2,930.4	2,815.5	2,958.5	2,901.5
Center	24.00	2,815.5	2,873.5	2,986.3	2,891.8	2,815.5	2,844.6	2,815.5	2,825.2
5	15.50	2,902.1	2,844.6	2,786.0	2,844.2	2,786.0	2,873.5	2,786.0	2,815.2
6	9.31	2,873.5	2,930.4	2,902.1	2,902.0	2,695.6	2,873.5	2,726.1	2,765.1
7	5.04	2,844.6	2,815.5	2,695.6	2,785.2	2,695.6	2,664.8	2,726.1	2,695.5
8	1.54	2,602.1	2,695.6	2,505.1	2,600.9	2,369.6	2,505.1	2,570.2	2,481.6
Averages ---------->		2,784.0	2,781.4	2,754.3	2,773.2	2,741.7	2,780.3	2,735.3	2,752.4

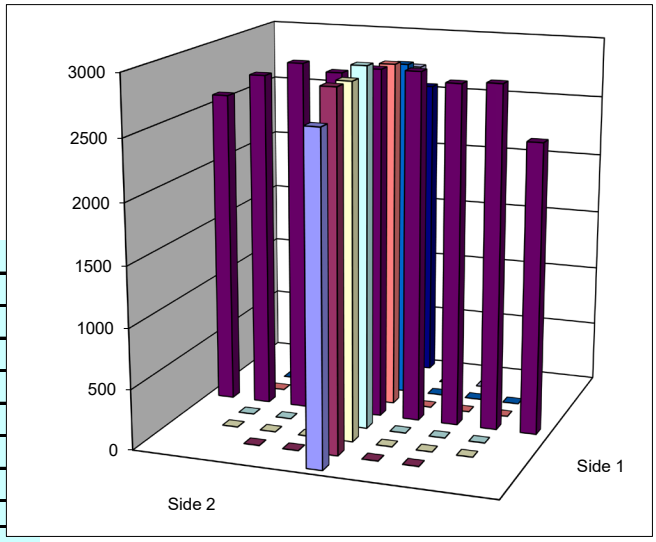
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	2762.8		Mean	2852.2	2811.7	2832.0
Min Point	2392.5	-13.4%	Std. Dev.	44.5	65.3	57.6
Max Point	2902.0	5.0%	COV as %	1.6	2.3	**2.0**

Flow w/o C-Pt 34569 cfm

Vel Avg w/o C-Pt 2751 fpm

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

	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	26.75	32.51	mbars
Ambient pressure	980.02	978.67	mbars
Total Stack pressure	1006.8	1011.2	mbars
Ambient humidity	57%	53%	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/9/2020	Signature/date	3/9/2020	Signature/date	3/17/2020

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	2,511.7	2,478.4	2,544.5	2,511.5	2,733.2	2,576.9	2,671.8	2,660.6
2	42.96	2,733.2	2,793.3	2,822.9	2,783.1	2,822.9	2,702.7	2,763.4	2,763.0
3	38.69	2,909.7	2,733.2	2,881.1	2,841.3	2,881.1	2,881.1	2,881.1	2,881.1
4	32.50	2,793.3	2,733.2	2,909.7	2,812.1	2,822.9	2,733.2	2,881.1	2,812.4
Center	24.00	2,938.1	2,938.1	2,881.1	2,919.1	2,909.7	2,909.7	2,822.9	2,880.8
5	15.50	2,938.1	2,938.1	2,909.7	2,928.6	2,733.2	2,852.1	2,909.7	2,831.7
6	9.31	2,909.7	2,938.1	2,994.1	2,947.3	2,822.9	2,909.7	2,881.1	2,871.2
7	5.04	2,852.1	2,733.2	2,822.9	2,802.7	2,763.4	2,793.3	2,881.1	2,812.6
8	1.54	2,671.8	2,576.9	2,511.7	2,586.8	2,671.8	2,478.4	2,304.9	2,485.0
Averages ---------->		2,806.4	2,762.5	2,808.6	2,792.5	2,795.7	2,759.7	2,777.5	2,777.6

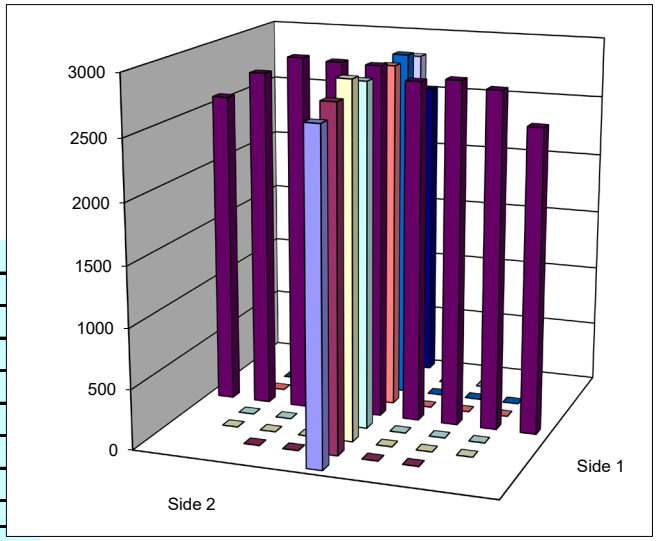
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	2785.1		Mean	2862.0	2836.1	2849.1
Min Point	2485.0	-10.8%	Std. Dev.	67.9	44.2	56.6
Max Point	2947.3	5.8%	COV as %	2.4	1.6	**2.0**

Flow w/o C-Pt 34818 cfm

Vel Avg w/o C-Pt 2771 fpm

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

	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	28.78	18.29	mbars
Ambient pressure	980.36	980.36	mbars
Total Stack pressure	1009.1	998.6	mbars
Ambient humidity	44%	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/9/2020	Signature/date	3/9/2020	Signature/date	3/17/2020

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	2,482.5	2,448.7	2,613.3	2,514.8	2,581.2	2,613.3	2,414.5	2,536.3
2	42.96	2,737.8	2,768.0	2,827.6	2,777.8	2,827.6	2,856.9	2,827.6	2,837.4
3	38.69	2,707.2	2,768.0	2,798.0	2,757.7	2,827.6	2,885.9	2,914.6	2,876.0
4	32.50	2,856.9	2,707.2	2,885.9	2,816.7	2,768.0	2,971.2	2,827.6	2,855.6
Center	24.00	2,885.9	2,856.9	2,856.9	2,866.6	2,798.0	2,768.0	2,885.9	2,817.3
5	15.50	2,856.9	2,613.3	2,885.9	2,785.4	2,885.9	2,798.0	2,768.0	2,817.3
6	9.31	2,885.9	2,885.9	2,885.9	2,885.9	2,827.6	2,827.6	2,856.9	2,837.4
7	5.04	2,707.2	2,707.2	2,798.0	2,737.5	2,737.8	2,768.0	2,737.8	2,747.9
8	1.54	2,581.2	2,548.7	2,613.3	2,581.1	2,548.7	2,515.8	2,482.5	2,515.7
erages ---------->		2,744.6	2,700.4	2,796.1	2,747.0	2,755.8	2,778.3	2,746.2	2,760.1

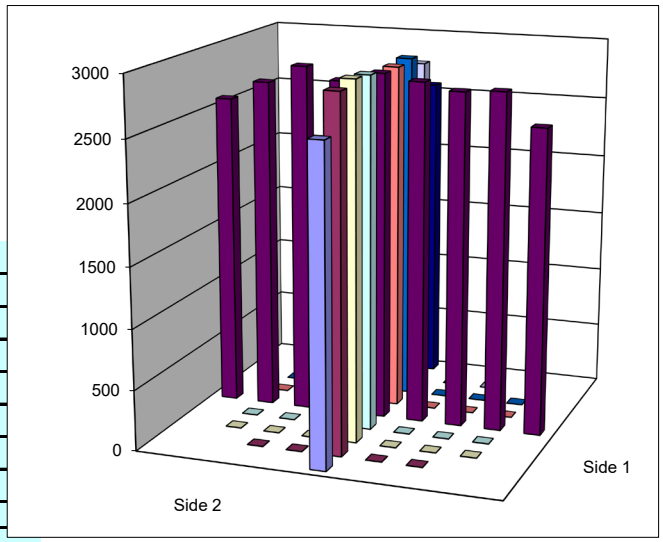
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	2753.6		Mean	2803.9	2827.0	2815.5
Min Point	2514.8	-8.7%	Std. Dev.	55.3527	40.6	48.1
Max Point	2885.9	4.8%	COV as %	2.0	1.4	**1.7**

Flow w/o C-Pt 34464 cfm

Vel Avg w/o C-Pt 2743 fpm

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

	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	12.19	14.22	mbars
Ambient pressure	980.70	980.70	mbars
Total Stack pressure	992.9	994.9	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

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Signature/date	3/9/2020	Signature/date	3/9/2020	Signature/date	3/18/2020

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	2,638.5	2,700.6	2,638.5	2,659.2	2,606.9	2,542.5	2,574.9	2,574.8
2	42.96	3,019.3	3,046.6	3,046.6	3,037.5	2,963.9	2,849.9	3,073.7	2,962.5
3	38.69	3,205.7	3,127.2	3,205.7	3,179.5	3,019.3	3,046.6	3,019.3	3,028.4
4	32.50	3,100.6	3,153.6	3,100.6	3,118.3	3,100.6	3,073.7	3,153.6	3,109.3
Center	24.00	3,073.7	3,127.2	3,100.6	3,100.5	3,046.6	3,100.6	3,073.7	3,073.6
5	15.50	3,046.6	3,046.6	3,073.7	3,055.6	3,046.6	3,073.7	3,019.3	3,046.5
6	9.31	3,019.3	3,100.6	3,073.7	3,064.5	3,046.6	3,073.7	3,100.6	3,073.6
7	5.04	2,991.7	3,046.6	2,991.7	3,010.0	3,073.7	2,935.8	2,935.8	2,981.8
8	1.54	2,700.6	2,638.5	2,606.9	2,648.7	2,878.8	2,700.6	2,731.1	2,770.2
Averages ---------->		2,977.3	2,998.6	2,982.0	2,986.0	2,975.9	2,933.0	2,964.7	2,957.9

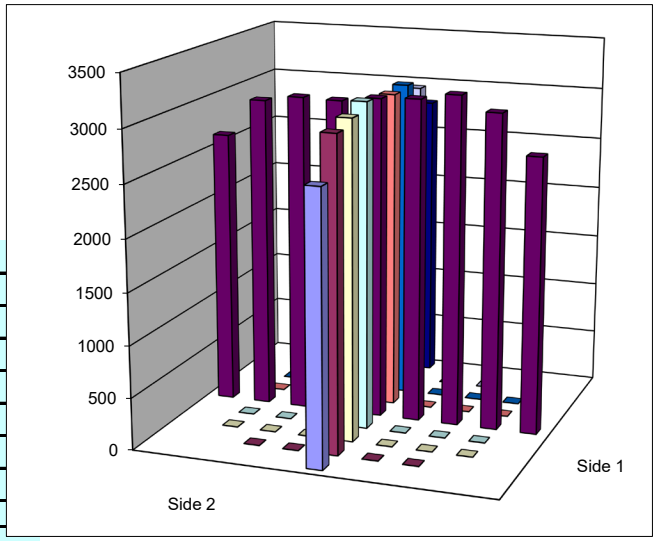
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	2971.9		Mean	3080.9	3039.4	3060.1
Min Point	2574.8	-13.4%	Std. Dev.	56.8	52.7	56.8
Max Point	3179.5	7.0%	COV as %	1.8	1.7	**1.9**

Flow w/o C-Pt 37165 cfm

Vel Avg w/o C-Pt 2958 fpm

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

	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	19.64	17.61	mbars
Ambient pressure	980.70	980.70	mbars
Total Stack pressure	1000.34	998.31	mbars
Ambient humidity	45%	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

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Signature/date	3/9/2020	Signature/date	3/9/2020	Signature/date	3/18/2020

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	2,700.5	2,731.0	2,638.4	2,690.0	2,638.4	2,542.4	2,574.8	2,585.2
2	42.96	3,127.1	3,046.5	2,849.8	3,007.8	3,100.5	3,019.2	2,907.4	3,009.0
3	38.69	3,179.6	3,100.5	3,127.1	3,135.7	3,179.6	3,073.6	2,991.6	3,081.6
4	32.50	3,127.1	3,073.6	3,153.5	3,118.1	3,100.5	3,127.1	3,179.6	3,135.7
Center	24.00	3,100.5	3,153.5	3,153.5	3,135.8	3,073.6	3,100.5	3,127.1	3,100.4
5	15.50	3,179.6	3,127.1	3,127.1	3,144.6	3,073.6	3,100.5	3,073.6	3,082.6
6	9.31	3,153.5	3,046.5	2,991.6	3,063.9	3,019.2	3,046.5	3,127.1	3,064.3
7	5.04	2,963.8	2,935.7	3,046.5	2,982.0	2,991.6	3,019.2	2,991.6	3,000.8
8	1.54	2,638.4	2,700.5	2,638.4	2,659.1	2,761.2	2,820.5	2,731.0	2,770.9
Averages ---------->		3,018.9	2,990.5	2,969.5	2,993.0	2,993.1	2,983.3	2,967.1	2,981.2

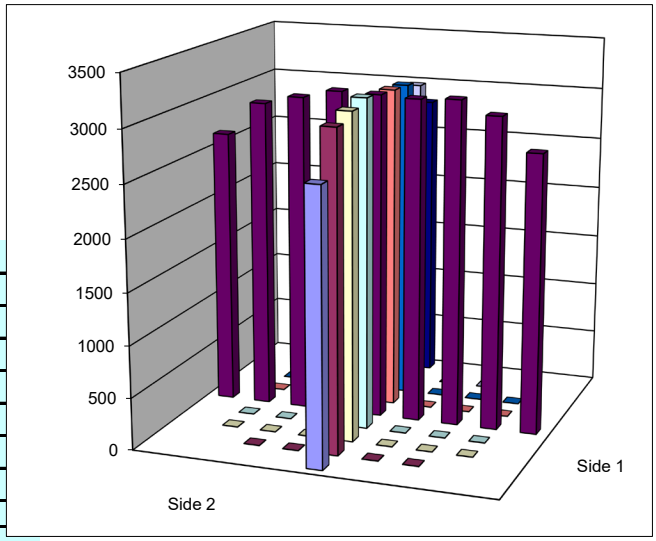
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	2987.1		Mean	3084.0	3067.8	3075.9
Min Point	2585.2	-13.5%	Std. Dev.	66.8	48.4	56.7
Max Point	3144.6	5.3%	COV as %	2.2	1.6	**1.8**

Flow w/o C-Pt 37331 cfm

Vel Avg w/o C-Pt 2971 fpm

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

	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	18.29	16.59	mbars
Ambient pressure	981.04	980.70	mbars
Total Stack pressure	999.3	997.3	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/9/2020	Signature/date	3/9/2020	Signature/date	3/18/2020

VELOCITY TRAVERSE DATA FORM

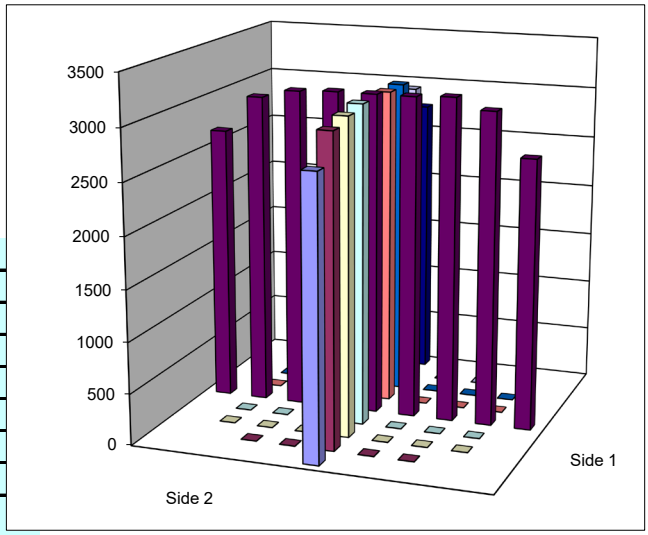
Stack	LB-C2	Run No.	VT-12
Date	10/18/19	Fan Configuration	Fan A&B
Testers	ZDH/LCE	Fan Setting	N/A Hz
Stack Dia.	48 in.	Stack Temp	61.80 deg F
Stack X-Area	1809.6 in.2	Start/End Time	8:49 8:55
Test Port	2	Center 2/3 from	4.40 to: 43.60
Distance to disturbance	53.3 ft	Points in Center 2/3	2 to: 7
Velocity 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	2,551.6	2,676.2	2,583.3	2,603.7	2,736.3	2,706.4	2,706.4	2,716.4
2	42.96	2,964.7	3,046.0	3,046.0	3,018.9	2,937.1	2,992.0	3,072.6	3,000.6
3	38.69	3,072.6	3,176.7	3,125.1	3,124.8	3,019.1	3,098.9	3,072.6	3,063.5
4	32.50	3,125.1	3,098.9	3,098.9	3,107.6	3,125.1	3,072.6	3,125.1	3,107.6
Center	24.00	3,125.1	3,072.6	3,125.1	3,107.6	3,098.9	3,125.1	3,176.7	3,133.6
5	15.50	3,098.9	3,072.6	3,151.0	3,107.5	3,072.6	3,098.9	3,098.9	3,090.1
6	9.31	3,046.0	3,151.0	3,072.6	3,089.9	3,072.6	3,098.9	3,125.1	3,098.9
7	5.04	3,019.1	3,125.1	2,881.2	3,008.5	2,909.3	2,992.0	3,072.6	2,991.3
8	1.54	2,676.2	2,614.6	2,676.2	2,655.7	2,736.3	2,765.9	2,736.3	2,746.2
Averages ---------->		2,964.4	3,003.7	2,973.3	2,980.5	2,967.5	2,994.5	3,020.7	2,994.2

All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	2987.3		Mean	3080.7	3069.4	3075.0
Min Point	2603.7	-12.8%	Std. Dev.	47.0	54.4	49.2
Max Point	3133.6	4.9%	COV as %	1.5	1.8	**1.6**

Flow w/o C-Pt	37331 cfm	**Instuments Used:**	Cal Due
Vel Avg w/o C-Pt	2971 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	22.0	17.6	mbars
Ambient pressure	985.4	985.8	mbars
Total Stack pressure	1007.5	1003.4	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

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Signature/date	3/9/2020	Signature/date	3/9/2020	Signature/date	3/18/2020

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	2,681.7	2,830.0	2,771.6	2,761.1	2,556.9	2,712.0	2,771.6	2,680.2
2	42.96	2,970.8	3,105.3	3,025.4	3,033.8	3,105.3	3,052.2	3,025.4	3,061.0
3	38.69	3,131.5	3,052.2	3,131.5	3,105.1	3,105.3	3,078.9	3,078.9	3,087.7
4	32.50	3,131.5	3,078.9	3,157.5	3,122.6	3,052.2	2,998.2	3,078.9	3,043.1
Center	24.00	3,078.9	3,078.9	3,025.4	3,061.1	3,052.2	3,105.3	3,078.9	3,078.8
5	15.50	3,105.3	3,078.9	3,105.3	3,096.5	3,105.3	3,078.9	3,025.4	3,069.9
6	9.31	3,105.3	2,998.2	3,078.9	3,060.8	3,052.2	3,105.3	3,052.2	3,069.9
7	5.04	2,998.2	2,943.2	2,970.8	2,970.7	3,052.2	2,998.2	3,052.2	3,034.2
8	1.54	2,651.0	2,588.7	2,620.0	2,619.9	2,742.0	2,681.7	2,742.0	2,721.9
Averages ---------->		2,983.8	2,972.7	2,987.4	2,981.3	2,980.4	2,979.0	2,989.5	2,983.0

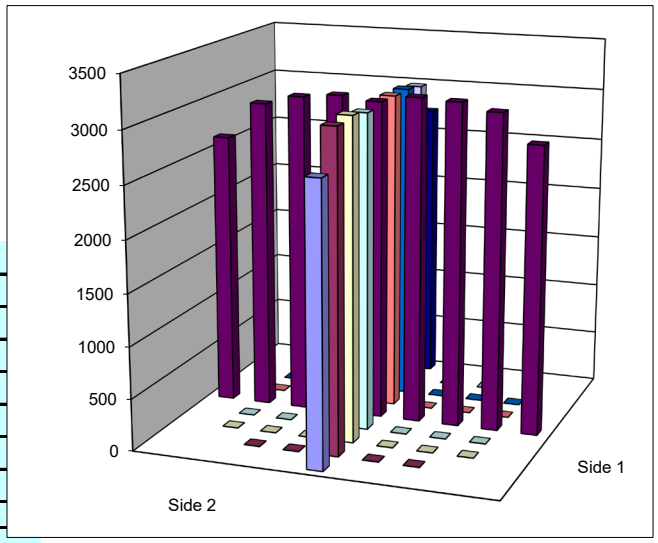
All	ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	2982.1		Mean	3064.4	3063.5	3063.9
Min Point	2619.9	-12.1%	Std. Dev.	51.3	19.1	37.2
Max Point	3122.6	4.7%	COV as %	1.7	0.6	**1.2**

Flow w/o C-Pt 37337 cfm

Vel Avg w/o C-Pt 2971 fpm

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

	Start	Finish	
Stack temp	64	64.9	F
Equipment temp	56.8	64.9	F
Ambient temp	56.8	56.4	F
Stack static	16.9	18.0	mbars
Ambient pressure	986.5	986.5	mbars
Total Stack pressure	1003.4	1004.4	mbars
Ambient humidity	38%	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/9/2020	Signature/date	3/9/2020	Signature/date	3/18/2020

FLOW ANGLE DATA FORM

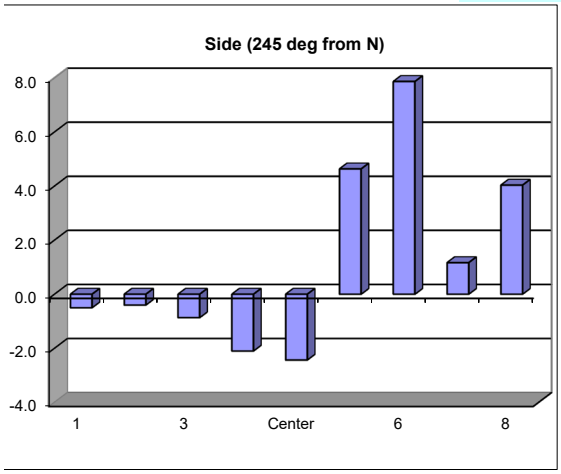
Stack	LB-C2	Run No.	FA-11
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	15:15 15:21	Fan Configuration	Fans A & B
Testers	ZDH/LCE	Stack Temp	68.9 deg F
Stack Dia.	48 in	Approx. air vel.	2987 afpm at point > Mean All
Stack X-Area	1809.6 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	53.3 ft		

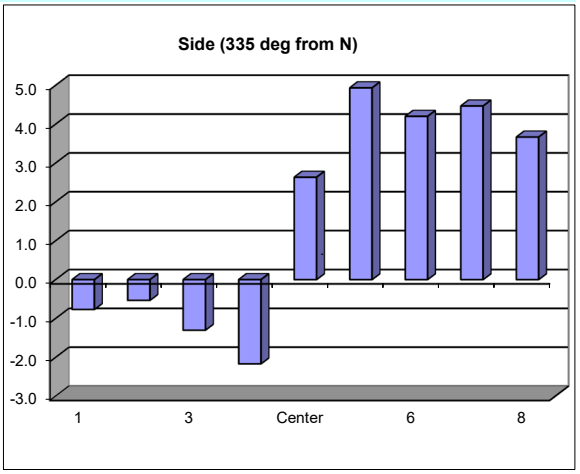
Order -->	First				Second			
Traverse-->	Side 1 (245 deg from N)				Side 2 (335 deg from N)			
Trial ---->	1	2	3	Mean	1	2	3	Mean
Point / Depth, in.	deg. cw				deg. cw			
1 / 46.46	-1.0	-0.2	-0.3	-0.5	-0.8	-0.7	-0.8	-0.8
2 / 42.96	-0.1	-0.5	-0.6	-0.4	-0.7	-0.3	-0.6	-0.5
3 / 38.69	-1.9	-0.4	-0.3	-0.9	-1.1	-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





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Appendix B – LB-S1 Stack Verification Data Sheets

B.1 Flow Angle Data Forms

FLOW ANGLE DATA FORM

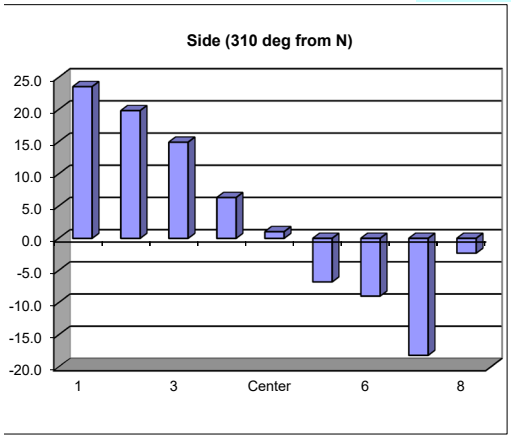
Stack	LB-S1	Run No.	FA-1
Date	10/15/2019	Fan Setting	N/A Hz
Start/End Time	13:26 13:42	Fan Configuration	Fan A & B
Testers	ZDH/LCE	Stack Temp	66.5 deg F
Stack Dia.	60 in	Approx. air vel.	3931 afpm at point > Mean All
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

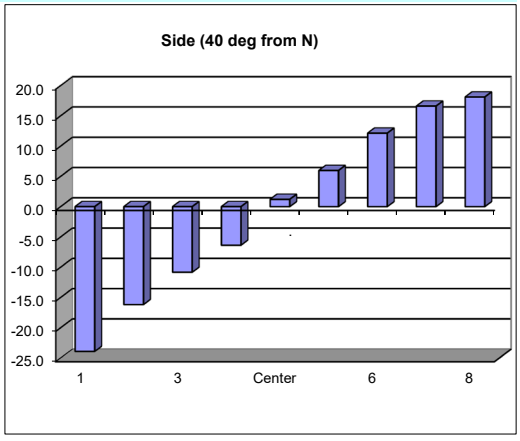
Order -->		First				Second			
Traverse-->		Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	58.08	22.8	25.0	22.9	23.6	-28.4	-21.7	-21.6	-23.9
2	53.70	20.8	18.0	20.7	19.8	-16.1	-16.3	-16.1	-16.2
3	48.36	14.9	14.3	15.6	14.9	-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 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 Forms





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FLOW ANGLE DATA FORM

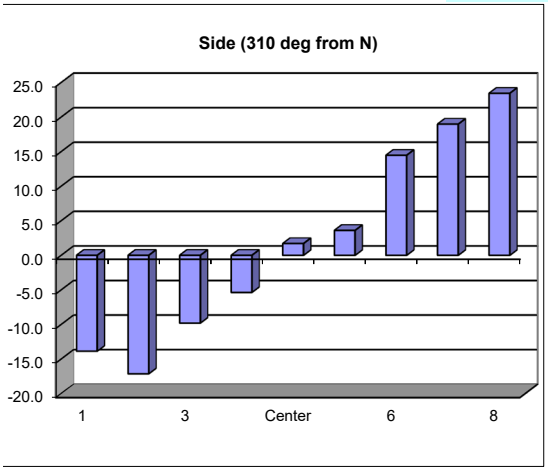
Stack	LB-S1	Run No.	FA-2
Date	10/15/2019	Fan Setting	N/A Hz
Start/End Time	15:32 15:42	Fan Configuration	Fan A & B
Testers	ZDH/LCE	Stack Temp	67 deg F
Stack Dia.	60 in	Approx. air vel.	3975 afpm at point > Mean All
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

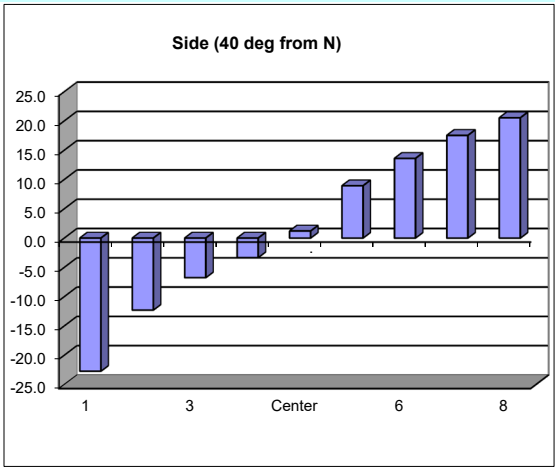
Order -->		First				Second			
Traverse-->		Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	58.08	-14.0	-13.9	-13.7	-13.9	-23.2	-22.8	-22.2	-22.7
2	53.70	-17.4	-17.1	-16.9	-17.1	-13.5	-12.4	-11.0	-12.3
3	48.36	-10.1	-9.7	-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
								Grand mean ABS w/o wall pts	9.6

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 Forms





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FLOW ANGLE DATA FORM

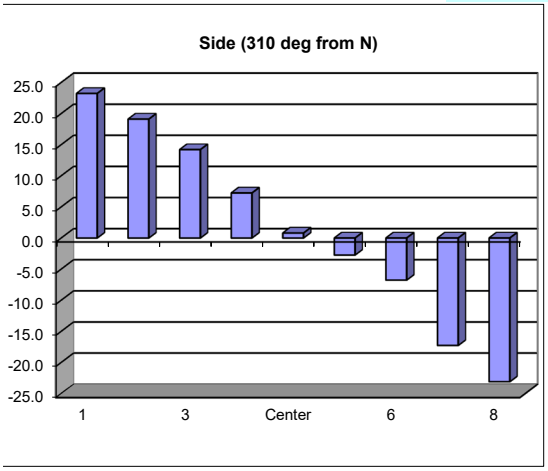
Stack	LB-S1	Run No.	FA-3
Date	10/16/2019	Fan Setting	N/A Hz
Start/End Time	9:30 9:41	Fan Configuration	Fan A & B
Testers	ZDH/LCE	Stack Temp	63.6 deg F
Stack Dia.	60 in	Approx. air vel.	3934 afpm at point > Mean All
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

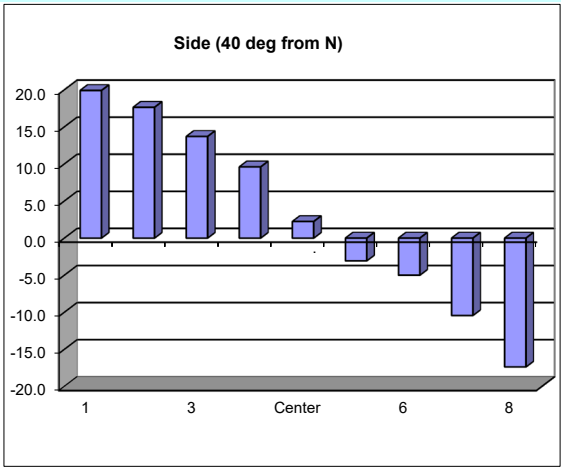
Order -->		First				Second			
Traverse-->		Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	58.08	23.3	23.1	23.3	23.2	21.6	18.3	19.8	19.9
2	53.70	19.4	19.3	18.6	19.1	18.0	17.7	17.2	17.6
3	48.36	15.2	13.9	13.5	14.2	14.2	13.4	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
								Grand mean ABS w/o wall pts	9.3

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 Forms





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FLOW ANGLE DATA FORM

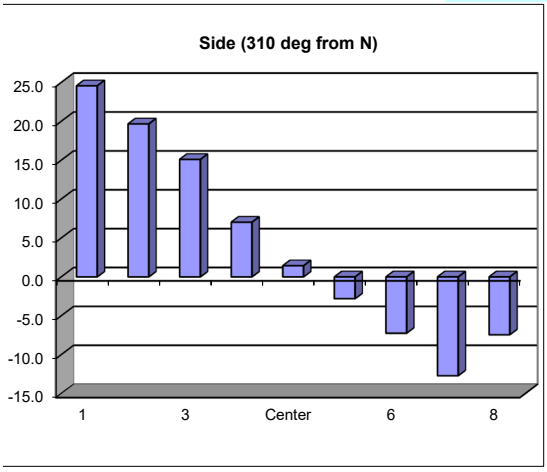
Stack	LB-S1	Run No.	FA-4
Date	10/16/2019	Fan Setting	N/A Hz
Start/End Time	10:56 11:08	Fan Configuration	Fan A & B
Testers	ZDH/LCE	Stack Temp	66.3 deg F
Stack Dia.	60 in	Approx. air vel.	3883 afpm at point > Mean All
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

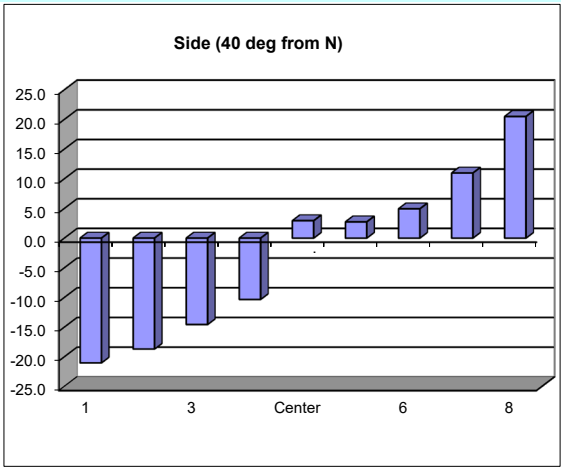
Order -->		First				Second			
Traverse-->		Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	58.08	24.8	24.5	24.4	24.6	-21.1	-21.5	-20.5	-21.0
2	53.70	18.9	20.6	19.5	19.7	-19.2	-19.4	-17.5	-18.7
3	48.36	15.4	13.8	16.1	15.1	-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 Forms





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Signature/date	3/4/2020	Signature/date	3/5/2020	Signature/date	3/18/2020

FLOW ANGLE DATA FORM

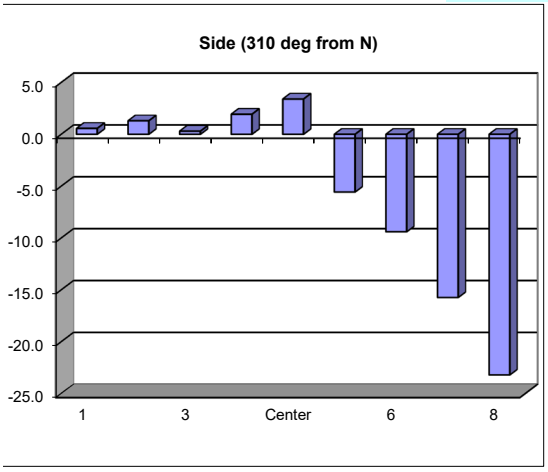
Stack	LB-S1	Run No.	FA-5
Date	10/16/2019	Fan Setting	N/A Hz
Start/End Time	13:10 13:20	Fan Configuration	Fan B&C
Testers	ZDH/LCE	Stack Temp	67.8 deg F
Stack Dia.	60 in	Approx. air vel.	3874 afpm at point > Mean All
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

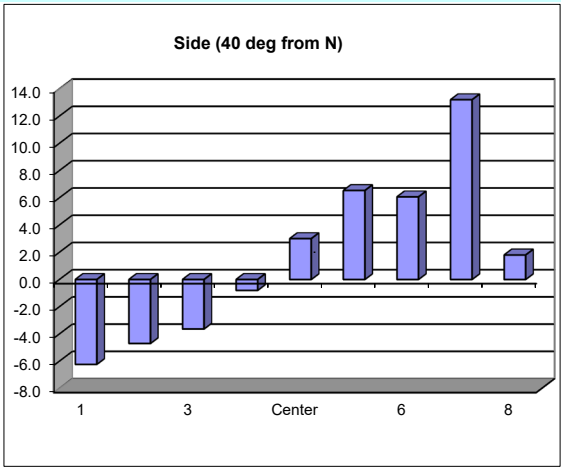
Order -->		First				Second			
Traverse-->		Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	58.08	0.4	0.7	0.6	0.6	-7.1	-5.9	-5.7	-6.2
2	53.70	0.8	1.2	1.9	1.3	-3.5	-5.4	-5.2	-4.7
3	48.36	0.3	0.5	0.1	0.3	-5.0	-3.6	-2.3	-3.6
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 Forms





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Signature/date	3/4/2020	Signature/date	3/5/2020	Signature/date	3/18/2020

FLOW ANGLE DATA FORM

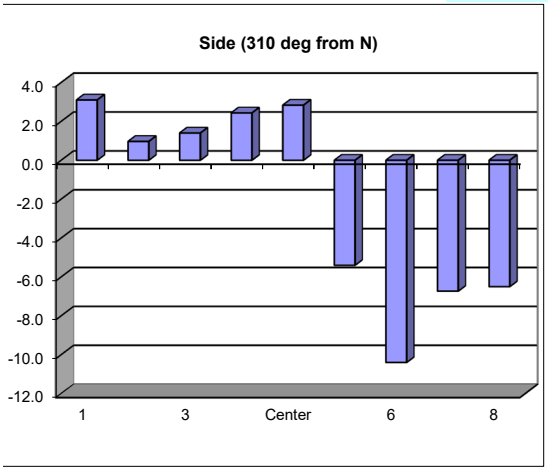
Stack	LB-S1	Run No.	FA-6
Date	10/16/2019	Fan Setting	N/A Hz
Start/End Time	14:15 14:24	Fan Configuration	Fan B&C
Testers	ZDH/LCE	Stack Temp	68.7 deg F
Stack Dia.	60 in	Approx. air vel.	3870 afpm at point > Mean All
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

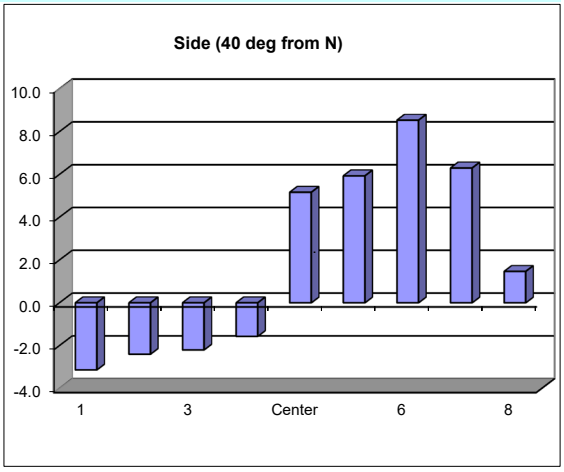
Order -->		First				Second			
Traverse-->		Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	58.08	3.0	2.7	3.6	3.1	-1.7	-2.1	-5.6	-3.1
2	53.70	1.2	1.2	0.5	1.0	-2.6	-2.1	-2.5	-2.4
3	48.36	1.2	2.2	0.8	1.4	-1.2	-2.0	-3.4	-2.2
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 Forms





Data Transcribed by:	Ernest Antonio	Data Entered by:	Ernest Antonio	Transciption Review performed by:	Jennifer Yao
Signature/date	3/4/2020	Signature/date	3/5/2020	Signature/date	3/18/2020

FLOW ANGLE DATA FORM

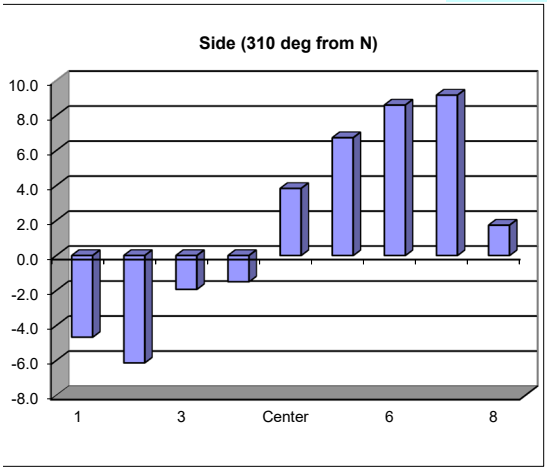
Stack	LB-S1	Run No.	FA-7
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	9:23 9:32	Fan Configuration	Fan B&C
Testers	ZDH/LCE	Stack Temp	65.7 deg F
Stack Dia.	60 in	Approx. air vel.	3893 afpm at point > Mean All
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

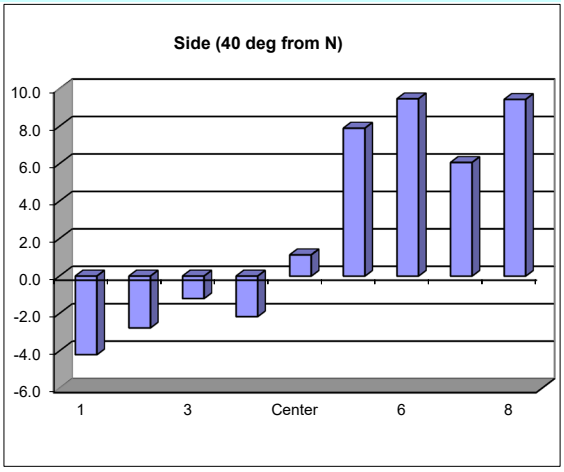
Order -->		First				Second			
Traverse-->		Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	58.08	-4.0	-5.2	-4.8	-4.7	-3.9	-4.4	-4.3	-4.2
2	53.70	-6.1	-6.6	-5.7	-6.1	-2.9	-2.9	-2.5	-2.8
3	48.36	-1.5	-2.0	-2.3	-1.9	-0.2	-1.6	-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 Forms





Data Transcribed by:	Ernest Antonio	Data Entered by:	Ernest Antonio	Transciption Review performed by:	Jennifer Yao
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FLOW ANGLE DATA FORM

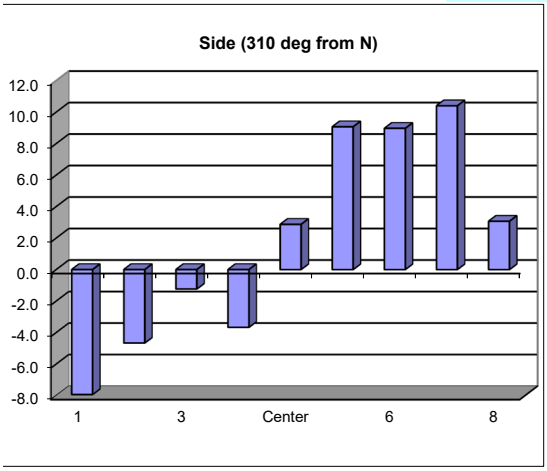
Stack	LB-S1	Run No.	FA-8
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	10:31 10:40	Fan Configuration	Fan B&C
Testers	ZDH/LCE	Stack Temp	68.7 deg F
Stack Dia.	60 in	Approx. air vel.	3919 afpm at point > Mean All
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

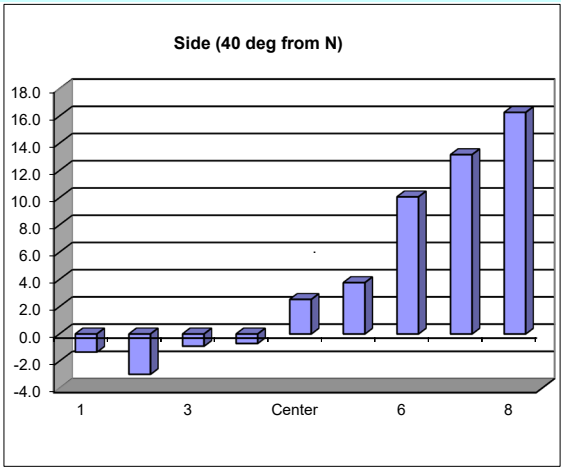
Order -->		First				Second			
Traverse-->		Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	58.08	-8.2	-7.9	-7.7	-7.9	-1.5	-1.6	-0.9	-1.3
2	53.70	-5.0	-4.2	-4.8	-4.7	-3.2	-2.9	-2.8	-3.0
3	48.36	-1.4	-1.1	-1.2	-1.2	-0.8	-1.2	-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 Forms





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FLOW ANGLE DATA FORM

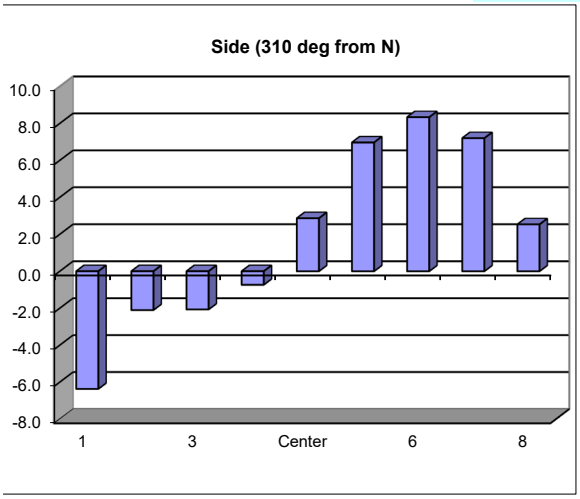
Stack	LB-S1	Run No.	FA-9
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	11:39 11:47	Fan Configuration	Fan B&C
Testers	ZDH/LCE	Stack Temp	70.2 deg F
Stack Dia.	60 in	Approx. air vel.	3898 afpm at point : Mean All
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

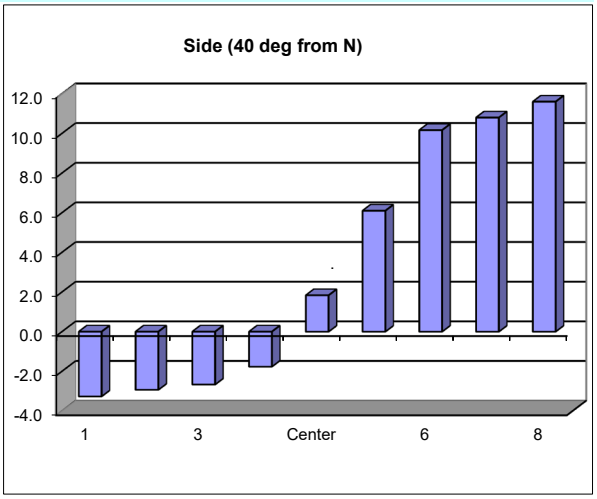
Order -->		First				Second			
Traverse-->		Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	58.08	-7.0	-6.1	-6.0	-6.4	-2.7	-3.6	-3.5	-3.3
2	53.70	-1.8	-1.9	-2.6	-2.1	-1.2	-3.5	-4.1	-2.9
3	48.36	-1.6	-2.7	-1.9	-2.1	-2.5	-2.9	-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 Forms





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FLOW ANGLE DATA FORM

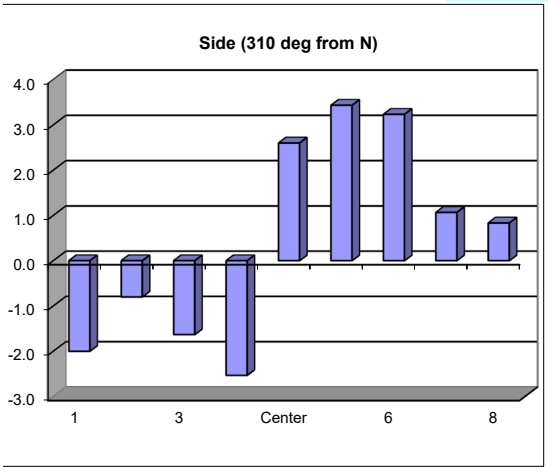
Stack	LB-S1	Run No.	FA-10
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	14:26 14:36	Fan Configuration	Fan A&C
Testers	ZDH/LCE	Stack Temp	69.7 deg F
Stack Dia.	60 in	Approx. air vel.	4015 afpm at point > Mean All
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

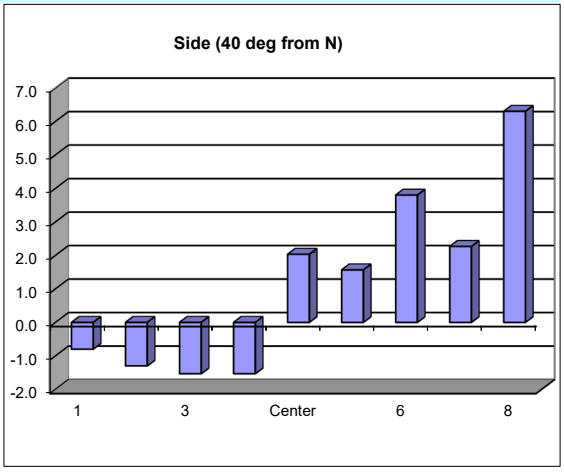
Order -->		First				Second			
Traverse-->		Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	58.08	-2.2	-2.0	-1.8	-2.0	-0.8	-0.6	-1.0	-0.8
2	53.70	-0.5	-0.5	-1.4	-0.8	-1.7	-0.9	-1.3	-1.3
3	48.36	-1.2	-1.7	-2.0	-1.6	-1.0	-2.6	-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 Forms





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FLOW ANGLE DATA FORM

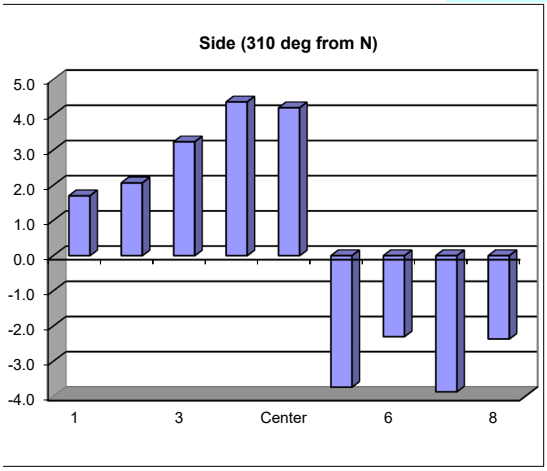
Stack	LB-S1	Run No.	FA-11
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	15:34 15:41	Fan Configuration	Fan A&C
Testers	ZDH/LCE	Stack Temp	70.5 deg F
Stack Dia.	60 in	Approx. air vel.	4003 afpm at point > Mean All
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

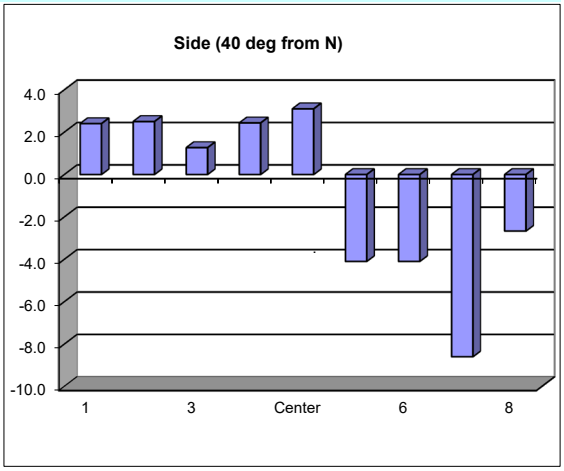
Order -->		First				Second			
Traverse-->		Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	58.08	1.2	2.5	1.4	1.7	1.7	2.8	2.7	2.4
2	53.70	4.4	0.4	1.4	2.1	2.6	2.8	2.1	2.5
3	48.36	2.3	4.2	3.2	3.2	1.6	0.9	1.3	1.3
4	40.62	4.5	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 Forms





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Signature/date	3/4/2020	Signature/date	3/5/2020	Signature/date	3/18/2020

FLOW ANGLE DATA FORM

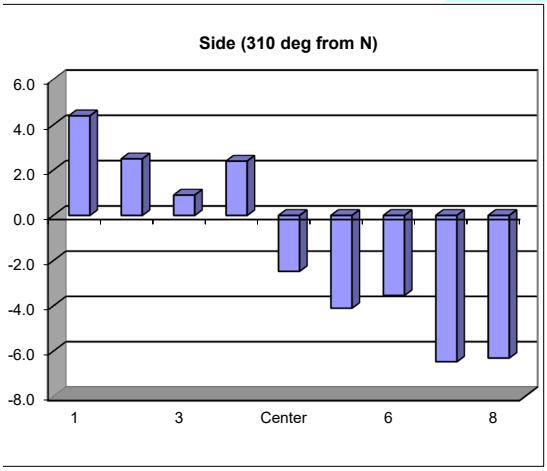
Stack	LB-S1	Run No.	FA-12
Date	10/18/2019	Fan Setting	N/A Hz
Start/End Time	9:14 9:22	Fan Configuration	Fan A&C
Testers	ZDH/LCE	Stack Temp	63.7 deg F
Stack Dia.	60 in	Approx. air vel.	4031 afpm at point > Mean All
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

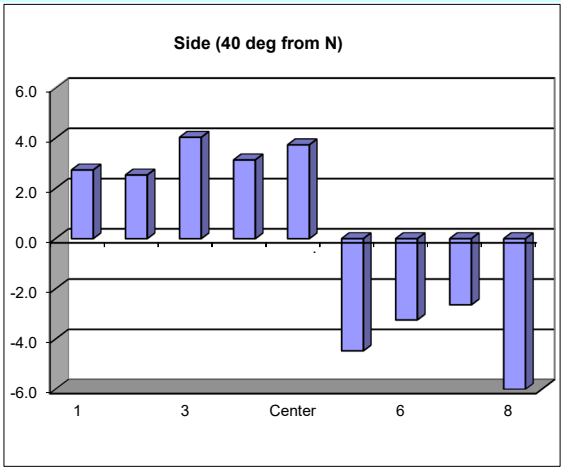
Order -->		First				Second			
Traverse-->		Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	58.08	4.3	4.4	4.5	4.4	3.2	2.3	2.7	2.7
2	53.70	2.9	2.2	2.4	2.5	4.0	2.4	1.2	2.5
3	48.36	0.8	0.8	1.1	0.9	4.5	3.9	3.7	4.0
4	40.62	1.8	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 Forms





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Signature/date	3/4/2020	Signature/date	3/5/2020	Signature/date	3/18/2020

FLOW ANGLE DATA FORM

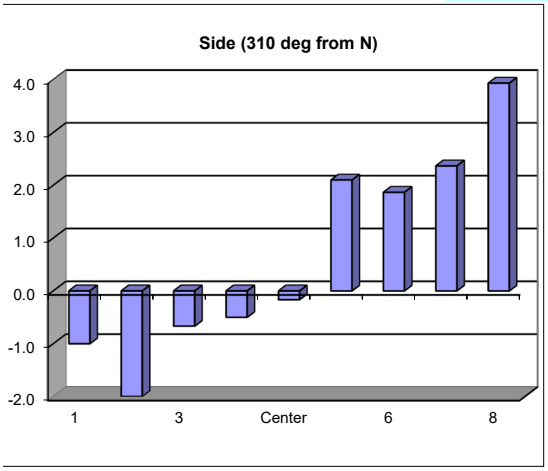
Stack	LB-S1	Run No.	FA-13
Date	10/18/2019	Fan Setting	N/A Hz
Start/End Time	10:22 10:31	Fan Configuration	Fan A&C
Testers	ZDH/LCE	Stack Temp	66 deg F
Stack Dia.	60 in	Approx. air vel.	4007 afpm at point > Mean All
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

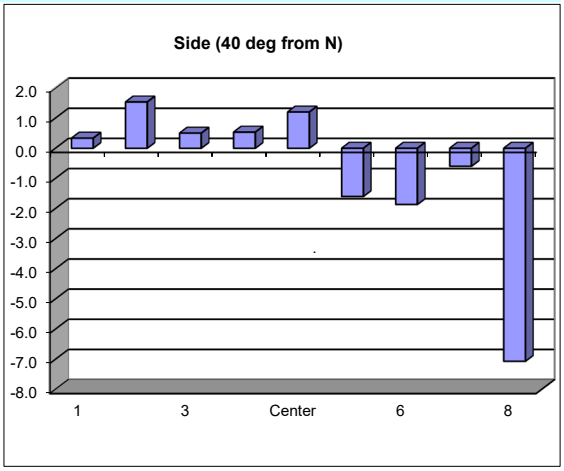
Order -->		First				Second			
Traverse-->		Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	58.08	-0.5	-1.1	-1.4	-1.0	0.1	0.1	0.8	0.3
2	53.70	-2.3	-1.8	-1.9	-2.0	1.6	1.4	1.6	1.5
3	48.36	-0.5	-0.7	-0.8	-0.7	0.4	0.5	0.6	0.5
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 Forms





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Signature/date	3/4/2020	Signature/date	3/5/2020	Signature/date	3/18/2020

FLOW ANGLE DATA FORM

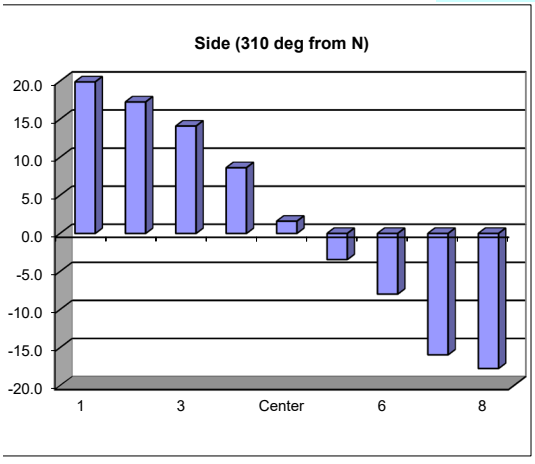
Stack	LB-S1	Run No.	FA-14
Date	10/19/2019	Fan Setting	N/A Hz
Start/End Time	9:26 9:33	Fan Configuration	Fan A &B
Testers	ZDH/LCE	Stack Temp	61.8 deg F
Stack Dia.	60 in	Approx. air vel.	4077 afpm at point > Mean All
Stack X-Area	2827.4 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	1
Distance to disturbance	56.5 ft		

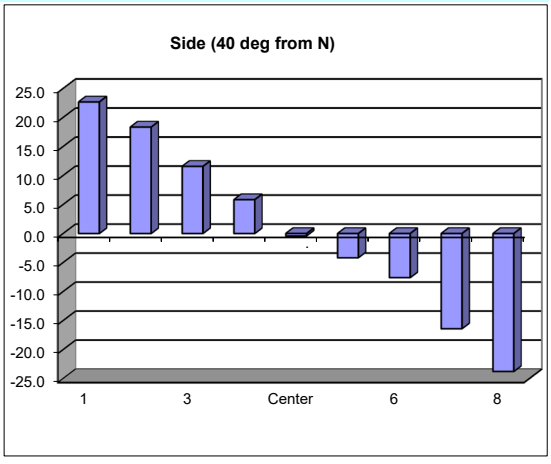
Order -->		First				Second			
Traverse-->		Side 1 (310 deg from N)				Side 2 (40 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	58.08	19.4	19.8	20.5	19.9	23.3	21.9	22.8	22.7
2	53.70	15.9	17.9	18.0	17.3	18.6	18.6	17.8	18.3
3	48.36	14.3	14.2	13.8	14.1	11.8	11.4	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 Forms





Data Transcribed by:	Ernest Antonio	Data Entered by:	Ernest Antonio	Transciption Review performed by:	Jennifer Yao
Signature/date	3/4/2020	Signature/date	3/5/2020	Signature/date	3/18/2020

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	3,996.4	3,934.7	3,851.0	3927.4	3,765.4	3,829.8	3,787.0	3,794.1
2	53.7	4,116.9	4,036.9	3,975.9	4043.2	3,955.4	3,975.9	3,872.1	3,934.5
3	48.4	3,934.7	3,975.9	4,016.7	3975.8	3,851.0	3,975.9	3,975.9	3,934.3
4	40.6	3,975.9	3,934.7	3,913.9	3941.5	3,893.1	3,765.4	3,913.9	3,857.5
Center	30.0	3,851.0	3,975.9	3,872.1	3899.7	3,872.1	3,808.4	3,913.9	3,864.8
5	19.4	4,036.9	4,016.7	3,913.9	3989.2	4,057.1	3,975.9	4,016.7	4,016.6
6	11.6	3,913.9	4,036.9	3,975.9	3975.6	4,116.9	4,234.0	4,077.1	4,142.7
7	6.3	3,872.1	3,975.9	3,893.1	3913.7	4,136.6	4,097.0	4,057.1	4,096.9
8	1.9	3,655.6	3,496.1	3,565.3	3572.3	3,851.0	3,934.7	3,851.0	3,878.9
Averages ---------->		3,928.2	3,931.5	3,886.4	3,915.4	3,944.3	3,955.2	3,940.5	3,946.7

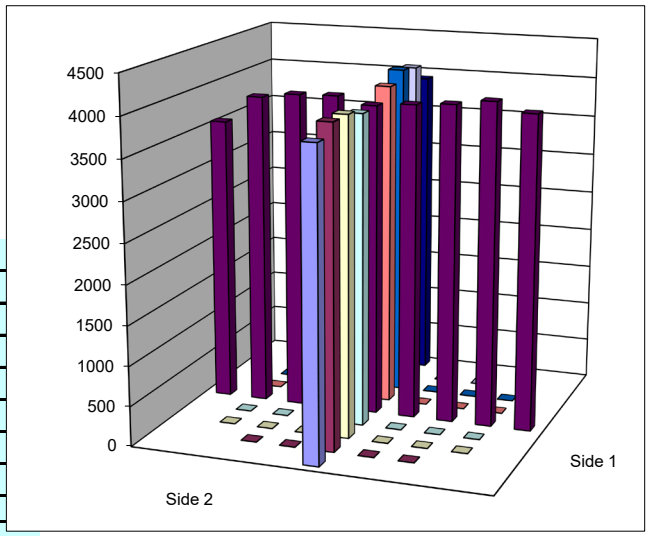
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	3931.0		Mean	3962.7	3978.2	3970.4
Min Point	3572.3	-9.1%	Std. Dev.	48.9	111.0	82.8
Max Point	4142.7	5.4%	COV as %	1.2	2.8	**2.1**

Flow w/o C-Pt 77305 cfm

Vel Avg w/o C-Pt 3937 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	12.19	13.55	mbars
Ambient pressure	991.87	991.87	mbars
Total Stack pressure	1004.1	1005.4	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/10/2020	Signature/date	3/10/2020	Signature/date	3/18/2020

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	4,140.2	4,040.4	3,999.8	4,060.1	3,746.9	3,790.2	3,854.3	3,797.1
2	53.7	4,140.2	4,159.8	4,140.2	4,146.7	3,999.8	3,917.3	3,958.8	3,958.6
3	48.4	3,999.8	3,958.8	4,080.6	4,013.1	3,938.1	3,938.1	3,896.4	3,924.2
4	40.6	4,040.4	4,020.1	3,999.8	4,020.1	3,790.2	3,938.1	3,833.0	3,853.8
Center	30.0	3,999.8	4,020.1	4,040.4	4,020.1	4,080.6	4,020.1	3,999.8	4,033.5
5	19.4	3,999.8	3,938.1	3,979.3	3,972.4	3,979.3	4,040.4	3,999.8	4,006.5
6	11.6	3,875.4	3,938.1	4,080.6	3,964.7	4,080.6	4,198.9	4,140.2	4,139.9
7	6.3	3,938.1	3,917.3	3,958.8	3,938.1	3,999.8	4,120.4	4,020.1	4,046.8
8	1.9	3,703.1	3,703.1	3,658.7	3,688.3	3,938.1	3,958.8	3,999.8	3,965.6
Averages ---------->		3,981.9	3,966.2	3,993.1	3,980.4	3,950.4	3,991.4	3,966.9	3,969.6

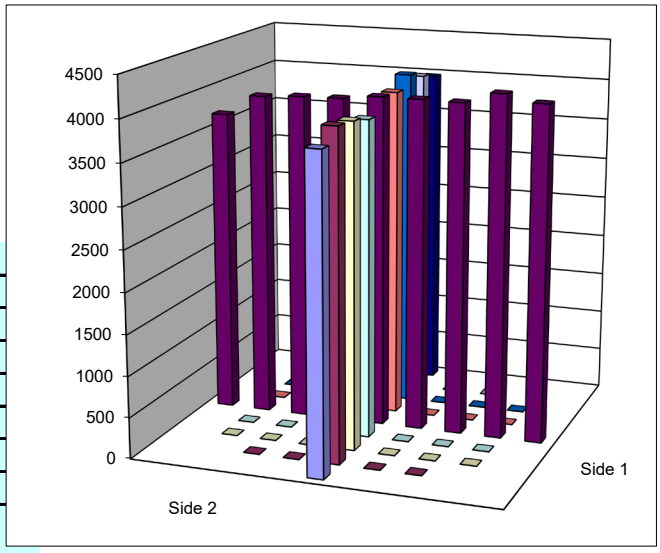
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	3975.0		Mean	4010.7	3994.8	4002.7
Min Point	3688.3	-7.2%	Std. Dev.	67.8	92.7	78.5
Max Point	4146.7	4.3%	COV as %	1.7	2.3	**2.0**

Flow w/o C-Pt 77921 cfm

Vel Avg w/o C-Pt 3968 fpm

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

	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	38.94	5.76	mbars
Ambient pressure	991.87	990.86	mbars
Total Stack pressure	1030.8	996.6	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/10/2020	Signature/date	3/10/2020	Signature/date	3/18/2020

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	3,917.7	3,875.8	3,938.5	3,910.7	3,769.0	3,812.1	3,636.8	3,739.3
2	53.7	4,040.8	4,081.0	4,040.8	4,054.2	3,875.8	3,875.8	3,917.7	3,889.8
3	48.4	4,040.8	4,140.6	3,959.2	4,046.9	3,854.7	3,938.5	3,854.7	3,882.6
4	40.6	3,979.8	3,896.8	3,959.2	3,945.3	3,875.8	3,896.8	3,896.8	3,889.8
Center	30.0	3,979.8	3,896.8	4,000.2	3,958.9	3,979.8	3,959.2	3,896.8	3,945.3
5	19.4	4,040.8	3,917.7	4,020.6	3,993.0	4,020.6	4,000.2	3,979.8	4,000.2
6	11.6	4,020.6	4,081.0	4,020.6	4,040.7	4,101.0	4,081.0	4,120.9	4,101.0
7	6.3	3,854.7	3,917.7	3,790.6	3,854.3	4,120.9	4,199.4	4,081.0	4,133.8
8	1.9	3,614.2	3,568.8	3,681.4	3,621.5	3,725.5	3,896.8	3,790.6	3,804.3
Averages ---------->		3,943.2	3,930.7	3,934.6	3,936.2	3,924.8	3,962.2	3,908.3	3,931.8

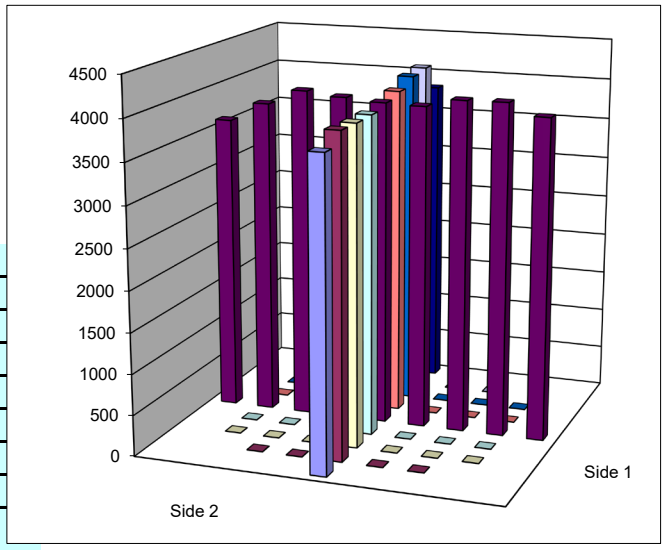
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	3934.0		Mean	3984.8	3977.5	3981.1
Min Point	3621.5	-7.9%	Std. Dev.	72.0	104.6	86.3
Max Point	4133.8	5.1%	COV as %	1.8	2.6	**2.2**

Flow w/o C-Pt 77199 cfm

Vel Avg w/o C-Pt 3932 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	33.19	20.32	mbars
Ambient pressure	985.44	985.44	mbars
Total Stack pressure	1018.6	1005.8	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/10/2020	Signature/date	3/10/2020	Signature/date	3/18/2020

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	3,821.7	3,906.6	3,906.6	3,878.3	3,712.8	3,600.6	3,668.3	3,660.6
2	53.7	4,111.3	4,051.0	4,151.0	4,104.4	3,734.8	3,843.1	3,712.8	3,763.6
3	48.4	3,864.4	4,051.0	3,948.4	3,954.6	3,843.1	3,906.6	3,712.8	3,820.8
4	40.6	3,948.4	3,864.4	3,885.6	3,899.5	3,778.5	3,821.7	3,885.6	3,828.6
Center	30.0	3,885.6	3,948.4	3,969.1	3,934.4	3,927.6	3,843.1	3,969.1	3,913.3
5	19.4	4,010.3	3,989.7	3,969.1	3,989.7	3,969.1	4,091.3	4,131.2	4,063.9
6	11.6	3,969.1	3,948.4	3,885.6	3,934.4	4,091.3	4,071.2	4,111.3	4,091.3
7	6.3	3,800.2	3,778.5	3,843.1	3,807.3	4,051.0	3,948.4	4,131.2	4,043.5
8	1.9	3,600.6	3,484.8	3,531.6	3,539.0	3,800.2	3,484.8	3,734.8	3,673.3
Averages ---------->		3,890.2	3,891.4	3,898.9	3,893.5	3,878.7	3,845.6	3,895.2	3,873.2

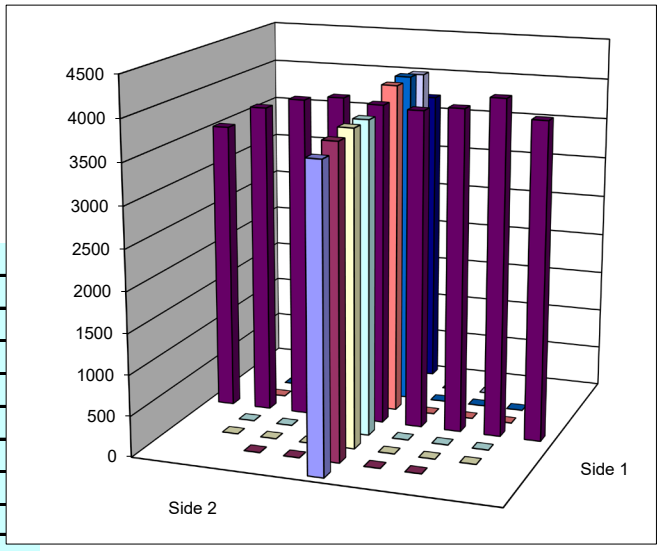
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	3883.3		Mean	3946.3	3932.1	3939.2
Min Point	3539.0	-8.9%	Std. Dev.	90.2	133.5	109.7
Max Point	4104.4	5.7%	COV as %	2.3	3.4	**2.8**

Flow w/o C-Pt 76150 cfm

Vel Avg w/o C-Pt 3878 fpm

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

	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	53.84	34.88	mbars
Ambient pressure	985.10	984.76	mbars
Total Stack pressure	1038.9	1019.6	mbars
Ambient humidity	36%	38%	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/10/2020	Signature/date	3/10/2020	Signature/date	3/18/2020

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	3,397.6	3,493.3	3,445.8	3,445.6	3,699.6	3,721.9	3,978.8	3,800.1
2	53.7	3,852.5	3,831.0	3,895.1	3,859.5	4,141.3	4,020.1	3,852.5	4,004.6
3	48.4	3,999.5	3,873.8	3,895.1	3,922.8	4,040.5	4,161.2	4,121.4	4,107.7
4	40.6	4,101.3	3,958.1	4,040.5	4,033.3	4,081.1	4,020.1	4,040.5	4,047.2
Center	30.0	4,040.5	3,978.8	4,060.9	4,026.7	3,895.1	4,040.5	3,999.5	3,978.4
5	19.4	3,852.5	3,721.9	3,699.6	3,758.0	3,937.2	4,020.1	4,040.5	3,999.3
6	11.6	4,101.3	4,020.1	3,916.2	4,012.5	3,916.2	3,873.8	3,958.1	3,916.0
7	6.3	3,999.5	3,958.1	3,916.2	3,957.9	3,677.3	3,721.9	3,809.5	3,736.2
8	1.9	3,787.7	3,677.3	3,721.9	3,729.0	3,469.6	3,299.1	3,421.8	3,396.8
Averages ---------->		3,903.6	3,834.7	3,843.5	3,860.6	3,873.1	3,875.4	3,913.6	3,887.4

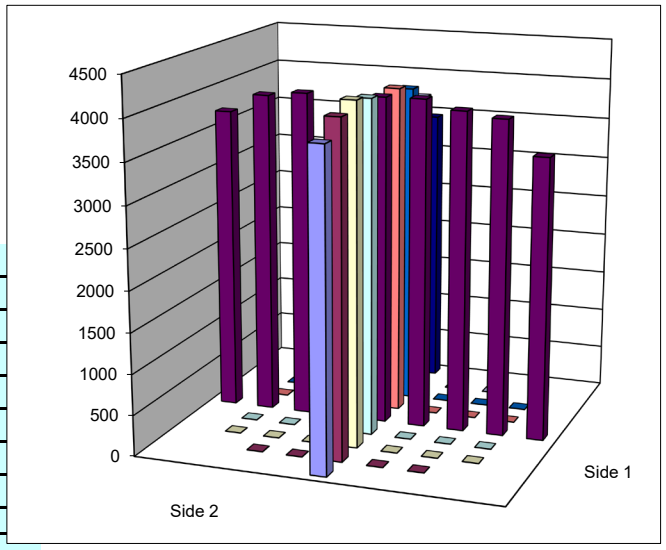
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	3874.0		Mean	3938.7	3969.9	3954.3
Min Point	3396.8	-12.3%	Std. Dev.	101.4	118.8	107.3
Max Point	4107.7	6.0%	COV as %	2.6	3.0	**2.7**

Flow w/o C-Pt 75750 cfm

Vel Avg w/o C-Pt 3858 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	51.47	58.92	mbars
Ambient pressure	983.75	983.41	mbars
Total Stack pressure	1035.2	1042.3	mbars
Ambient humidity	34%		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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/10/2020	Signature/date	3/10/2020	Signature/date	3/18/2020

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	3,704.5	3,857.5	3,942.3	3,834.8	3,303.4	3,377.6	3,402.0	3,361.0
2	53.7	3,814.4	3,857.5	3,963.2	3,878.4	3,942.3	4,045.8	3,984.0	3,990.7
3	48.4	3,963.2	3,921.3	4,045.8	3,976.8	4,106.7	4,106.7	4,086.5	4,100.0
4	40.6	4,025.3	3,942.3	4,025.3	3,997.6	4,106.7	4,004.7	4,106.7	4,072.7
Center	30.0	4,045.8	3,984.0	3,984.0	4,004.6	4,025.3	3,900.2	4,025.3	3,983.6
5	19.4	3,921.3	4,004.7	3,900.2	3,942.1	3,942.3	3,921.3	3,857.5	3,907.0
6	11.6	4,045.8	4,004.7	3,984.0	4,011.5	3,770.8	3,814.4	3,814.4	3,799.9
7	6.3	3,921.3	3,963.2	3,984.0	3,956.2	3,659.6	3,748.9	3,857.5	3,755.3
8	1.9	3,450.3	3,544.8	3,497.9	3,497.7	3,704.5	3,591.2	3,474.2	3,590.0
Averages ---------->		3,876.9	3,897.8	3,925.2	3,899.9	3,840.2	3,834.5	3,845.3	3,840.0

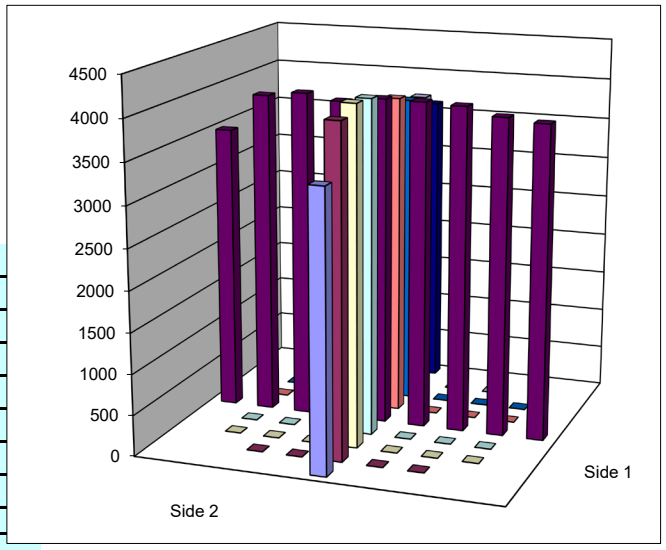
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	3870.0		Mean	3966.7	3944.2	3955.5
Min Point	3361.0	-13.2%	Std. Dev.	46.6	130.6	94.9
Max Point	4100.0	5.9%	COV as %	1.2	3.3	**2.4**

Flow w/o C-Pt 75682 cfm

Vel Avg w/o C-Pt 3854 fpm

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

	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	56.21	54.18	mbars
Ambient pressure	983.41	983.07	mbars
Total Stack pressure	1039.6	1037.3	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/10/2020	Signature/date	3/10/2020	Signature/date	3/18/2020

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	3,519.0	3,611.6	3,588.7	3,573.1	3,542.4	3,447.9	3,588.7	3,526.3
2	53.7	4,143.9	4,022.6	4,083.7	4,083.4	4,002.0	3,939.6	3,939.6	3,960.4
3	48.4	3,981.3	4,063.4	4,163.7	4,069.5	3,981.3	4,002.0	4,043.0	4,008.8
4	40.6	4,022.6	3,981.3	4,022.6	4,008.8	3,960.5	4,002.0	3,876.2	3,946.2
Center	30.0	4,043.0	4,063.4	3,897.5	4,001.3	3,897.5	3,918.6	3,897.5	3,904.5
5	19.4	3,854.9	3,981.3	3,981.3	3,939.2	3,939.6	3,981.3	4,022.6	3,981.2
6	11.6	3,918.6	3,939.6	3,960.5	3,939.6	3,939.6	4,022.6	3,960.5	3,974.2
7	6.3	3,854.9	3,833.4	3,960.5	3,882.9	4,083.7	4,002.0	4,123.9	4,069.9
8	1.9	3,657.1	3,679.6	3,423.9	3,586.9	3,679.6	3,634.4	3,519.0	3,611.0
Averages ---------->		3,888.4	3,908.5	3,898.0	3,898.3	3,891.8	3,883.4	3,885.7	3,886.9

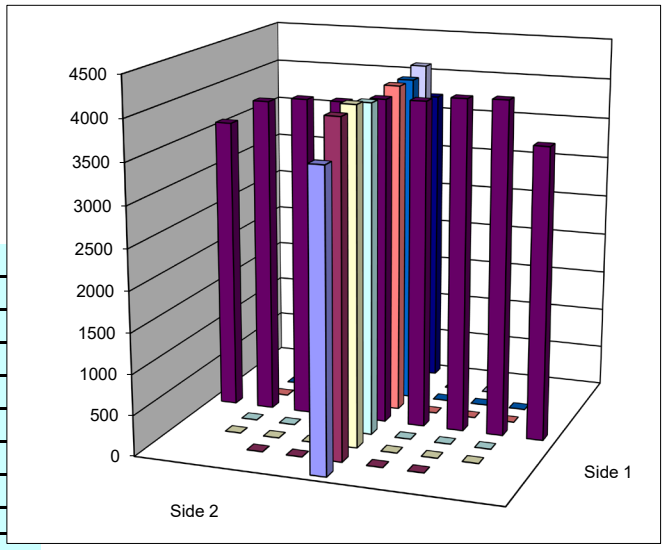
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	3892.6		Mean	3989.2	3977.9	3983.6
Min Point	3526.3	-9.4%	Std. Dev.	73.2	51.8	61.2
Max Point	4083.4	4.9%	COV as %	1.8	1.3	**1.5**

Flow w/o C-Pt 76283 cfm

Vel Avg w/o C-Pt 3885 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	32.51	42.33	mbars
Ambient pressure	980.02	980.36	mbars
Total Stack pressure	1012.5	1022.7	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/10/2020	Signature/date	3/10/2020	Signature/date	3/18/2020

VELOCITY TRAVERSE DATA FORM

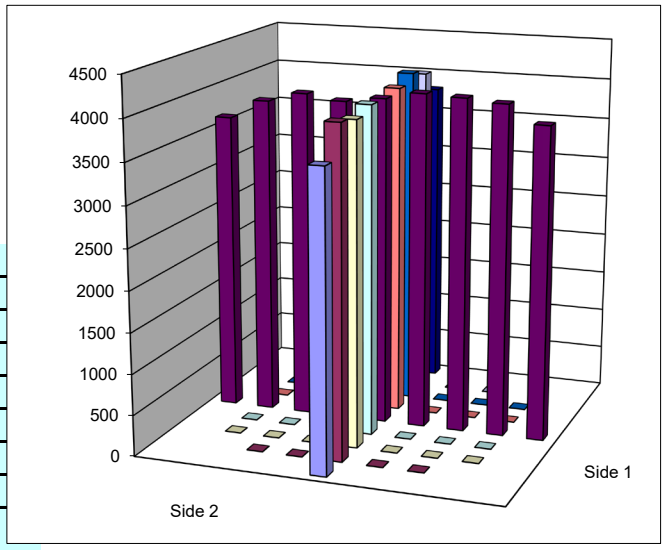
Stack	LB-S1	Run No.	VT-8
Date	10/17/19	Fan Configuration	Fan B&C
Testers	ZDH/LCE	Fan Setting	NA Hz
Stack Dia.	60 in.	Stack Temp	68.40 deg F
Stack X-Area	2827.4 in.2	Start/End Time	10:21 10:30
Test Port	1	Center 2/3 from	5.51 to: 54.49
Distance to disturbance	56.5 ft	Points in Center 2/3	2 to: 7
Velocity 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	3,860.9	3,839.3	3,752.1	3,817.4	3,617.2	3,429.2	3,571.1	3,539.2
2	53.7	4,049.3	4,028.8	4,028.8	4,035.6	3,924.7	3,882.2	3,966.6	3,924.5
3	48.4	4,190.0	4,049.3	3,987.5	4,075.6	3,882.2	3,945.7	3,774.1	3,867.3
4	40.6	4,090.0	4,150.3	4,049.3	4,096.5	4,049.3	3,882.2	3,924.7	3,952.1
Center	30.0	4,049.3	4,028.8	3,945.7	4,007.9	3,903.5	3,945.7	3,966.6	3,938.6
5	19.4	3,882.2	4,049.3	3,903.5	3,945.0	3,966.6	3,987.5	3,987.5	3,980.5
6	11.6	4,069.7	4,028.8	3,924.7	4,007.7	3,966.6	4,150.3	4,130.3	4,082.4
7	6.3	3,966.6	3,817.7	3,882.2	3,888.8	3,966.6	3,987.5	4,049.3	4,001.1
8	1.9	3,662.7	3,729.9	3,571.1	3,654.6	3,839.3	3,594.3	3,752.1	3,728.6
Averages ---------->		3,980.1	3,969.1	3,893.9	3,947.7	3,901.8	3,867.2	3,902.5	3,890.5

All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	3919.1		Mean	4008.2	3963.8	3986.0
Min Point	3539.2	-9.7%	Std. Dev.	72.3	67.5	71.0
Max Point	4096.5	4.5%	COV as %	1.8	1.7	**1.8**

Flow w/o C-Pt	76818 cfm	**Instuments Used:**	Cal Due
Vel Avg w/o C-Pt	3912 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	29.1	72.1	mbars
Ambient pressure	980.7	980.7	mbars
Total Stack pressure	1009.8	1052.8	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

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Signature/date	3/10/2020	Signature/date	3/10/2020	Signature/date	3/18/2020

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	3,646.0	3,646.0	3,802.1	3,698.0	3,410.5	3,458.9	3,386.0	3,418.5
2	53.7	4,014.7	4,055.9	4,035.3	4,035.3	3,758.2	3,993.9	3,823.9	3,858.7
3	48.4	4,157.0	4,096.6	4,055.9	4,103.2	3,909.9	3,845.6	3,931.0	3,895.5
4	40.6	3,952.1	4,055.9	4,035.3	4,014.4	3,823.9	3,952.1	4,055.9	3,944.0
Center	30.0	3,867.1	4,055.9	3,952.1	3,958.4	4,116.9	3,973.1	3,952.1	4,014.0
5	19.4	3,780.2	3,993.9	3,888.5	3,887.5	3,973.1	3,931.0	4,157.0	4,020.4
6	11.6	3,952.1	3,867.1	3,931.0	3,916.7	4,096.6	4,035.3	4,055.9	4,062.6
7	6.3	3,845.6	3,993.9	4,014.7	3,951.4	3,973.1	4,055.9	4,096.6	4,041.9
8	1.9	3,736.0	3,434.8	3,530.2	3,567.0	3,713.7	3,780.2	3,823.9	3,772.6
Averages ---------->		3,883.4	3,911.1	3,916.1	3,903.6	3,864.0	3,891.8	3,920.3	3,892.0

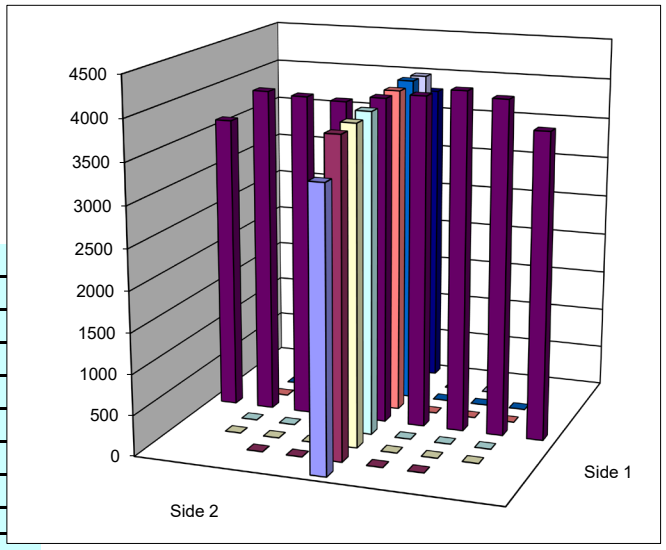
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	3897.8		Mean	3981.0	3976.7	3978.9
Min Point	3418.5	-12.3%	Std. Dev.	74.4	78.0	73.3
Max Point	4103.2	5.3%	COV as %	1.9	2.0	**1.8**

Flow w/o C-Pt 76316 cfm

Vel Avg w/o C-Pt 3887 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	28.78	27.77	mbars
Ambient pressure	981.04	980.36	mbars
Total Stack pressure	1009.8	1008.1	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

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Signature/date	3/10/2020	Signature/date	3/10/2020	Signature/date	3/18/2020

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	3,800.7	3,929.6	3,712.3	3,814.2	3,822.5	3,689.9	3,756.7	3,756.4
2	53.7	4,155.5	4,013.2	4,074.8	4,081.2	4,095.1	4,155.5	4,054.3	4,101.6
3	48.4	4,054.3	4,175.4	4,074.8	4,101.5	4,013.2	4,135.4	4,175.4	4,108.0
4	40.6	4,312.3	4,273.7	4,273.7	4,286.6	4,234.6	4,095.1	4,135.4	4,155.0
Center	30.0	4,293.0	4,175.4	4,215.0	4,227.8	4,115.3	4,074.8	4,195.2	4,128.4
5	19.4	4,095.1	4,115.3	4,195.2	4,135.2	4,175.4	4,293.0	4,254.2	4,240.9
6	11.6	4,074.8	4,195.2	4,155.5	4,141.8	4,293.0	4,135.4	4,054.3	4,160.9
7	6.3	3,992.4	3,929.6	3,992.4	3,971.5	3,992.4	4,033.8	4,013.2	4,013.1
8	1.9	3,384.8	3,335.3	3,575.6	3,431.9	3,310.4	3,528.9	3,384.8	3,408.0
Averages ---------->		4,018.1	4,015.9	4,029.9	4,021.3	4,005.8	4,015.8	4,002.6	4,008.0

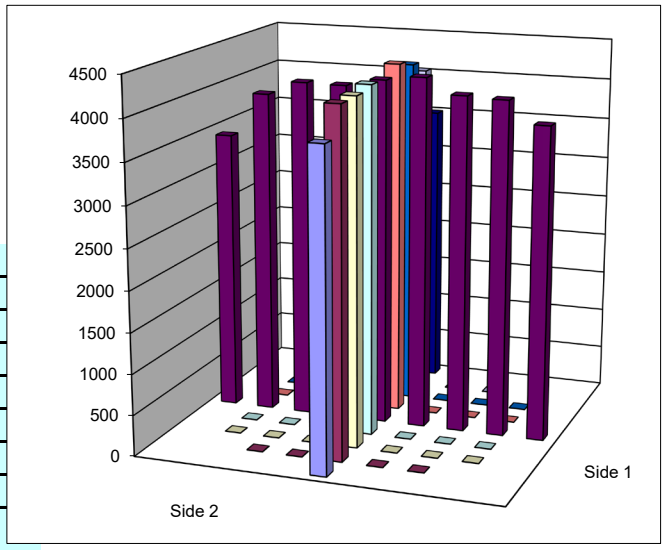
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4014.7		Mean	4135.1	4129.7	4132.4
Min Point	3408.0	-15.1%	Std. Dev.	102.0	69.3	83.8
Max Point	4286.6	6.8%	COV as %	2.5	1.7	**2.0**

Flow w/o C-Pt 78427 cfm

Vel Avg w/o C-Pt 3994 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	31.49	35.56	mbars
Ambient pressure	981.04	980.70	mbars
Total Stack pressure	1012.5	1016.3	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

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Signature/date	3/10/2020	Signature/date	3/10/2020	Signature/date	3/18/2020

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	3,714.9	3,692.4	3,803.3	3,736.9	3,825.1	3,759.3	3,601.2	3,728.5
2	53.7	3,974.3	4,118.2	3,953.4	4,015.3	4,217.9	3,889.8	3,974.3	4,027.3
3	48.4	4,178.3	4,138.3	4,057.1	4,124.6	4,217.9	3,932.3	4,036.6	4,062.3
4	40.6	4,077.6	4,178.3	4,178.3	4,144.7	4,097.9	4,118.2	4,077.6	4,097.9
Center	30.0	4,138.3	4,097.9	4,097.9	4,111.4	4,118.2	4,118.2	4,138.3	4,124.9
5	19.4	4,118.2	4,276.6	4,118.2	4,171.0	4,178.3	4,158.3	4,178.3	4,171.6
6	11.6	4,016.0	4,057.1	4,077.6	4,050.2	4,217.9	4,138.3	3,953.4	4,103.2
7	6.3	3,995.2	4,097.9	4,158.3	4,083.8	4,097.9	4,057.1	3,932.3	4,029.1
8	1.9	3,435.8	3,531.3	3,578.1	3,515.1	3,825.1	3,781.4	3,647.1	3,751.2
Averages ---------->		3,961.0	4,020.9	4,002.5	3,994.8	4,088.5	3,994.8	3,948.8	4,010.7

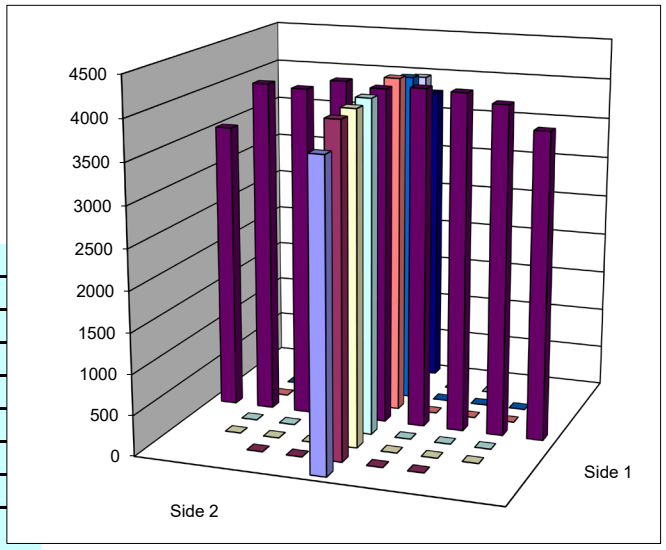
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4002.7		Mean	4100.1	4088.0	4094.1
Min Point	3515.1	-12.2%	Std. Dev.	54.3	52.4	51.7
Max Point	4171.6	4.2%	COV as %	1.3	1.3	**1.3**

Flow w/o C-Pt 78310 cfm

Vel Avg w/o C-Pt 3988 fpm

	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	34.20	28.78	mbars
Ambient pressure	980.70	980.36	mbars
Total Stack pressure	1014.9	1009.1	mbars
Ambient humidity	42%	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/10/2020	Signature/date	3/10/2020	Signature/date	3/18/2020

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	3,660.1	3,592.5	3,637.7	3,630.1	3,682.3	3,660.1	3,704.4	3,682.3
2	53.7	4,062.0	4,141.7	4,062.0	4,088.6	4,021.6	3,980.8	4,041.9	4,014.8
3	48.4	4,180.9	4,082.1	4,141.7	4,134.9	4,161.4	4,180.9	4,200.4	4,180.9
4	40.6	4,239.2	4,200.4	4,277.5	4,239.0	4,258.4	4,102.1	4,161.4	4,174.0
Center	30.0	4,082.1	4,121.9	4,200.4	4,134.8	4,121.9	4,141.7	4,141.7	4,135.1
5	19.4	4,239.2	4,141.7	4,277.5	4,219.5	4,062.0	4,200.4	4,121.9	4,128.1
6	11.6	4,161.4	4,277.5	4,161.4	4,200.1	4,161.4	4,141.7	4,141.7	4,148.3
7	6.3	4,021.6	4,141.7	3,980.8	4,048.0	4,121.9	4,102.1	3,980.8	4,068.3
8	1.9	3,637.7	3,682.3	3,660.1	3,660.0	3,523.6	3,637.7	3,834.5	3,665.3
Averages ---------->		4,031.6	4,042.4	4,044.3	4,039.4	4,012.7	4,016.4	4,036.5	4,021.9

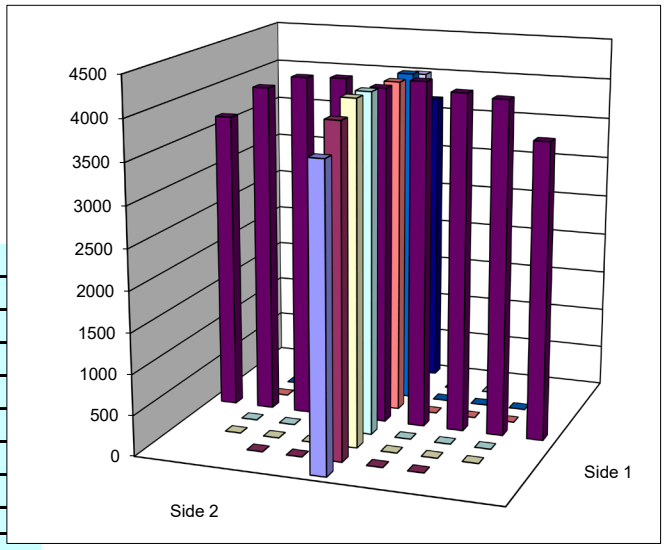
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4030.7		Mean	4152.1	4121.3	4136.7
Min Point	3630.1	-9.9%	Std. Dev.	70.5	59.8	64.8
Max Point	4239.0	5.2%	COV as %	1.7	1.5	**1.6**

Flow w/o C-Pt 78886 cfm

Vel Avg w/o C-Pt 4018 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	40.0	32.5	mbars
Ambient pressure	985.8	985.8	mbars
Total Stack pressure	1025.7	1018.3	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
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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	3,799.7	3,734.4	3,667.9	3,734.0	3,756.3	3,734.4	3,778.1	3,756.3
2	53.7	4,030.2	4,130.7	4,110.8	4,090.6	4,070.7	4,070.7	4,090.8	4,077.4
3	48.4	4,090.8	4,286.6	4,170.2	4,182.5	3,968.7	3,968.7	3,989.3	3,975.6
4	40.6	4,150.5	4,110.8	4,110.8	4,124.0	4,090.8	4,286.6	4,050.5	4,142.6
Center	30.0	4,130.7	4,170.2	4,130.7	4,143.9	4,090.8	4,130.7	4,110.8	4,110.8
5	19.4	4,170.2	4,090.8	4,050.5	4,103.8	4,209.4	4,150.5	4,150.5	4,170.1
6	11.6	4,050.5	4,209.4	4,189.9	4,149.9	4,189.9	4,209.4	4,090.8	4,163.4
7	6.3	4,070.7	4,090.8	4,009.8	4,057.1	3,968.7	4,050.5	4,009.8	4,009.7
8	1.9	3,554.3	3,600.2	3,622.9	3,592.5	3,531.1	3,531.1	3,577.3	3,546.5
Averages ---------->		4,005.3	4,047.1	4,007.1	4,019.8	3,986.3	4,014.7	3,983.1	3,994.7

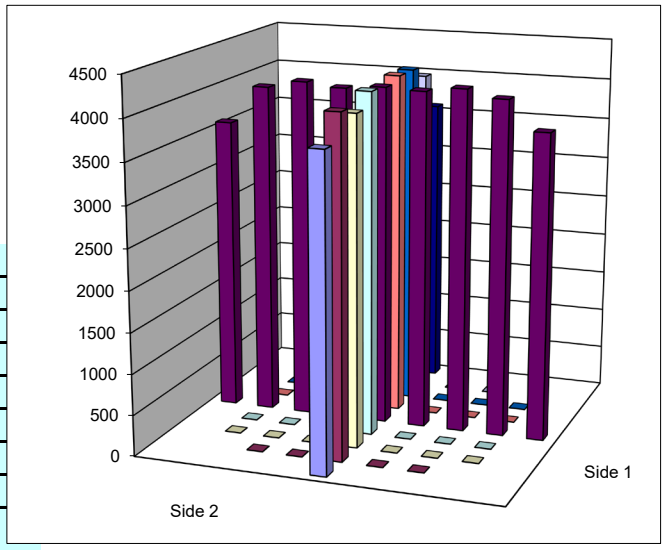
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4007.3		Mean	4121.7	4092.8	4107.2
Min Point	3546.5	-11.5%	Std. Dev.	41.7	76.0	60.8
Max Point	4182.5	4.4%	COV as %	1.0	1.9	**1.5**

Flow w/o C-Pt 78388 cfm

Vel Avg w/o C-Pt 3992 fpm

	Start	Finish	
Stack temp	67	66	F
Equipment temp	56.6	57.2	F
Ambient temp	56.6	57.2	F
Stack static	40.0	32.5	mbars
Ambient pressure	985.8	985.8	mbars
Total Stack pressure	1025.7	1018.3	mbars
Ambient humidity	37%	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

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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	3,993.9	4,075.5	4,055.2	4,041.5	4,075.5	4,155.4	4,034.9	4,088.6
2	53.7	4,135.5	4,214.3	4,115.6	4,155.1	4,135.5	4,214.3	4,253.2	4,201.0
3	48.4	4,095.6	4,075.5	4,034.9	4,068.7	4,214.3	4,175.1	4,214.3	4,201.2
4	40.6	4,014.5	3,993.9	4,075.5	4,028.0	4,075.5	3,993.9	4,055.2	4,041.5
Center	30.0	4,014.5	4,034.9	4,014.5	4,021.3	4,135.5	4,055.2	4,055.2	4,082.0
5	19.4	4,155.4	4,155.4	4,135.5	4,148.8	4,095.6	4,214.3	4,194.8	4,168.2
6	11.6	4,291.6	4,194.8	4,214.3	4,233.6	4,272.4	4,075.5	3,993.9	4,113.9
7	6.3	4,329.8	3,847.1	3,910.7	4,029.2	4,135.5	4,155.4	3,952.5	4,081.1
8	1.9	3,868.4	3,910.7	3,952.5	3,910.5	3,782.5	3,825.7	3,694.5	3,767.6
Averages ---------->		4,099.9	4,055.8	4,056.5	4,070.7	4,102.5	4,096.1	4,049.8	4,082.8

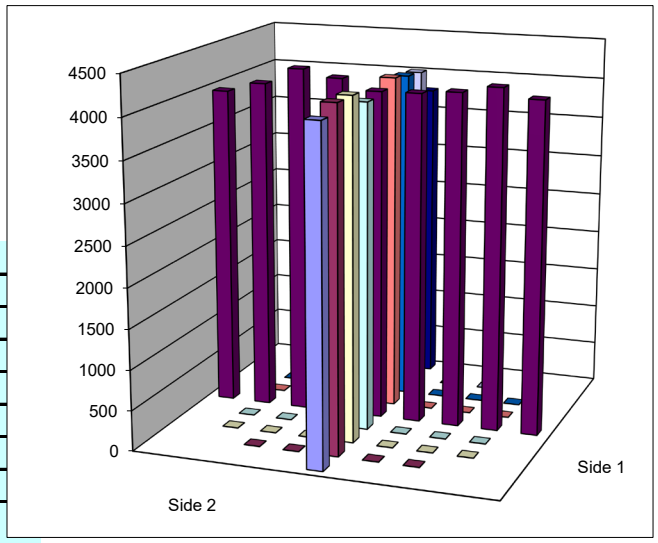
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4076.8		Mean	4097.8	4127.0	4112.4
Min Point	3767.6	-7.6%	Std. Dev.	82.3	63.6	72.3
Max Point	4233.6	3.8%	COV as %	2.0	1.5	**1.8**

Flow w/o C-Pt 80109 cfm

Vel Avg w/o C-Pt 4080 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	32.51	28.45	mbars
Ambient pressure	975.28	975.62	mbars
Total Stack pressure	1007.79	1004.07	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

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Signature/date	3/10/2020	Signature/date	3/10/2020	Signature/date	3/18/2020

Appendix C – LB-S2 Stack Verification Data Sheets

C.1 Flow Angle Data Forms

FLOW ANGLE DATA FORM

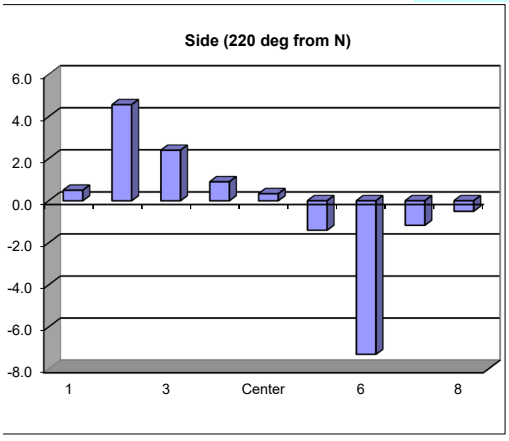
Stack	LB-S2	Run No.	FA-1
Date	10/15/2019	Fan Setting	N/A Hz
Start/End Time	14:15 14:30	Fan Configuration	Fan A
Testers	ZDH/LCE	Stack Temp	68 deg F
Stack Dia.	28 in	Approx. air vel.	4098 afpm at point > Mean All
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

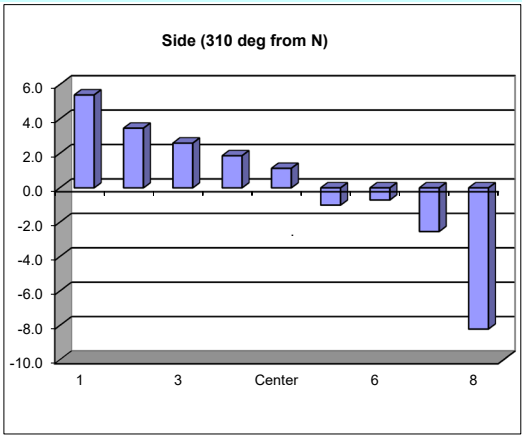
Order -->	First					Second			
Traverse-->	Side 1 (220 deg from N)					Side 2 (310 deg from N)			
Trial ---->	1	2	3	Mean		1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	27.1	1.2	0.2	0.1	0.5	5.5	5.6	5.1	5.4
2	25.1	4.3	4.3	5.1	4.6	3.5	2.7	4.2	3.5
3	22.6	2.0	2.7	2.5	2.4	1.7	2.8	3.3	2.6
4	19.0	1.3	0.6	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 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





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Signature/date	3/4/2020	Signature/date	3/5/2020	Signature/date

FLOW ANGLE DATA FORM

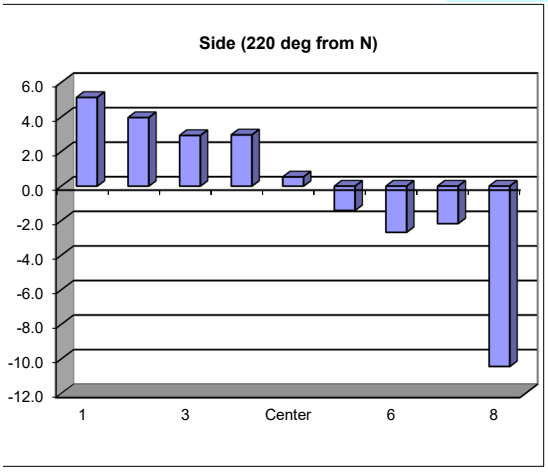
Stack	LB-S2	Run No.	FA-2
Date	10/15/2019	Fan Setting	N/A Hz
Start/End Time	15:55 16:04	Fan Configuration	Fan A
Testers	ZDH/LCE	Stack Temp	68.9 deg F
Stack Dia.	28 in	Approx. air vel.	4123 afpm at point > Mean All
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

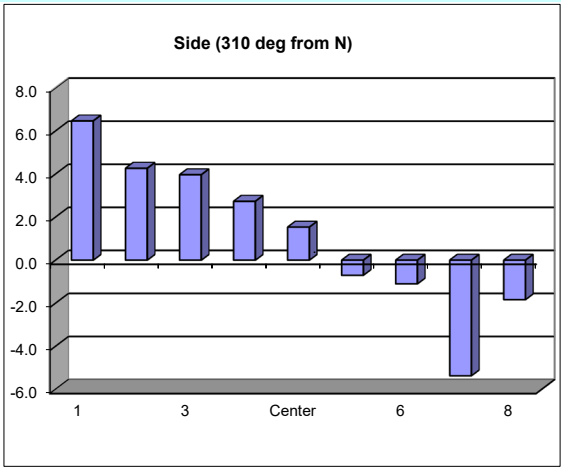
Order -->		First				Second			
Traverse-->		Side 1 (220 deg from N)				Side 2 (310 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	27.1	4.6	5.7	5.1	5.1	6.4	7.8	5.2	6.5
2	25.1	3.9	4.5	3.5	4.0	3.4	4.7	4.7	4.3
3	22.6	3.1	2.7	3.0	2.9	5.3	1.9	4.7	4.0
4	19.0	2.6	3.4	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 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





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Signature/date	3/4/2020	Signature/date	3/5/2020	Signature/date	3/18/2020

FLOW ANGLE DATA FORM

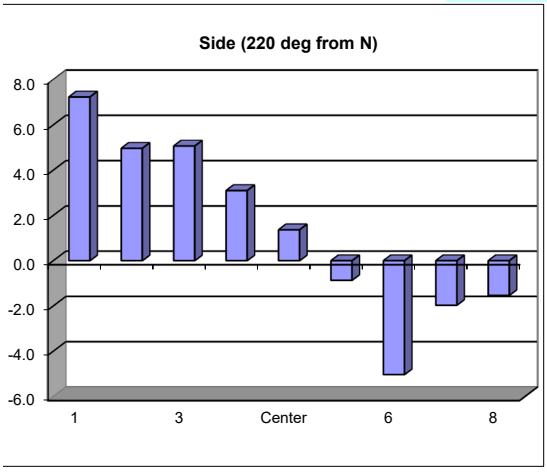
Stack	LB-S2	Run No.	FA-3
Date	10/16/2019	Fan Setting	N/A Hz
Start/End Time	9:52 10:01	Fan Configuration	Fan A
Testers	ZDH/LCE	Stack Temp	66.8 deg F
Stack Dia.	28 in	Approx. air vel.	4093 afpm at point > Mean All
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

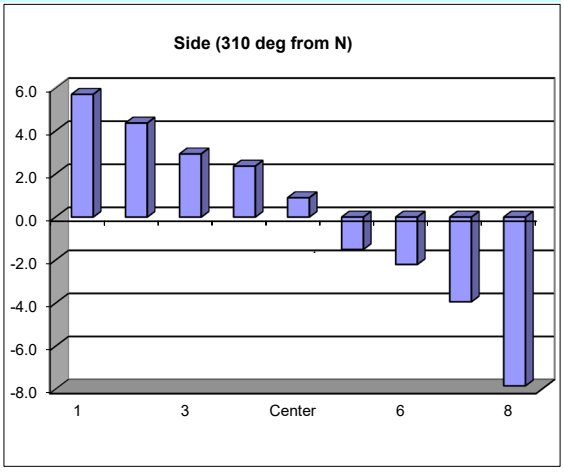
Order -->		First				Second			
Traverse-->		Side 1 (220 deg from N)				Side 2 (310 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	27.1	8.0	7.1	6.6	7.2	6.3	4.7	6.1	5.7
2	25.1	5.9	4.8	4.2	5.0	4.5	4.3	4.3	4.4
3	22.6	5.3	5.1	4.8	5.1	4.0	2.6	2.2	2.9
4	19.0	3.6	3.3	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
								Grand mean ABS w/o wall pts	2.9

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 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





Data Transcribed by:	Ernest Antonio	Data Entered by:	Ernest Antonio	Transciption Review performed by:	Jennifer Yao
Signature/date	3/4/2020	Signature/date	3/5/2020	Signature/date	3/18/2020

FLOW ANGLE DATA FORM

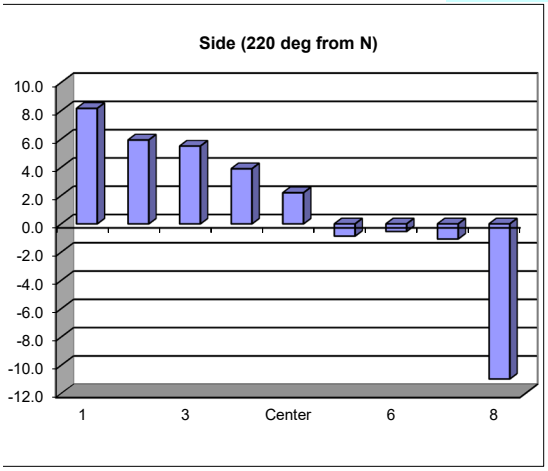
Stack	LB-S2	Run No.	FA-4
Date	10/16/2019	Fan Setting	N/A Hz
Start/End Time	11:21 11:29	Fan Configuration	Fan A
Testers	ZDH/LCE	Stack Temp	68.3 deg F
Stack Dia.	28 in	Approx. air vel.	4103 afpm at point > Mean All
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

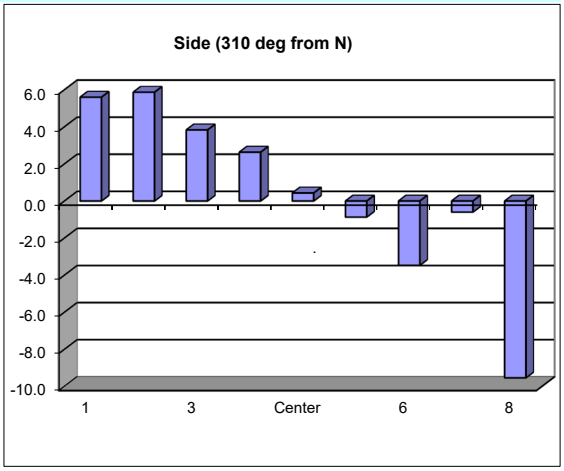
Order -->		First				Second			
Traverse-->		Side 1 (220 deg from N)				Side 2 (310 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	27.1	7.9	9.7	6.9	8.2	4.6	5.9	6.3	5.6
2	25.1	5.9	5.9	6.0	5.9	6.5	6.0	5.1	5.9
3	22.6	5.7	5.2	5.6	5.5	4.4	3.6	3.5	3.8
4	19.0	3.1	4.4	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 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





Data Transcribed by:	Ernest Antonio	Data Entered by:	Ernest Antonio	Transciption Review performed by:	Jennifer Yao
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FLOW ANGLE DATA FORM

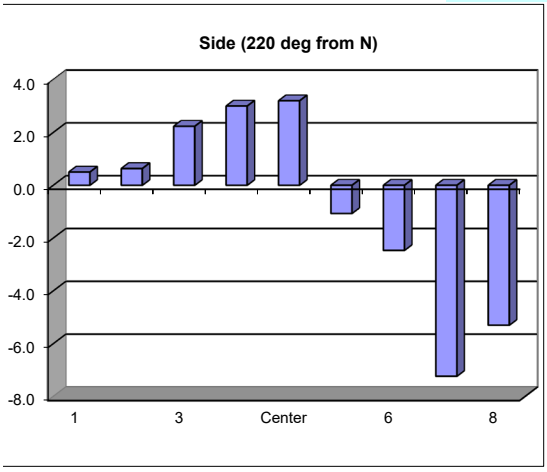
Stack	LB-S2	Run No.	FA-5
Date	10/16/2019	Fan Setting	N/A Hz
Start/End Time	13:27 13:33	Fan Configuration	Fan A
Testers	ZDH/LCE	Stack Temp	68.7 deg F
Stack Dia.	28 in	Approx. air vel.	4078 afpm at point > Mean All
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

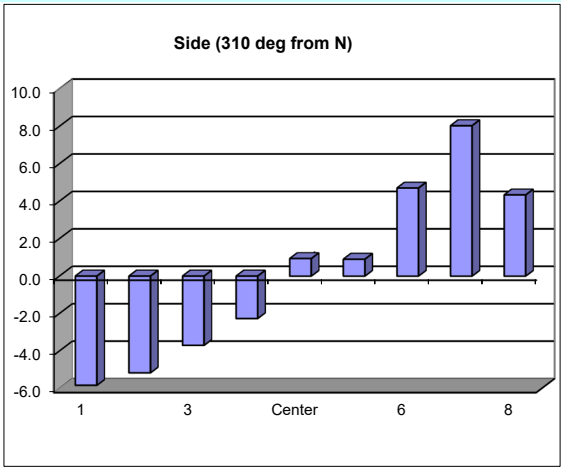
Order -->		First				Second			
Traverse-->		Side 1 (220 deg from N)				Side 2 (310 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	27.1	0.5	0.5	0.5	0.5	-7.1	-5.4	-5.0	-5.8
2	25.1	0.7	0.6	0.6	0.6	-3.4	-6.1	-6.0	-5.2
3	22.6	0.7	3.3	2.7	2.2	-3.2	-3.7	-4.2	-3.7
4	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 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





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FLOW ANGLE DATA FORM

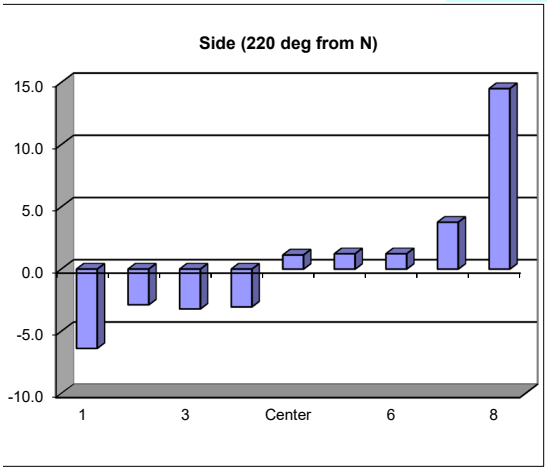
Stack	LB-S2	Run No.	FA-6
Date	10/16/2019	Fan Setting	N/A Hz
Start/End Time	14:34 14:40	Fan Configuration	Fan A
Testers	ZDH/LCE	Stack Temp	69.1 deg F
Stack Dia.	28 in	Approx. air vel.	4072 afpm at point > Mean All
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

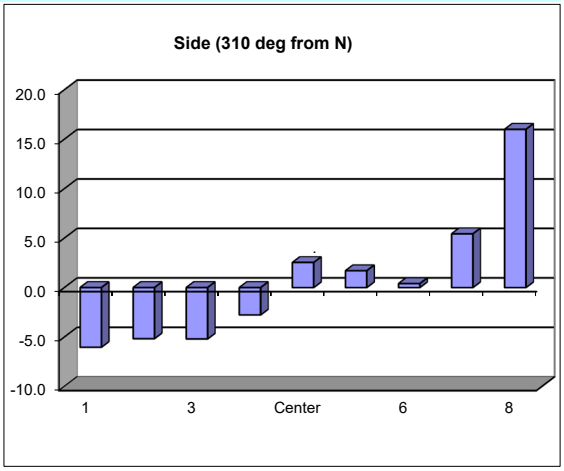
Order -->		First				Second			
Traverse-->		Side 1 (220 deg from N)				Side 2 (310 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	27.1	-4.0	-7.7	-7.4	-6.4	-6.3	-5.8	-6.0	-6.0
2	25.1	-3.0	-2.7	-2.9	-2.9	-5.4	-5.0	-5.1	-5.2
3	22.6	-2.8	-3.3	-3.5	-3.2	-5.6	-4.9	-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 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





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FLOW ANGLE DATA FORM

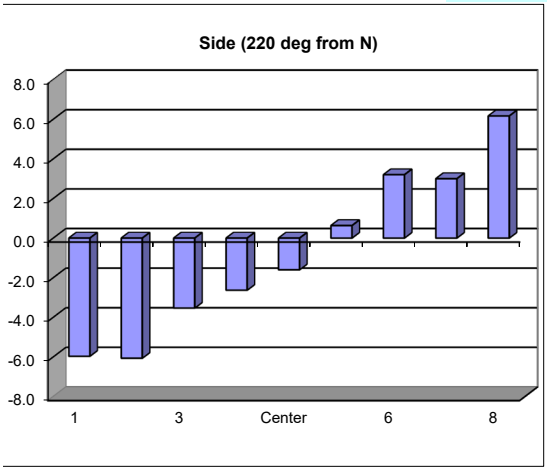
Stack	LB-S2	Run No.	FA-7
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	9:43 9:51	Fan Configuration	Fan A
Testers	ZDH/LCE	Stack Temp	69.2 deg F
Stack Dia.	28 in	Approx. air vel.	4108 afpm at point > Mean All
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

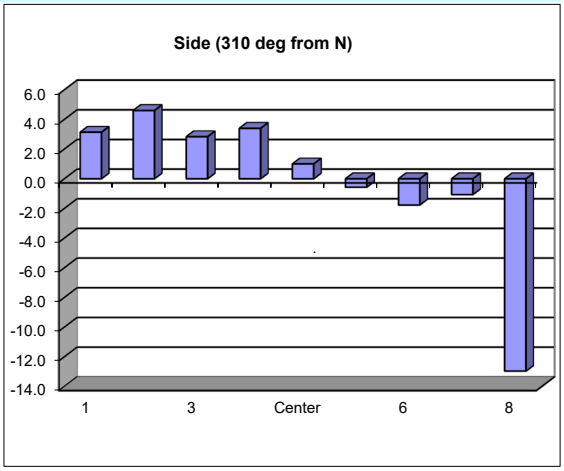
Order -->		First				Second			
Traverse-->		Side 1 (220 deg from N)				Side 2 (310 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	27.1	-5.9	-5.4	-6.6	-6.0	3.2	3.1	3.1	3.1
2	25.1	-6.1	-5.8	-6.3	-6.1	4.6	5.0	4.2	4.6
3	22.6	-4.2	-3.8	-2.6	-3.5	2.5	3.2	2.8	2.8
4	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 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





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FLOW ANGLE DATA FORM

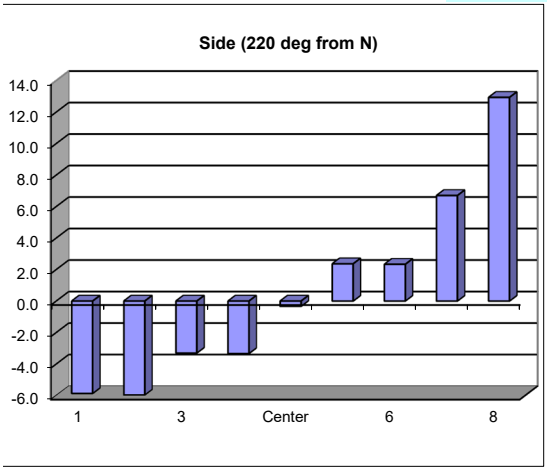
Stack	LB-S2	Run No.	FA-8
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	10:52 11:00	Fan Configuration	Fan B Only
Testers	ZDH/LCE	Stack Temp	69.2 deg F
Stack Dia.	28 in	Approx. air vel.	4274 afpm at point > Mean All
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

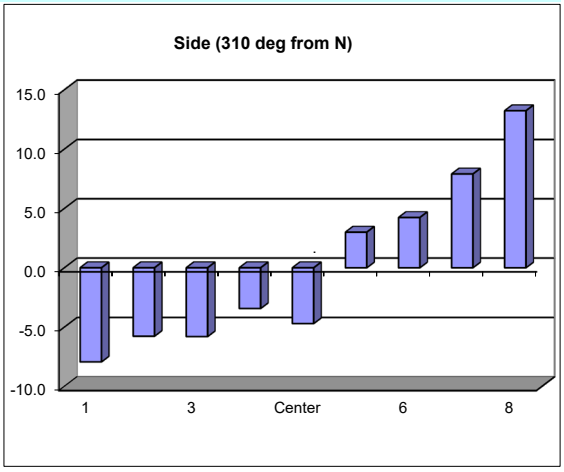
Order -->		First				Second			
Traverse-->		Side 1 (220 deg from N)				Side 2 (310 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	27.1	-7.6	-4.3	-5.7	-5.9	-8.2	-7.9	-7.7	-7.9
2	25.1	-5.7	-6.5	-5.7	-6.0	-6.7	-5.3	-5.3	-5.8
3	22.6	-5.4	-3.2	-1.3	-3.3	-6.3	-5.8	-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 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





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Signature/date	3/4/2020	Signature/date	3/5/2020	Signature/date	3/18/2020

FLOW ANGLE DATA FORM

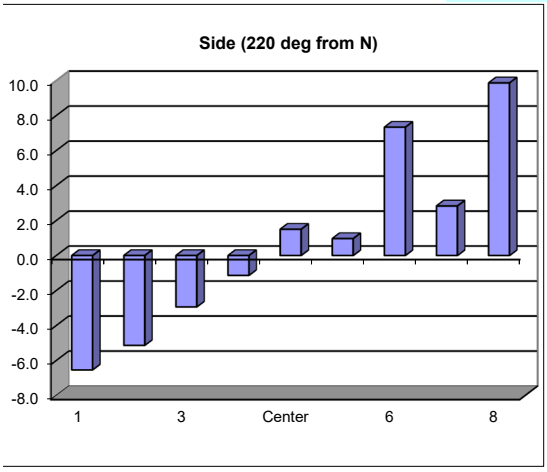
Stack	LB-S2	Run No.	FA-9
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	13:20 13:27	Fan Configuration	Fan B Only
Testers	ZDH/LCE	Stack Temp	70.6 deg F
Stack Dia.	28 in	Approx. air vel.	4294 afpm at point > Mean All
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

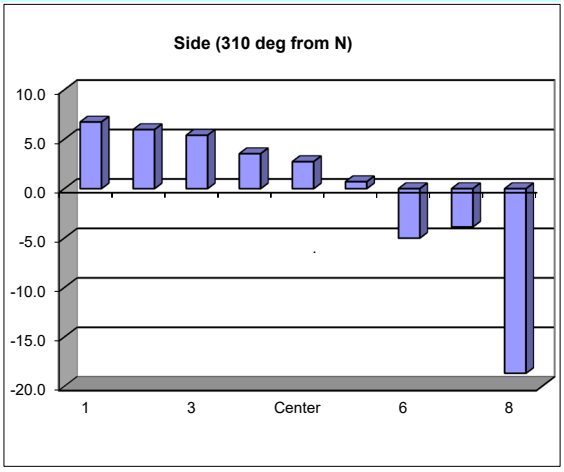
Order -->		First				Second			
Traverse-->		Side 1 (220 deg from N)				Side 2 (310 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	27.1	-6.6	-6.8	-6.2	-6.5	6.4	7.5	6.3	6.7
2	25.1	-5.1	-5.6	-4.7	-5.1	6.1	5.8	6.0	6.0
3	22.6	-2.7	-2.8	-3.3	-2.9	5.5	5.8	4.9	5.4
4	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
								Grand mean ABS w/o wall pts	3.5

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 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





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FLOW ANGLE DATA FORM

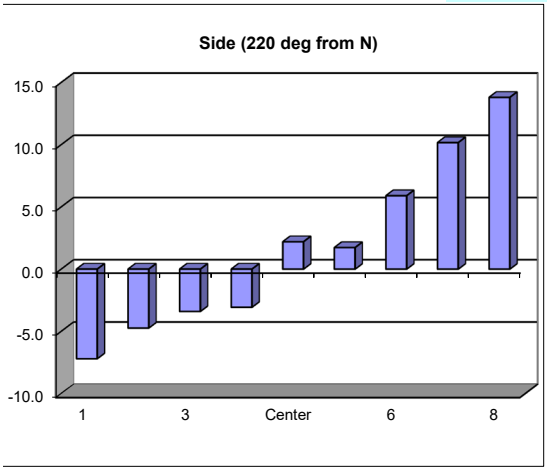
Stack	LB-S2	Run No.	FA-10
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	14:45 14:52	Fan Configuration	Fan B
Testers	ZDH/LCE	Stack Temp	70.2 deg F
Stack Dia.	28 in	Approx. air vel.	4225 afpm at point > Mean All
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

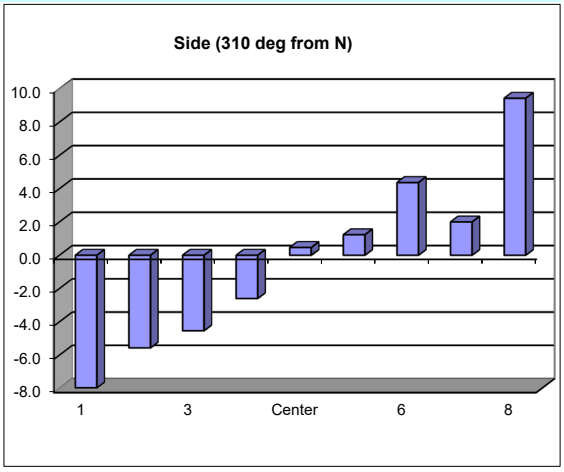
Order -->		First				Second			
Traverse-->		Side 1 (220 deg from N)				Side 2 (310 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	27.1	-8.4	-6.6	-6.6	-7.2	-8.4	-7.4	-8.1	-8.0
2	25.1	-5.7	-4.2	-4.3	-4.7	-6.1	-4.5	-6.1	-5.6
3	22.6	-3.4	-3.9	-2.9	-3.4	-4.6	-4.9	-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 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





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FLOW ANGLE DATA FORM

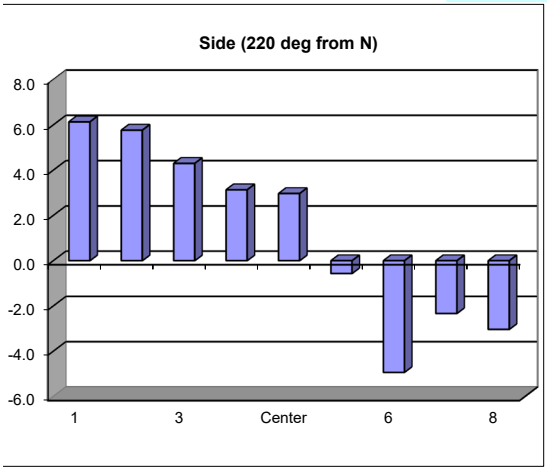
Stack	LB-S2	Run No.	FA-11
Date	10/17/2019	Fan Setting	N/A Hz
Start/End Time	15:52 15:57	Fan Configuration	Fan B
Testers	ZDH/LCE	Stack Temp	70.4 deg F
Stack Dia.	28 in	Approx. air vel.	4251 afpm at point > Mean All
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

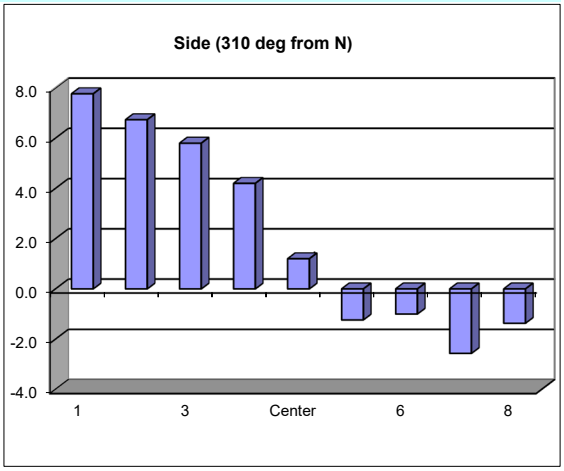
Order -->		First				Second			
Traverse-->		Side 1 (220 deg from N)				Side 2 (310 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	27.1	6.4	6.1	5.9	6.1	8.3	7.4	7.6	7.8
2	25.1	5.5	5.8	6.0	5.8	6.7	6.9	6.6	6.7
3	22.6	4.0	4.6	4.3	4.3	6.4	5.4	5.6	5.8
4	19.0	4.1	2.7	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 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





Data Transcribed by:	Ernest Antonio	Data Entered by:	Ernest Antonio	Transciption Review performed by:	Jennifer Yao
Signature/date	3/4/2020	Signature/date	3/5/2020	Signature/date	3/18/2020

FLOW ANGLE DATA FORM

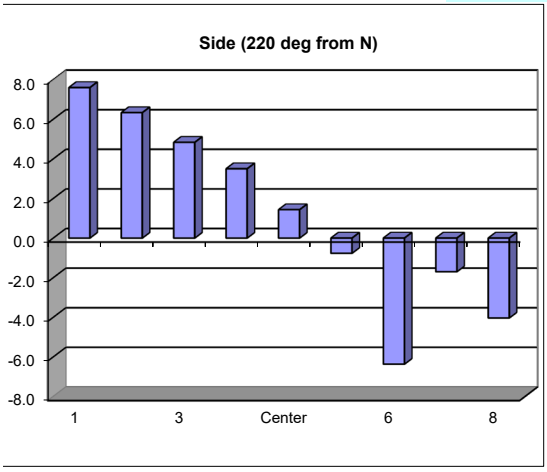
Stack	LB-S2	Run No.	FA-12
Date	10/18/2019	Fan Setting	N/A Hz
Start/End Time	9:31 9:37	Fan Configuration	Fan B
Testers	ZDH/LCE	Stack Temp	67.8 deg F
Stack Dia.	28 in	Approx. air vel.	4260 afpm at point > Mean All
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

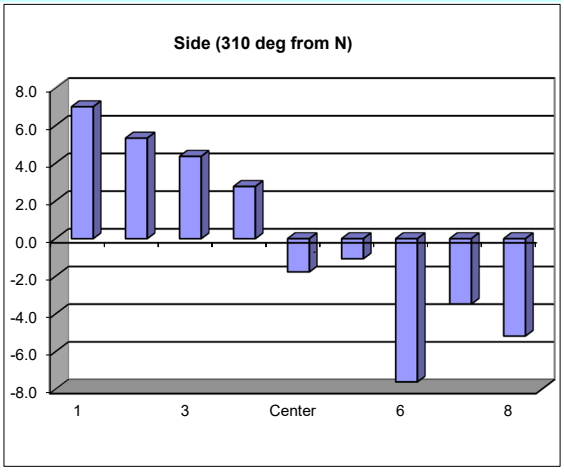
Order -->		First				Second			
Traverse-->		Side 1 (220 deg from N)				Side 2 (310 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	27.1	7.7	7.6	7.5	7.6	7.6	6.9	6.5	7.0
2	25.1	7.1	5.2	6.7	6.3	5.6	5.0	5.4	5.3
3	22.6	5.3	4.6	4.6	4.8	4.6	4.1	4.4	4.4
4	19.0	3.5	3.1	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 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





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Signature/date	3/4/2020	Signature/date	3/5/2020	Signature/date	3/18/2020

FLOW ANGLE DATA FORM

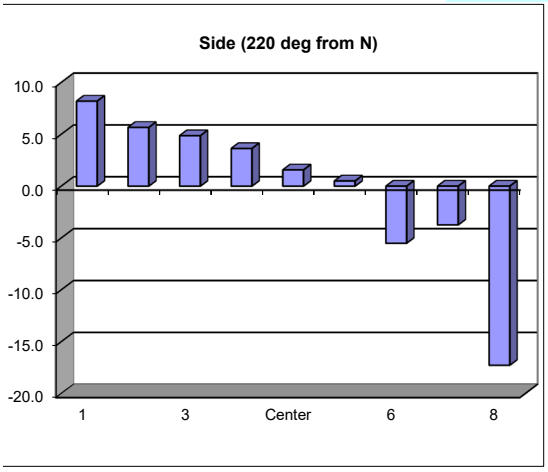
Stack	LB-S2	Run No.	FA-13
Date	10/18/2019	Fan Setting	N/A Hz
Start/End Time	10:39 19:46	Fan Configuration	Fan B
Testers	ZDH/LCE	Stack Temp	67.7 deg F
Stack Dia.	28 in	Approx. air vel.	4257 afpm at point > Mean All
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

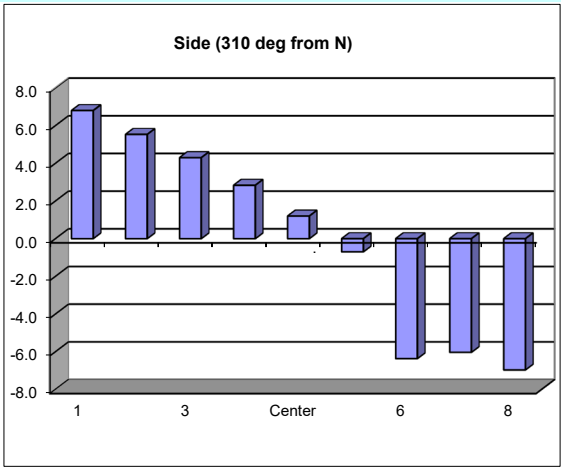
Order -->		First				Second			
Traverse-->		Side 1 (220 deg from N)				Side 2 (310 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	27.1	8.8	7.7	8.1	8.2	7.4	6.8	6.2	6.8
2	25.1	5.5	5.8	5.7	5.7	5.7	5.4	5.5	5.5
3	22.6	4.5	5.2	4.9	4.9	4.4	4.3	4.2	4.3
4	19.0	3.6	3.9	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 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





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FLOW ANGLE DATA FORM

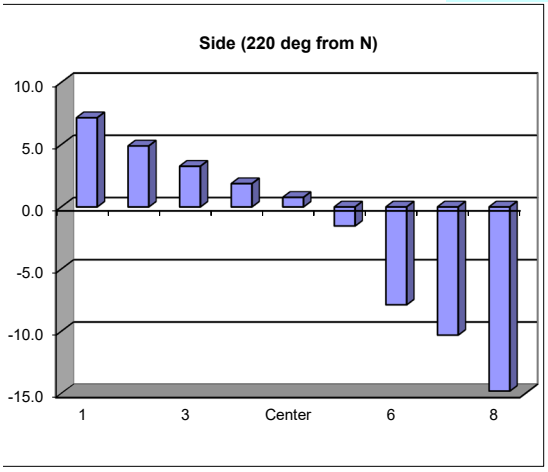
Stack	LB-S2	Run No.	FA-14
Date	10/19/2019	Fan Setting	N/A Hz
Start/End Time	9:45 9:51	Fan Configuration	Fan B
Testers	ZDH/LCE	Stack Temp	66.6 deg F
Stack Dia.	28 in	Approx. air vel.	4246 afpm at point > Mean All
Stack X-Area	615.8 in2	Units	degrees (clockwise > pos. nos.)
Elevation	753 ft	Port	2
Distance to disturbance	57.5 ft		

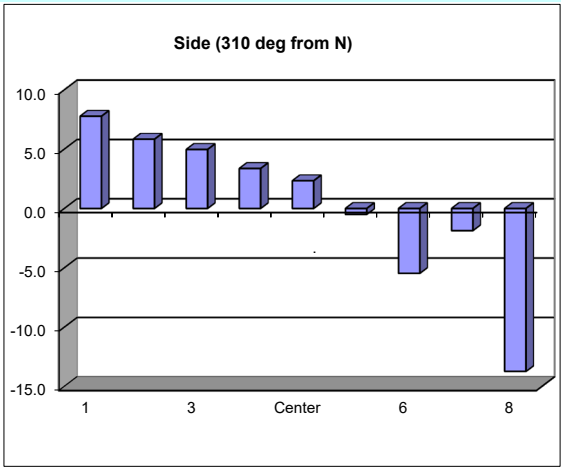
Order -->		First				Second			
Traverse-->		Side 1 (220 deg from N)				Side 2 (310 deg from N)			
Trial ---->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	deg. cw				deg. cw			
1	27.1	6.7	7.0	7.8	7.2	8.2	7.8	7.3	7.8
2	25.1	4.4	5.7	4.6	4.9	6.2	5.6	5.7	5.8
3	22.6	3.2	3.7	2.9	3.3	4.8	5.0	5.1	5.0
4	19.0	2.3	2.1	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 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





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Signature/date	3/4/2020	Signature/date	3/5/2020	Signature/date	3/18/2020

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	3,859.8	3,838.5	3,902.0	3,866.8	3,361.0	3,236.9	3,480.6	3,359.5
2	25.1	4,165.8	4,025.9	4,046.2	4,079.3	3,922.9	3,964.4	4,086.4	3,991.2
3	22.6	4,395.3	4,262.9	4,395.3	4,351.2	4,204.9	4,243.7	4,106.4	4,185.0
4	19.0	4,432.4	4,450.8	4,320.1	4,401.1	4,376.6	4,395.3	4,320.1	4,364.0
Center	14.0	4,432.4	4,413.9	4,395.3	4,413.9	4,432.4	4,357.9	4,395.3	4,395.2
5	9.0	4,339.0	4,320.1	4,339.0	4,332.7	4,395.3	4,243.7	4,395.3	4,344.8
6	5.4	4,224.3	4,282.1	4,262.9	4,256.4	4,106.4	3,922.9	4,185.4	4,071.6
7	2.9	4,025.9	4,106.4	3,943.7	4,025.3	4,005.5	4,066.4	4,046.2	4,039.4
8	0.9	3,752.3	3,774.0	3,664.0	3,730.1	3,527.4	3,550.5	3,596.3	3,558.1
Averages ---------->		4,180.8	4,163.8	4,140.9	4,161.9	4,036.9	3,998.0	4,068.0	4,034.3

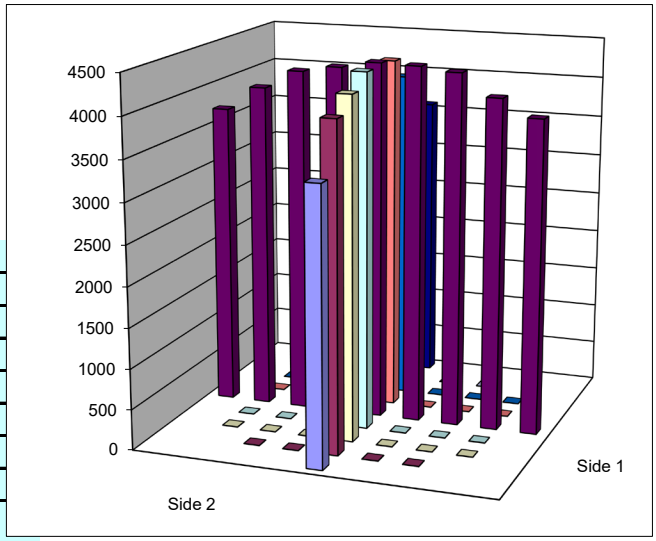
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4098.1		Mean	4265.7	4198.7	4232.2
Min Point	3359.5	-18.0%	Std. Dev.	155.3	169.3	159.9
Max Point	4413.9	7.7%	COV as %	3.6	4.0	**3.8**

Flow w/o C-Pt 17360 cfm

Vel Avg w/o C-Pt 4060 fpm

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

	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	6.77	6.77	mbars
Ambient pressure	991.20	991.20	mbars
Total Stack pressure	998.0	998.0	mbars
Ambient humidity	25%	27%	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/12/2020	Signature/date	3/12/2020	Signature/date	3/18/2020

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	3,364.0	3,483.7	3,364.0	3,403.9	3,622.2	3,599.5	3,644.8	3,622.2
2	25.1	3,967.9	4,069.9	4,208.6	4,082.1	4,129.9	4,149.7	4,208.6	4,162.7
3	22.6	4,380.5	4,323.9	4,304.9	4,336.4	4,129.9	4,304.9	4,342.9	4,259.2
4	19.0	4,417.7	4,361.7	4,399.1	4,392.8	4,491.4	4,380.5	4,399.1	4,423.7
Center	14.0	4,473.1	4,417.7	4,454.7	4,448.5	4,399.1	4,491.4	4,473.1	4,454.5
5	9.0	4,436.3	4,417.7	4,380.5	4,411.5	4,380.5	4,436.3	4,417.7	4,411.5
6	5.4	4,149.7	4,285.8	4,323.9	4,253.1	4,285.8	4,228.0	4,323.9	4,279.2
7	2.9	4,129.9	4,049.7	3,947.2	4,042.3	4,069.9	4,029.4	4,149.7	4,083.0
8	0.9	3,644.8	3,483.7	3,576.6	3,568.4	3,576.6	3,553.6	3,622.2	3,584.1
Averages ---------->		4,107.1	4,099.3	4,106.6	4,104.3	4,120.6	4,130.4	4,175.8	4,142.2

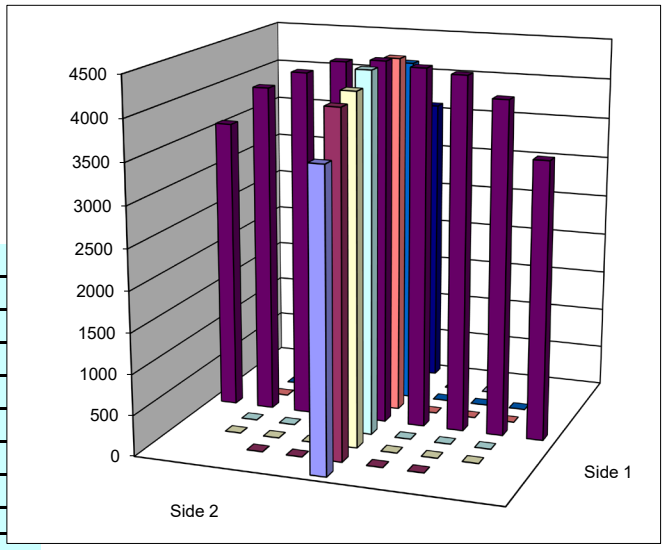
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4123.3		Mean	4281.0	4296.3	4288.6
Min Point	3403.9	-17.4%	Std. Dev.	162.3	141.1	146.3
Max Point	4454.5	8.0%	COV as %	3.8	3.3	**3.4**

Flow w/o C-Pt 17456 cfm

Vel Avg w/o C-Pt 4082 fpm

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

	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	62.31	54.86	mbars
Ambient pressure	990.86	990.52	mbars
Total Stack pressure	1053.2	1045.4	mbars
Ambient humidity	32%	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/12/2020	Signature/date	3/12/2020	Signature/date	3/18/2020

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	3,343.0	3,415.9	3,391.8	3,383.6	3,603.2	3,557.3	3,648.5	3,603.0
2	25.1	3,992.7	4,154.0	3,951.3	4,032.7	4,013.2	3,909.5	4,033.6	3,985.4
3	22.6	4,347.4	4,403.7	4,403.7	4,384.9	4,271.1	4,213.0	4,114.3	4,199.5
4	19.0	4,385.0	4,403.7	4,422.3	4,403.7	4,347.4	4,366.2	4,347.4	4,353.7
Center	14.0	4,440.9	4,459.3	4,385.0	4,428.4	4,459.3	4,403.7	4,403.7	4,422.2
5	9.0	4,403.7	4,290.3	4,328.4	4,340.8	4,328.4	4,422.3	4,328.4	4,359.7
6	5.4	4,251.8	4,251.8	4,213.0	4,238.9	4,309.4	4,347.4	4,232.4	4,296.4
7	2.9	4,074.2	4,033.6	3,951.3	4,019.7	4,114.3	3,972.0	4,033.6	4,040.0
8	0.9	3,693.3	3,534.1	3,557.3	3,594.9	3,557.3	3,557.3	3,626.0	3,580.2
Averages ---------->		4,103.6	4,105.2	4,067.1	4,091.9	4,111.5	4,083.2	4,085.3	4,093.3

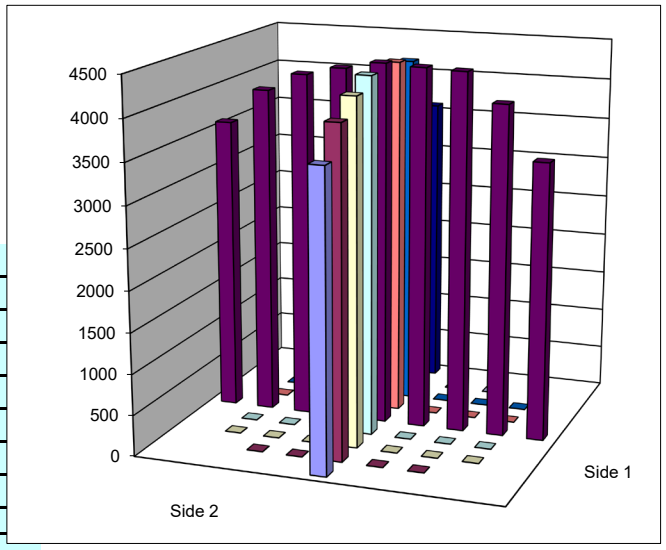
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4092.6		Mean	4264.1	4236.7	4250.4
Min Point	3383.6	-17.3%	Std. Dev.	173.6	168.3	164.9
Max Point	4428.4	8.2%	COV as %	4.1	4.0	**3.9**

Flow w/o C-Pt 17323 cfm

Vel Avg w/o C-Pt 4051 fpm

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

	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	62.31	45.38	mbars
Ambient pressure	985.44	985.10	mbars
Total Stack pressure	1047.7	1030.5	mbars
Ambient humidity	48%	46%	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/12/2020	Signature/date	3/12/2020	Signature/date	3/18/2020

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	3,653.6	3,585.3	3,562.3	3,600.4	3,396.5	3,322.9	3,396.5	3,372.0
2	25.1	4,100.0	3,977.5	4,140.0	4,072.5	3,956.8	3,998.2	3,872.6	3,942.5
3	22.6	4,277.0	4,353.4	4,238.3	4,289.6	4,257.7	4,277.0	4,296.2	4,277.0
4	19.0	4,409.8	4,353.4	4,353.4	4,372.2	4,334.4	4,465.5	4,315.4	4,371.8
Center	14.0	4,447.0	4,409.8	4,277.0	4,377.9	4,372.3	4,447.0	4,391.1	4,403.5
5	9.0	4,296.2	4,372.3	4,334.4	4,334.3	4,372.3	4,428.5	4,409.8	4,403.5
6	5.4	4,218.8	4,315.4	4,296.2	4,276.8	4,277.0	4,372.3	4,428.5	4,359.3
7	2.9	4,059.6	4,100.0	4,140.0	4,099.9	4,159.8	4,079.8	3,956.8	4,065.5
8	0.9	3,492.2	3,631.0	3,539.0	3,554.1	3,764.7	3,631.0	3,653.6	3,683.1
Averages ---------->		4,106.0	4,122.0	4,097.8	4,108.6	4,099.1	4,113.6	4,080.1	4,097.6

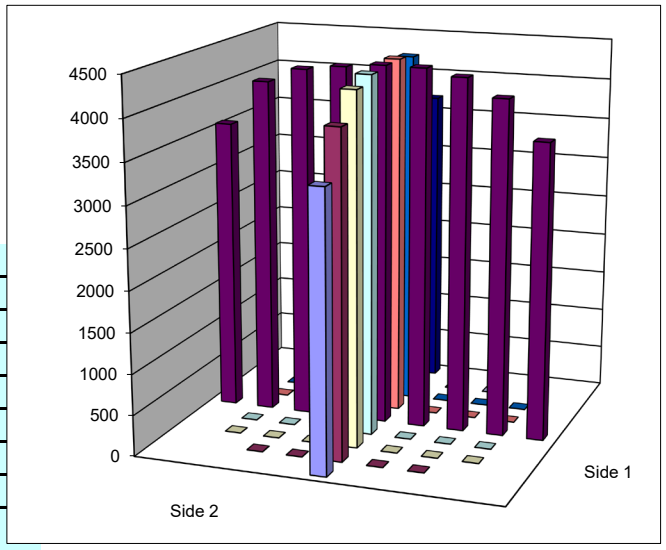
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4103.1		Mean	4260.5	4260.4	4260.4
Min Point	3372.0	-17.8%	Std. Dev.	125.1	183.7	151.0
Max Point	4403.5	7.3%	COV as %	2.9	4.3	**3.5**

Flow w/o C-Pt 17391 cfm

Vel Avg w/o C-Pt 4067 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	87.03	56.21	mbars
Ambient pressure	984.76	984.76	mbars
Total Stack pressure	1071.8	1041.0	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/12/2020	Signature/date	3/12/2020	Signature/date	3/18/2020

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	4,066.4	3,521.6	3,637.1	3,741.7	3,353.2	3,353.2	3,328.5	3,345.0
2	25.1	4,066.4	4,046.0	4,106.9	4,073.1	3,963.4	4,066.4	4,046.0	4,025.3
3	22.6	4,303.5	4,322.6	4,225.9	4,284.0	4,303.5	4,186.6	4,245.4	4,245.2
4	19.0	4,360.7	4,379.6	4,322.6	4,354.3	4,303.5	4,360.7	4,379.6	4,347.9
Center	14.0	4,341.7	4,435.9	4,398.5	4,392.0	4,360.7	4,379.6	4,417.2	4,385.8
5	9.0	4,225.9	4,186.6	4,264.9	4,225.8	4,303.5	4,245.4	4,146.9	4,231.9
6	5.4	4,126.9	4,025.5	4,206.3	4,119.6	4,303.5	4,264.9	4,284.2	4,284.2
7	2.9	4,004.9	4,146.9	4,004.9	4,052.2	3,921.5	3,984.2	4,004.9	3,970.2
8	0.9	3,474.3	3,568.2	3,614.3	3,552.3	3,857.7	3,704.7	3,749.0	3,770.5
Averages ---------->		4,107.9	4,070.3	4,086.8	4,088.3	4,074.5	4,060.6	4,066.9	4,067.3

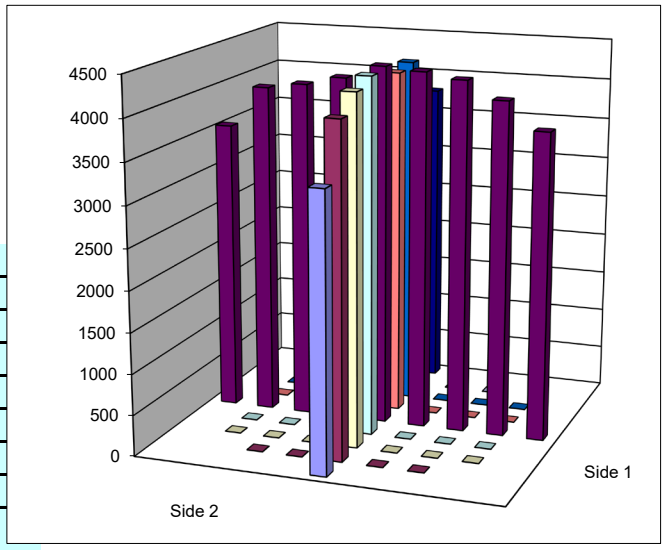
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4077.8		Mean	4214.4	4212.9	4213.7
Min Point	3345.0	-18.0%	Std. Dev.	136.2	157.4	141.4
Max Point	4392.0	7.7%	COV as %	3.2	3.7	**3.4**

Flow w/o C-Pt 17271 cfm

Vel Avg w/o C-Pt 4039 fpm

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

	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	55.54	63.33	mbars
Ambient pressure	983.41	983.41	mbars
Total Stack pressure	1038.9	1046.7	mbars
Ambient humidity	34%	34%	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/12/2020	Signature/date	3/12/2020	Signature/date	3/18/2020

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	3,154.1	3,282.9	3,526.4	3,321.1	3,257.6	3,406.8	3,431.1	3,365.2
2	25.1	4,051.5	4,051.5	4,010.4	4,037.8	4,818.0	3,947.9	4,031.0	4,265.6
3	22.6	4,212.1	4,347.7	4,309.4	4,289.7	4,290.1	4,270.7	4,309.4	4,290.1
4	19.0	4,328.5	4,423.3	4,328.5	4,360.1	4,404.5	4,366.7	4,404.5	4,391.9
Center	14.0	4,404.5	4,347.7	4,347.7	4,366.6	4,442.0	4,460.6	4,385.6	4,429.4
5	9.0	4,385.6	4,366.7	4,404.5	4,385.6	4,270.7	4,290.1	4,309.4	4,290.1
6	5.4	4,270.7	4,231.7	4,385.6	4,296.0	4,270.7	4,132.6	4,092.3	4,165.2
7	2.9	3,968.9	4,031.0	3,989.7	3,996.5	4,212.1	4,051.5	3,947.9	4,070.5
8	0.9	3,479.1	3,431.1	3,406.8	3,439.0	3,573.1	3,596.3	3,455.2	3,541.5
Averages ---------->		4,028.3	4,057.1	4,078.8	4,054.7	4,171.0	4,058.1	4,040.7	4,089.9

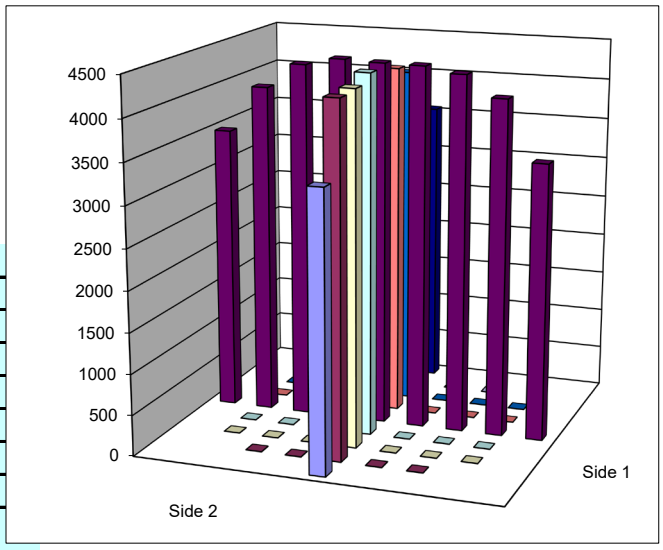
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4072.3		Mean	4247.5	4271.8	4259.7
Min Point	3321.1	-18.4%	Std. Dev.	161.8	123.7	138.9
Max Point	4429.4	8.8%	COV as %	3.8	2.9	**3.3**

Flow w/o C-Pt 17239 cfm

Vel Avg w/o C-Pt 4032 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	77.21	72.13	mbars
Ambient pressure	982.39	982.39	mbars
Total Stack pressure	1059.6	1054.5	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/12/2020	Signature/date	3/12/2020	Signature/date	3/18/2020

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	3,551.0	3,620.4	3,551.0	3,574.1	3,456.2	3,432.2	3,432.2	3,440.2
2	25.1	4,252.6	4,113.8	4,052.8	4,139.7	3,990.9	4,133.9	4,052.8	4,059.2
3	22.6	4,329.9	4,424.7	4,291.4	4,348.7	4,291.4	4,291.4	4,424.7	4,335.8
4	19.0	4,424.7	4,480.5	4,405.9	4,437.0	4,349.0	4,443.4	4,349.0	4,380.5
Center	14.0	4,443.4	4,443.4	4,480.5	4,455.8	4,462.0	4,424.7	4,424.7	4,437.1
5	9.0	4,252.6	4,272.0	4,387.0	4,303.9	4,443.4	4,368.0	4,387.0	4,399.5
6	5.4	4,193.6	4,272.0	4,133.9	4,199.8	4,193.6	4,349.0	4,213.4	4,252.0
7	2.9	3,990.9	4,032.3	3,928.1	3,983.8	4,113.8	4,329.9	4,153.9	4,199.2
8	0.9	3,407.9	3,574.2	3,407.9	3,463.3	3,527.5	3,551.0	3,503.9	3,527.5
Averages ---------->		4,094.1	4,137.0	4,070.9	4,100.7	4,092.0	4,147.1	4,104.6	4,114.6

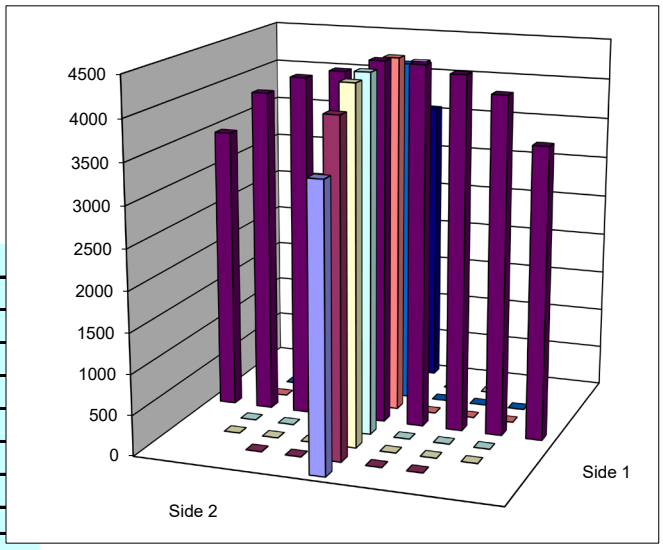
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4107.6		Mean	4267.0	4294.8	4280.9
Min Point	3440.2	-16.2%	Std. Dev.	170.1	133.4	147.5
Max Point	4455.8	8.5%	COV as %	4.0	3.1	**3.4**

Flow w/o C-Pt 17383 cfm

Vel Avg w/o C-Pt 4065 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	49.44	56.55	mbars
Ambient pressure	980.02	980.02	mbars
Total Stack pressure	1029.5	1036.6	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/12/2020	Signature/date	3/12/2020	Signature/date	3/18/2020

Fan B Only

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	3,408.9	3,528.6	3,575.3	3,504.3	3,734.3	3,712.0	3,621.4	3,689.2
2	25.1	4,312.0	4,253.8	4,074.4	4,213.4	4,407.2	4,388.3	4,350.3	4,381.9
3	22.6	4,407.2	4,273.3	4,369.4	4,350.0	4,500.4	4,555.4	4,591.7	4,549.2
4	19.0	4,663.4	4,518.8	4,500.4	4,560.9	4,645.6	4,698.9	4,609.7	4,651.4
Center	14.0	4,573.5	4,500.4	4,591.7	4,555.2	4,627.7	4,555.4	4,591.7	4,591.6
5	9.0	4,463.3	4,444.7	4,481.9	4,463.3	4,518.8	4,444.7	4,481.9	4,481.8
6	5.4	4,463.3	4,426.0	4,463.3	4,450.9	4,388.3	4,292.7	4,369.4	4,350.1
7	2.9	4,331.2	4,331.2	4,292.7	4,318.4	4,194.9	4,312.0	3,971.3	4,159.4
8	0.9	3,908.1	3,950.3	4,033.5	3,964.0	3,822.2	3,621.4	3,644.3	3,696.0
Averages ---------->		4,281.2	4,247.5	4,264.7	4,264.5	4,315.5	4,286.8	4,248.0	4,283.4

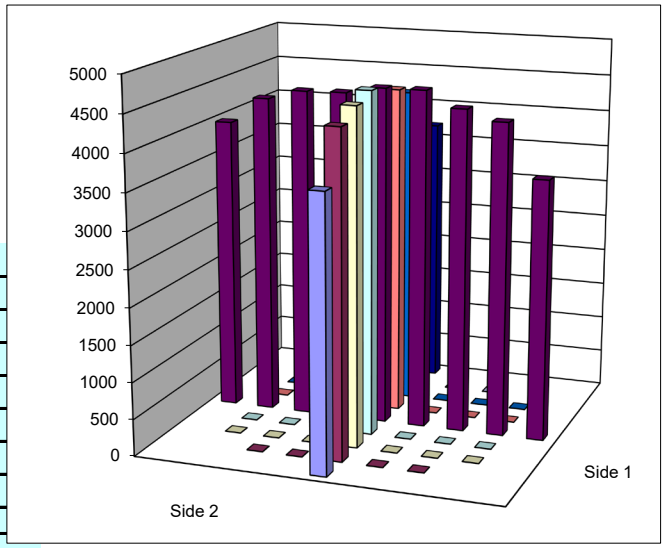
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4273.9		Mean	4416.0	4452.2	4434.1
Min Point	3504.3	-18.0%	Std. Dev.	128.3	168.6	145.1
Max Point	4651.4	8.8%	COV as %	2.9	3.8	**3.3**

Flow w/o C-Pt 18116 cfm

Vel Avg w/o C-Pt 4237 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	41.31	46.05	mbars
Ambient pressure	980.36	980.70	mbars
Total Stack pressure	1021.7	1026.8	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/12/2020	Signature/date	3/12/2020	Signature/date	3/18/2020

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	3,509.3	3,533.0	3,625.9	3,556.1	3,891.6	4,059.1	3,997.1	3,982.6
2	25.1	4,038.5	4,219.9	4,259.1	4,172.5	4,278.6	4,099.9	4,239.5	4,206.0
3	22.6	4,450.2	4,487.5	4,561.0	4,499.6	4,355.7	4,579.2	4,298.0	4,411.0
4	19.0	4,542.7	4,561.0	4,561.0	4,554.9	4,450.2	4,506.0	4,579.2	4,511.8
Center	14.0	4,506.0	4,597.4	4,615.4	4,572.9	4,468.9	4,524.4	4,524.4	4,505.9
5	9.0	4,542.7	4,487.5	4,431.5	4,487.2	4,561.0	4,468.9	4,431.5	4,487.1
6	5.4	4,219.9	4,298.0	4,393.8	4,303.9	4,355.7	4,561.0	4,431.5	4,449.4
7	2.9	4,099.9	4,200.1	5,711.3	4,670.4	4,355.7	4,393.8	4,160.3	4,303.3
8	0.9	3,716.6	3,738.9	3,671.6	3,709.0	3,997.1	3,870.2	3,870.2	3,912.5
Averages ---------->		4,180.6	4,235.9	4,425.6	4,280.7	4,301.6	4,340.3	4,281.3	4,307.7

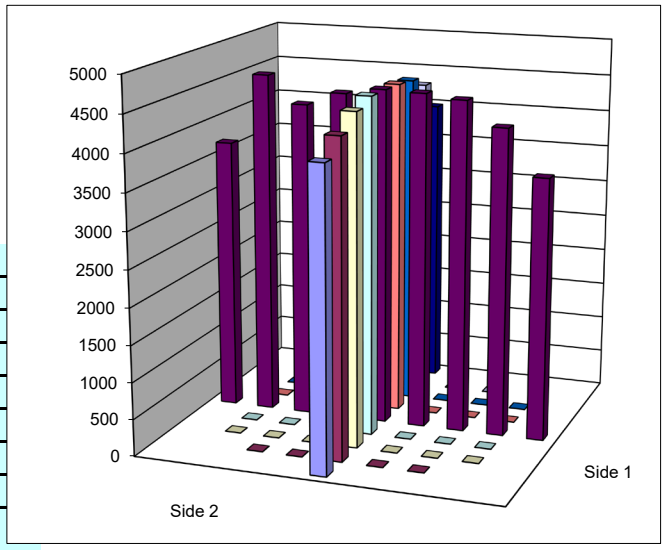
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4294.2		Mean	4465.9	4410.6	4438.3
Min Point	3556.1	-17.2%	Std. Dev.	170.8	115.5	143.0
Max Point	4670.4	8.8%	COV as %	3.8	2.6	**3.2**

Flow w/o C-Pt 18231 cfm

Vel Avg w/o C-Pt 4264 fpm

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

	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	45.7	50.1	mbars
Ambient pressure	980.7	980.7	mbars
Total Stack pressure	1026.4	1030.8	mbars
Ambient humidity	42%	41%	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/12/2020	Signature/date	3/12/2020	Signature/date	3/18/2020

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	3,158.0	3,078.1	3,105.0	3,113.7	3,736.6	3,646.6	3,623.7	3,669.0
2	25.1	4,333.9	4,217.3	4,372.1	4,307.8	4,177.7	4,217.3	4,276.0	4,223.7
3	22.6	4,353.1	4,391.1	4,521.6	4,421.9	4,540.0	4,314.7	4,484.7	4,446.5
4	19.0	4,558.2	4,503.2	4,576.4	4,545.9	4,503.2	4,447.5	4,612.6	4,521.1
Center	14.0	4,521.6	4,540.0	4,540.0	4,533.9	4,594.6	4,521.6	4,558.2	4,558.1
5	9.0	4,503.2	4,372.1	4,484.7	4,453.3	4,503.2	4,466.1	4,466.1	4,478.5
6	5.4	4,295.4	4,428.8	4,314.7	4,346.3	4,466.1	4,428.8	4,503.2	4,466.0
7	2.9	4,256.5	4,276.0	4,097.3	4,209.9	4,295.4	4,314.7	4,197.5	4,269.2
8	0.9	3,691.9	3,669.3	3,758.8	3,706.7	3,758.8	3,780.9	3,802.8	3,780.8
Averages ---------->		4,185.8	4,164.0	4,196.7	4,182.2	4,286.2	4,237.6	4,280.5	4,268.1

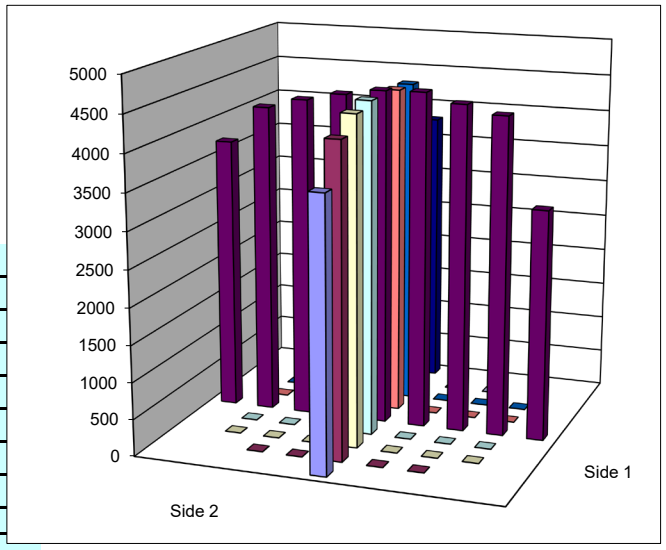
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4225.1		Mean	4402.7	4423.3	4413.0
Min Point	3113.7	-26.3%	Std. Dev.	122.5	127.0	120.3
Max Point	4558.1	7.9%	COV as %	2.8	2.9	**2.7**

Flow w/o C-Pt 17895 cfm

Vel Avg w/o C-Pt 4185 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	50.5	45.7	mbars
Ambient pressure	980.7	981.0	mbars
Total Stack pressure	1031.2	1026.8	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/12/2020	Signature/date	3/12/2020	Signature/date	3/18/2020

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	3,670.9	3,804.4	3,693.5	3,722.9	3,738.2	3,670.9	3,670.9	3,693.3
2	25.1	4,411.8	4,297.2	4,219.1	4,309.4	4,058.3	4,058.3	4,037.7	4,051.4
3	22.6	4,505.1	4,523.5	4,560.2	4,529.6	4,578.4	4,449.4	4,411.8	4,479.9
4	19.0	4,578.4	4,632.6	4,541.9	4,584.3	4,668.3	4,632.6	4,614.6	4,638.5
Center	14.0	4,523.5	4,560.2	4,560.2	4,548.0	4,523.5	4,578.4	4,505.1	4,535.7
5	9.0	4,316.5	4,468.0	4,335.8	4,373.4	4,354.9	4,411.8	4,468.0	4,411.6
6	5.4	4,119.3	4,335.8	4,316.5	4,257.2	4,430.6	4,374.0	4,430.6	4,411.7
7	2.9	4,219.1	4,139.5	4,058.3	4,139.0	4,179.5	4,316.5	4,238.7	4,244.9
8	0.9	3,826.2	3,804.4	3,648.1	3,759.6	3,782.5	3,847.9	3,847.9	3,826.1
Averages ---------->		4,241.2	4,285.1	4,214.8	4,247.0	4,257.1	4,260.0	4,247.3	4,254.8

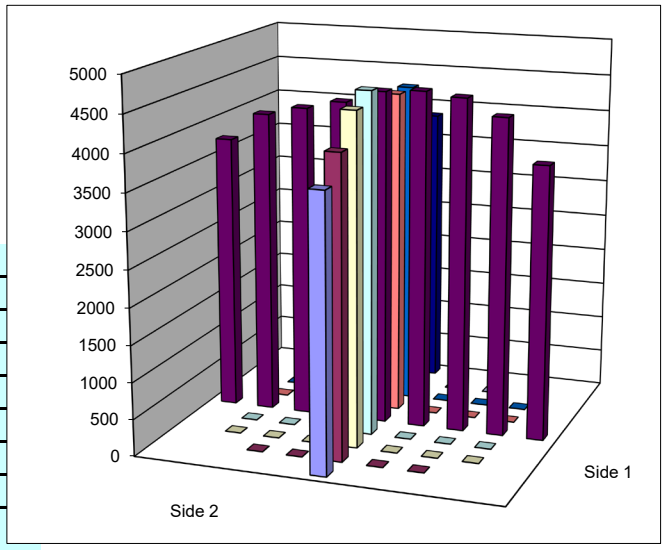
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4250.9		Mean	4391.5	4396.2	4393.9
Min Point	3693.3	-13.1%	Std. Dev.	168.1	194.7	174.8
Max Point	4638.5	9.1%	COV as %	3.8	4.4	**4.0**

Flow w/o C-Pt 18022 cfm

Vel Avg w/o C-Pt 4215 fpm

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

	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	51.8	47.4	mbars
Ambient pressure	980.7	980.7	mbars
Total Stack pressure	1032.5	1028.1	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/12/2020	Signature/date	3/12/2020	Signature/date	3/18/2020

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	3,717.4	3,717.4	3,650.4	3,695.1	3,559.1	3,535.9	3,320.0	3,471.7
2	25.1	4,195.6	4,215.1	4,116.4	4,175.7	4,368.4	4,443.1	4,349.6	4,387.0
3	22.6	4,480.0	4,292.5	4,234.6	4,335.7	4,570.9	4,480.0	4,498.3	4,516.4
4	19.0	4,552.9	4,570.9	4,443.1	4,522.3	4,624.6	4,642.3	4,606.7	4,624.5
Center	14.0	4,570.9	4,480.0	4,552.9	4,534.6	4,552.9	4,642.3	4,516.6	4,570.6
5	9.0	4,534.7	4,443.1	4,516.6	4,498.1	4,330.6	4,461.6	4,424.6	4,405.6
6	5.4	4,424.6	4,443.1	4,424.6	4,430.8	4,387.2	4,311.6	4,311.6	4,336.8
7	2.9	4,424.6	4,156.2	4,234.6	4,271.8	4,273.3	4,215.1	4,254.0	4,247.5
8	0.9	3,890.4	3,994.7	3,911.5	3,932.2	3,739.5	3,739.5	3,695.2	3,724.7
Averages ---------->		4,310.1	4,257.0	4,231.6	4,266.3	4,267.4	4,274.6	4,219.6	4,253.9

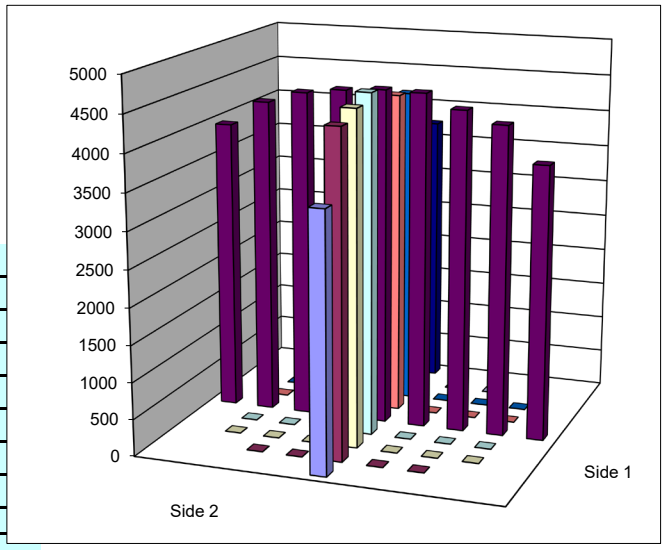
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4260.1		Mean	4395.6	4441.2	4418.4
Min Point	3471.7	-18.5%	Std. Dev.	138.1	134.6	133.1
Max Point	4624.5	8.6%	COV as %	3.1	3.0	**3.0**

Flow w/o C-Pt 18060 cfm

Vel Avg w/o C-Pt 4223 fpm

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

	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	49.10	49.78	mbars
Ambient pressure	986.12	986.12	mbars
Total Stack pressure	1035.2	1035.9	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/12/2020	Signature/date	3/12/2020	Signature/date	3/18/2020

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	3,760.1	3,671.6	3,716.1	3,715.9	3,243.7	3,580.9	3,534.7	3,453.1
2	25.1	4,329.1	4,460.1	4,134.9	4,308.0	4,213.7	4,385.7	4,291.0	4,296.8
3	22.6	4,533.2	4,478.5	4,460.1	4,490.6	4,605.2	4,515.0	4,533.2	4,551.1
4	19.0	4,533.2	4,460.1	4,348.1	4,447.1	4,623.0	4,605.2	4,623.0	4,617.1
Center	14.0	4,587.3	4,423.1	4,515.0	4,508.5	4,533.2	4,533.2	4,569.3	4,545.2
5	9.0	4,441.6	4,478.5	4,551.3	4,490.5	4,385.7	4,515.0	4,496.8	4,465.8
6	5.4	4,496.8	4,404.4	4,367.0	4,422.7	4,291.0	4,252.5	4,310.1	4,284.5
7	2.9	4,367.0	4,213.7	4,233.1	4,271.3	4,134.9	4,271.8	4,115.0	4,173.9
8	0.9	3,889.0	3,867.9	3,716.1	3,824.3	3,716.1	3,781.9	3,760.1	3,752.7
Averages ---------->		4,326.4	4,273.1	4,226.9	4,275.4	4,194.1	4,271.2	4,248.1	4,237.8

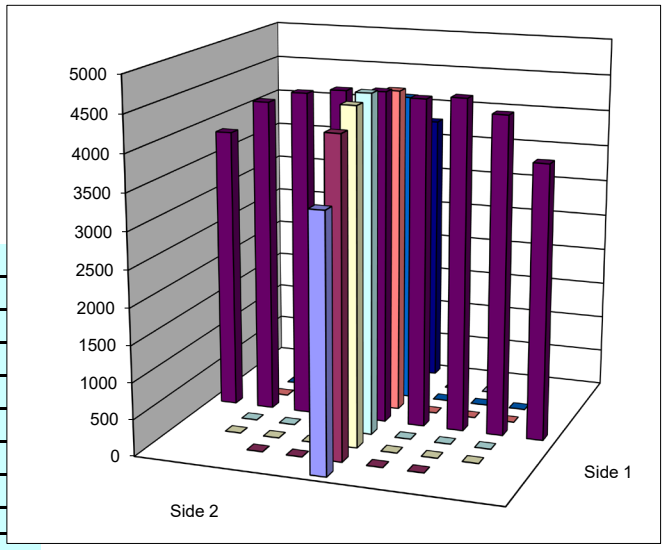
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4256.6		Mean	4419.8	4419.2	4419.5
Min Point	3453.1	-18.9%	Std. Dev.	94.1	167.3	130.4
Max Point	4617.1	8.5%	COV as %	2.1	3.8	**3.0**

Flow w/o C-Pt 18057 cfm

Vel Avg w/o C-Pt 4223 fpm

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

	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	50.1	52.2	mbars
Ambient pressure	986.8	987.1	mbars
Total Stack pressure	1036.9	1039.3	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/12/2020	Signature/date	3/12/2020	Signature/date	3/18/2020

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	3,024.7	3,288.2	3,185.4	3,166.1	3,890.7	3,826.0	3,760.2	3,825.6
2	25.1	4,354.7	4,258.1	4,316.3	4,309.7	4,373.7	4,199.1	4,316.3	4,296.4
3	22.6	4,449.2	4,578.1	4,596.3	4,541.2	4,504.9	4,392.7	4,335.5	4,411.0
4	19.0	4,578.1	4,668.1	4,559.9	4,602.0	4,578.1	4,541.7	4,614.3	4,578.0
Center	14.0	4,578.1	4,596.3	4,596.3	4,590.2	4,596.3	4,578.1	4,614.3	4,596.2
5	9.0	4,578.1	4,392.7	4,411.6	4,460.8	4,504.9	4,467.8	4,523.3	4,498.7
6	5.4	4,218.9	4,354.7	4,297.0	4,290.2	4,467.8	4,411.6	4,449.2	4,442.9
7	2.9	4,179.3	4,098.9	4,037.5	4,105.2	4,277.6	4,354.7	4,238.5	4,290.3
8	0.9	3,847.7	3,738.0	3,532.1	3,705.9	3,670.7	3,715.7	3,738.0	3,708.1
Averages ---------->		4,201.0	4,219.2	4,170.3	4,196.8	4,318.3	4,276.4	4,287.7	4,294.1

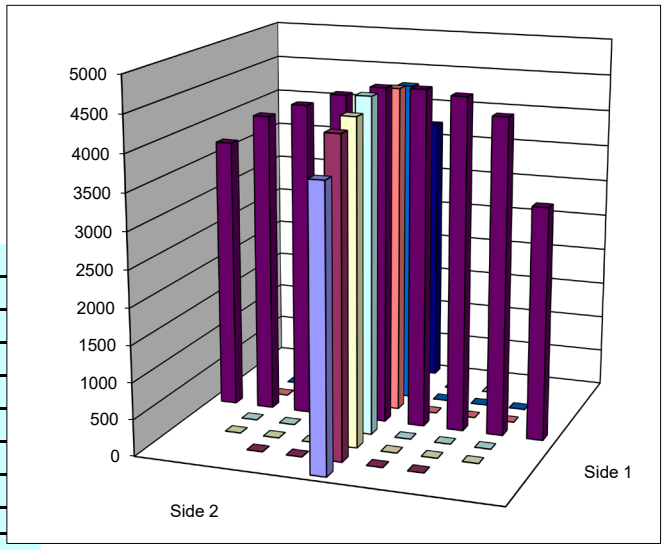
All	ft/min	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	4245.5		Mean	4414.2	4444.8	4429.5
Min Point	3166.1	-25.4%	Std. Dev.	185.4	122.9	152.0
Max Point	4602.0	8.4%	COV as %	4.2	2.8	**3.4**

Flow w/o C-Pt 17968 cfm

Vel Avg w/o C-Pt 4202 fpm

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

	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	49.78	48.43	mbars
Ambient pressure	975.62	975.62	mbars
Total Stack pressure	1025.40	1024.05	mbars
Ambient humidity	84%	86%	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 (fpm) (shown here) in a separate datasheet based on recorded barometric pressure, stack temperature and density of air for each run.

Data Transcribed by:	Jennifer Yao	Data Entered by	Jennifer Yao	Transciption Review performed by:	Ernest Antonio
Signature/date	3/12/2020	Signature/date	3/12/2020	Signature/date	3/18/2020

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 0	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 0	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 0	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

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