U.S. DEPARTMENT OF ENERGY

PNNL-21998
WTP-RPT-224 Rev 0

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

Assessment of the Group 3-4 (HV-S1, HV-S2, IHLW-S1) Stack Sampling Probe Locations for Compliance with ANSI/HPS N13.1-1999

JA Glissmeyer
JE Flaherty
EJ Antonio

January 2013

Pacific Northwest
NATIONAL LABORATORY

Proudly Operated by Battelle Since 1965

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor Battelle Memorial Institute, nor any of their employees, makes **any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights**. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or Battelle Memorial Institute. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

PACIFIC NORTHWEST NATIONAL LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC05-76RL01830

Printed in the United States of America

Available to DOE and DOE contractors from the
Office of Scientific and Technical Information,
P.O. Box 62, Oak Ridge, TN 37831-0062;
ph: (865) 576-8401
fax: (865) 576-5728
email: reports@adonis.osti.gov

Available to the public from the National Technical Information Service
5301 Shawnee Rd., Alexandria, VA 22312
ph: (800) 553-NTIS (6847)
email: orders@ntis.gov <http://www.ntis.gov/about/form.aspx>
Online ordering: http://www.ntis.gov

This document was printed on recycled paper.
(8/2010)

PNNL-21998
WTP-RPT-224 Rev 0

Assessment of the Group 3-4 (HV-S1, HV-S2, IHLW-S1) Stack Sampling Probe Locations for Compliance with ANSI/HPS N13.1-1999

JA Glissmeyer
JE Flaherty
EJ Antonio

January 2013

Test Specification:	N/A
Statement of Work	24590-QL-SRA-W000-00101
Work Authorization:	WA# 009
Test Plan:	TP-WTPSP-032, Rev 0.0
Test Exceptions:	N/A
Test Scoping Statement(s):	NA
QA Technology Level:	Developmental Research

Prepared for
the U.S. Department of Energy
under Contract DE-AC05-76RL01830 and
Subcontract Number MOA: 24590-QL-HC9-WA49-00001

Pacific Northwest National Laboratory
Richland, Washington 99352

Completeness of Testing

This report describes the results of work and testing specified by test plan TP-WTPSP-032. The work and any associated testing followed the quality assurance requirements outlined in the test plan. The descriptions provided in this test report are an accurate account of both the conduct of the work and the data collected. Test plan results are reported. Also reported are any unusual or anomalous occurrences that are different from expected results. The test results and this report have been reviewed and verified.

Approved:

D E Kurath 1/15/13

Dean E. Kurath, Manager
WTP Support Project

Date

Summary

This document reports on a series of tests conducted to assess the proposed air sampling locations for the Hanford Tank Waste Treatment and Immobilization Plant (WTP) Group 3-4 exhaust stacks with respect to the applicable criteria regarding the placement of an air sampling probe. The HV-S1, HV-S2, and IHLW-S1 exhaust stacks were tested together as a group (Test Group 3-4) because they share a geometric attribute: the common factor in their design is that the last significant flow disturbance upstream of the air sampling probe is a jog (i.e., two conjoined bends of equal and opposite curvature resulting in a change in elevation of the duct). Federal regulations[1] require 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*. These criteria address the capability of the sampling probe to extract a sample that represents the effluent stream.

The testing on scale models of the stacks conducted for this project was part of the River Protection Project—Waste Treatment Plant Support Program under Contract No. DE-AC05-76RL01830 according to the statement of work issued by Bechtel National, Inc. (BNI, 24590-QL-SRA-W000-00101, *N13.1-1999 Stack Monitor Scale Model Testing and Qualification*, Revision 1, 9/12/2007) and Work Authorization 09 of Memorandum of Agreement 24590-QL-HC9-WA49-00001. The internal Pacific Northwest National Laboratory (PNNL) project for this task is 53024, *Work for Hanford Contractors Stack Monitoring*. The testing described in this document was further guided by the Test Plan *Air Sampling Probe Location Tests for Waste Treatment Plant HV-S1, HV-S2 and IHLW-S1 (Group 3-4) Air Exhaust Systems* (TP-WTPSP-032).

The tests conducted by PNNL during 2012 on the Group 3-4 scale model systems are described in this report. The series of tests consists of various measurements taken over a grid of points in the duct cross section at the designed sampling probe locations. The ANSI/HPS N13.1-1999 qualification criteria concern the following properties of the air flowing through the ducts where the air sampling probes are to be located:

1. Uniform Air Velocity—The gas momentum across the stack cross section where the sample is extracted should be well mixed or uniform. The uniformity is expressed as the variability of the measurements about the mean, expressed as the percent coefficient of variance (%COV). It is calculated as the standard deviation divided by the mean and expressed as a percentage—the lower the %COV value, the more uniform the velocity.
2. Angular Flow—The purpose of this test is to determine whether the air velocity vector is aligned with the sampling nozzle.
3. Uniform Concentration of Tracer Gases—A uniform contaminant concentration in the sampling plane enables the extraction of samples that represent the true concentration.

[1] Title 40 of the Code of Federal Regulations (CFR), Part 61, National Emissions Standards for Hazardous Air Pollutants (NESHAP), Subpart H, *National Emission Standard For Emissions of Radionuclides other than Radon from Department of Energy Facilities*.

4. Uniform Concentration of Tracer Particles—Uniformity in contaminant concentration at the sampling probe was further demonstrated using tracer particles large enough to exhibit inertial effects. Particles of 10-µm aerodynamic diameter were used.

The scale model test results for the proposed sampling probe locations are summarized below.

Table S.1. Summary of Preferred Sampling Probe Location Results for the Group 3-4 Scale Model Stacks

	Acceptance Criteria	Units	HV-S1	HV-S2	IHLW-S1
Velocity Uniformity	≤20	%COV	2.8 – 6.6	2.5 – 7.8	4.2 – 10
Flow Angle	≤20	Degrees	3.1 – 4.7	3.9 – 12.5	1.3 – 9.3
Gas Tracer Uniformity	≤20	%COV	1.1 – 4.7	1.8 – 7.2	0.9 – 5.8
	≤30	Maximum % Deviation from Mean	2.6 – 7.9	4.3 – 14.2	1.8 – 11.2
Particle Tracer Uniformity	≤20	Normalized %COV	4.4 – 11.7	5.3 – 13	3.3 – 15.2

For the HV-S1 and HV-S2 stacks alternate test ports also showed satisfactory results and make allowance for limited construction variance in the probe locations.

Based on these scale model tests, the locations proposed for the air sampling probes in each of the three Group 3-4 stacks meet the requirements of the ANSI/HPS N13.1-1999 standard. Additional velocity uniformity and flow angle tests on the actual stacks will be necessary during cold-startup to confirm the validity of the scale model results in representing the actual stacks. In particular, the velocity uniformity test results for the actual stacks must be within 5%COV of the range of results listed for the scale model so that scale model results can be said to be representative of the stack. If the velocity uniformity results on the actual stack fall within these bounds and flow angle test results fall within qualification criteria (mean angle $\leq 20^{o}$), the scale model results may be used as a substitute for the actual stack.

Quality Assurance

The PNNL quality assurance (QA) program is based on the requirements defined in the U.S. Department of Energy Order 414.1D, *Quality Assurance,* and 10 CFR 830, *Energy/Nuclear Safety Management*, and Subpart A—*Quality Assurance Requirements* (a.k.a., the Quality Rule). PNNL has chosen to implement the following consensus standards in a graded approach:

- ASME NQA-1-2000, *Quality Assurance Requirements for Nuclear Facility Applications*, Part I, "Requirements for Quality Assurance Programs for Nuclear Facilities".
- ASME NQA-1-2000, Part II, Subpart 2.7, *Quality Assurance Requirements for Computer Software for Nuclear Facility Applications*.
- ASME NQA-1-2000, Part IV, Subpart 4.2, *Graded Approach Application of Quality Assurance Requirements for Research and Development*.

The procedures necessary to implement the requirements are documented through PNNL's "How Do I…?" (HDI), which is a system for managing the delivery of laboratory-level policies, requirements, and procedures.

The Waste Treatment Plant Support Program (WTPSP) implements an NQA-1-2000 QA program, using a graded approach presented in NQA-1-2000, Part IV, Subpart 4.2. The WTPSP Quality Assurance manual (QA-WTPSP-002) describes the technology life cycle stages under the WTPSP QA plan (QA-WTPSP-0001). The technology life cycle includes the progression of technology development, commercialization, and retirement in process phases of basic and applied research and development (R&D), engineering and production, and operation until process completion. The life cycle is characterized by flexible and informal QA activities in basic research, which becomes more structured and formalized through the applied R&D stages. The work described in this report has been completed under the QA Technology level of Developmental Work as the data will be used for applying air discharge permits. Developmental Work is described below:

- DEVELOPMENTAL WORK—Developmental work consists of research tasks moving toward technology commercialization. These tasks still require a degree of flexibility, and there is still a degree of uncertainty that exists in many cases. The role of quality on development work is to make sure that adequate controls exist to support movement into commercialization.

WTPSP addresses internal verification and validation activities by conducting an Independent Technical Review of the final data report in accordance with WTPSP's procedure QA-WTPSP-601, *Document Preparation and Change*. This review verifies that the reported results are traceable, that inferences and conclusions are soundly based, and the reported work satisfies the test plan objectives. Appendix E lists the reviewed test plan, test instructions, and calculation packages used for the tests documented in this report.

Acronyms

acfm	actual cubic feet per minute
afpm	actual feet per minute
AD	aerodynamic diameter
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
BNI	Bechtel National, Inc.
CCP	computer-assisted calculation package
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
DV	hydraulic diameter × mean velocity
EPA	U.S. Environmental Protection Agency
FA	flow angle test
GT	gaseous tracer test
HDI	"How Do I…?"
HEPA	high-efficiency particulate air (filter)
HPS	Health Physics Society
HV-S1	WTP High-Level Waste C3 (non-process) ventilation system exhaust stack
HV-S2	WTP High-Level Waste C5 (process) ventilation system exhaust stack
IHLW-S1	WTP High-Level Waste C3 (canister) ventilation system exhaust stack
NESHAP	National Emissions Standards for Hazardous Air Pollutants
OPC	optical particle counter
%COV	percent coefficient of variation
PNNL	Pacific Northwest National Laboratory
PT	particulate tracer test
QA	quality assurance
RMS	root mean square
scfm	standard cubic feet per minute
sfpm	standard feet per minute
SF_6	sulfur hexafluoride
TI	test instruction
VT	velocity uniformity test
WTP	Hanford Tank Waste Treatment and Immobilization Plant
WTPSP	Waste Treatment Plant Support Program

Acknowledgments

Preparing, executing, and post-processing these scale model measurements involved a number of Pacific Northwest National Laboratory staff. We would like to particularly acknowledge the support of our quality engineer, Kirsten Meier, and the administrative support from Andrea Boehler, Chrissy Charron, and Mona Champion. We would also like to express our appreciation to scientific staff members Carmen Arimescu, Yin-Fong Su, and Xiao-Ying Yu who conducted measurements under a variety of weather conditions. Additionally, Matthew Barnett, Carmen Arimescu, Rosanne Aaberg, Elizabeth Golovich, and Susan Sande provided technical reviews. Cary Counts and Megan Peters provided editorial support for this report.

Funding for this effort was provided by the Department of Energy's Waste Treatment and Immobilization Plant Project through a subcontract with Bechtel National, Inc. Pacific Northwest National Laboratory is operated for the U.S. Department of Energy by Battelle under Contract DE-AC05-76RL01830.

Contents

Summary iii
Acronyms vii
Acknowledgments ix
1.0 Introduction 1.1
1.1 Qualification Criteria 1.1
2.0 Group 3-4 Stacks 2.1
2.1 Stack Geometry 2.1
2.2 Stack Flows 2.6
3.0 Testing Methods 3.1
3.1 Quality Assurance 3.1
3.2 Stack Tests 3.2
3.2.1 Velocity Uniformity 3.3
3.2.2 Flow Angle 3.4
3.2.3 Gaseous Tracer Uniformity 3.5
3.2.4 Particle Tracer Uniformity 3.7
4.0 Stack Testing Results 4.1
4.1 HV-S1 Stack Results 4.1
4.1.1 HV-S1 Velocity Uniformity 4.1
4.1.2 HV-S1 Flow Angle 4.2
4.1.3 HV-S1 Gaseous Tracer Uniformity 4.2
4.1.4 HV-S1 Particle Tracer Uniformity 4.3
4.2 HV-S2 Stack Results 4.5
4.2.1 HV-S2 Velocity Uniformity 4.5
4.2.2 HV-S2 Flow Angle 4.6
4.2.3 HV-S2 Gaseous Tracer Uniformity 4.6
4.2.4 HV-S2 Particle Tracer Uniformity 4.7
4.3 IHLW-S1 Stack Results 4.9
4.3.1 Velocity Uniformity 4.9
4.3.2 IHLW-S1 Flow Angle 4.10
4.3.3 IHLW-S1 Gaseous Tracer Uniformity 4.10
4.3.4 IHLW-S1 Particle Tracer Uniformity 4.11
5.0 Conclusions 5.1
6.0 References 6.1
Appendix A – HV-S1 Data Sheets A.1
Appendix B – HV-S2 Data Sheets B.1
Appendix C – IHLW-S1 Data Sheets C.1

Appendix D – Flow Unit Conversions D.1
Appendix E – Document List E.1

Figures

2.1. HV-S1 (HLW-C3V) System Per Design 2.2
2.2. HV-S2 (HLW-C5V) System Per Design 2.2
2.3. IHLW-S1 (IHLW-C3V) System Per Design 2.3
2.4. Scale Model Layout of the HV-S1 (HLW-C3V) Model 2.3
2.5. Scale Model Layout of the HV-S2 (HLW-C5V) Model 2.4
2.6. Scale Model Layout of the IHLW-S1 (IHLW-C3V-Canister) Model 2.4
2.7. Photographs of the HV-S1 Test System 2.5
2.8. Photographs of the HV-S2 Test System 2.5
2.9. Photographs of the IHLW-S1 Test System 2.6
3.1. Cross Section of the Duct at the Testing Ports with Measurement Points 3.3
3.2. Equipment Used for the Velocity Uniformity Test 3.4
3.3. Equipment Used for the Flow Angle Test 3.5
3.4. Equipment Used for the Gaseous Tracer Injection 3.6
3.5. Illustration of Five Injection Points in a Circular Duct 3.6
3.6. Equipment Used for the Gaseous Tracer Sampling 3.7
3.7. Equipment Used for Particle Injection (IHLW-S1) 3.8
3.8. Particle Counters Used for the Particle Sampling 3.9
3.9. Probes Used for the Particle Sampling. 3.10
4.1. Measurement and Reference Particle Test Data from PT-3 on the HV-S1 Stack 4.4
4.2. Measurement and Reference Particle Test Data from PT-6 on the HV-S1 Stack 4.5
4.3. Measurement and Reference Particle Tracer Test Data from PT-1 of HV-S2. ..... 4.8
4.4. Measurement and Reference Particle Tracer Test Data from PT-7 of HV-S2 ..... 4.9
4.5. Measurement and Reference Particle Tracer Test Data from PT-3 of IHLW-S1 ..... 4.12

Tables

S.1. Summary of Preferred Sampling Probe Location Results for the Group 3-4 Scale Model Stacks iv
2.1. Scaling Factor for 12-in.-Diameter Scale Model Stack 2.6
2.2. Summary of Flow Parameters for Scale Model Stacks 2.7
2.3. Summary of DV Values for Scale Model Stacks 2.8

4.1. Summary of HV-S1 Velocity Uniformity Tests 4.2
4.2. Summary of HV-S1 Flow Angle Tests 4.2
4.3. Summary of HV-S1 Gas Tracer Uniformity Tests at Test Ports 1 and 2 ..... 4.3
4.4. Summary of HV-S1 Particle Tracer Uniformity Tests 4.4
4.5. Summary of HV-S2 Velocity Uniformity Tests 4.6
4.6. Summary of HV-S2 Flow Angle Tests 4.6
4.7. Summary of HV-S2 Gas Tracer Uniformity Tests at Test Port 2 ..... 4.7
4.8. Summary of HV-S2 Particle Tracer Uniformity Tests 4.8
4.9. Summary of IHLW-S1 Velocity Uniformity Tests 4.10
4.10. Summary of IHLW-S1 Flow Angle Tests 4.10
4.11. Summary of IHLW-S1 Gas Tracer Uniformity at Test Ports 1 and 2 ..... 4.11
4.12. Summary of IHLW-S1 Particle Tracer Uniformity Tests 4.12
5.1. Summary of Test Port 2 Results for the Group 3-4 Scale Model Stacks 5.1
5.2. Summary of Test Port 1 Results for the Group 3-4 Scale Model Stacks 5.1

1.0 Introduction

The purpose of this series of scale model tests is to document the extent to which the current Bechtel National, Inc. (BNI) designs for the HV-S1, HV-S2, and IHLW-S1 air exhaust stacks in the Hanford Tank Waste Treatment and Immobilization Plant (WTP) meet the applicable regulatory criteria governing effluent monitoring systems. The emissions from these high-level waste facility air exhaust stacks may exceed 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 (NESHAP), Subpart H, *National Emission Standard For Emissions of Radionuclides other than Radon from Department of Energy Facilities*. The NESHAP 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*.[1] The capability of the sampling probe locations to meet this standard has been demonstrated with a series of tests on scale models. These data will be used by BNI as input to the air discharge permitting process. These three stacks were tested together as a group (Test Group 3-4) because they share a geometric attribute: the common factor in their design is that the last significant flow disturbance upstream of the air sampling probe is a jog (i.e., two conjoined bends of equal and opposite curvature resulting in a change in elevation of the duct).

This work is performed as part of the River Protection Project—Waste Treatment Plant Support Program under Contract No. DE-AC05-76RL01830 according to the statement of work issued by BNI, 24590-QL-SRA-W000-00101, N13.1-1999 Stack Monitor Scale Model Testing and Qualification, Revision 1, 09/12/2007 and Work Authorization 09 of Memorandum of Agreement 24590-QL-HC9-WA49-00001. The internal Pacific Northwest National Laboratory (PNNL) project for this task is 53024, *Work for Hanford Contractors Stack Monitoring*.

PNNL personnel conducted scale model tests during 2012. No BNI personnel were directly involved in the tests. The BNI WTP point of contact and facility engineers provided the most current engineering input to support PNNL's tests. BNI retains responsibility for the technical design of the stack discharge and air monitoring systems.

1.1 Qualification Criteria

The qualification criteria for the location of a stack air monitoring probe are taken from ANSI/HPS N13.1-1999, section 5.2.2 and are paraphrased as follows:

1. Uniform Air Velocity—It is important that the gas velocity be fairly uniform across the stack cross section where the sample is extracted. Consequently, the velocity is measured at several discrete points in the duct cross section at the proposed location of the sampling nozzle. The uniformity is expressed as the variability of the measurements about the mean. This is expressed using the percent coefficient of variation (%COV),[2] 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 qualification

[1] Health Physics Society, McLean, Virginia. The standard has been reaffirmed in 2011 and is identical to the 1999 version. The regulations have not been updated yet, so the 1999 version is still referenced.

[2] *Coefficient of variation* is considered "dated" terminology. The modern terminology is *percent relative standard deviation*. However, because the standard uses the older terminology, it will likewise be used here.

criterion is that the %COV of the air velocity must be ≤20% in the center two-thirds of the duct cross section where the sampling probe is to be located.

2. Angular Flow—Sampling nozzles are typically aligned with the axis of the stack. If the air travels through 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. Consequently, the flow angle is measured in the duct at the proposed location of the sampling probe. The average of the flow angle measurements (made at the same grid of points as the velocity measurements) should not exceed 20° relative to the sampling nozzle axis.
3. Uniform Concentration of Tracer Gases—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 with 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 %COV of the measured tracer gas concentration is ≤20% across the center two-thirds of the duct cross section at the sampling location, and 2) the concentrations at all the measurement points cannot deviate from the mean by >30%.
4. Uniform Concentration of Tracer Particles—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 (AD) are used by default unless it is known that larger contaminant particles will be present in the airstream. The qualification criterion is that the %COV of particle concentration is ≤20% across the center two-thirds of the duct at sampling location.

Tests to determine if Criteria 1 through 4 were met were conducted on the three scale models of the Group 3-4 stacks (HV-S1, HV-S2, and IHLW-S1) at the proposed sampling location along the exhaust duct. By conducting tests on scale models of the exhaust systems, the designed air sampling locations can be qualified before cold commissioning, and compensatory measures could be made in the design if testing results were not satisfactory. All of the tracer concentration, velocity, and flow angle measurements were made using the same grid of points in a given cross section of the duct. The ANSI/HPS N13.1-1999 standard sets additional qualification criteria for the use of a scale model as a substitute for the actual stack.

- 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 scale model must be within a factor of six of the DV for the actual stack.
- The Reynolds number for the actual and model stacks must be >10,000.
- The scale model results are considered valid if it is further shown that:
  - The velocity profile in the actual stack meets the uniformity criterion (%COV ≤20%).
  - The velocity uniformity COV values for the actual and model stacks agree within 5%COV.
  - The flow angle criterion (with a mean value less than or equal to 20°) is met.

The tests to determine the validity of the scale model testing will be performed during cold startup testing on the actual WTP stacks under separate test plans. The scale model testing conducted, as well as the results of these tests, is described in subsequent sections of this report.

2.0 Group 3-4 Stacks

2.1 Stack Geometry

Group 3-4 consists of three different stacks: HV-S1, HV-S2, and IHLW-S1. These three stacks were tested together as a group (Test Group 3-4) because they share a geometric attribute in their design in that the last significant flow disturbance upstream of the air sampling probe is a jog (i.e., two conjoined bends of equal and opposite curvature resulting in a change in elevation of the duct).

In these three stacks, the designed sampling probes will be located in horizontal sections of duct. Figure 2.1 through Figure 2.3 show the layout for each of the three stack designs, from the fan outlet to the base of the vertical duct. Figure 2.4 through Figure 2.6 show the scale model layout for each of the three stack designs. The simplified models are based on assumptions about the necessary simulation detail. These assumptions are listed below.

- Geometric simulation of the components upstream of the backdraft damper was ignored. Backdraft damper blades do not usually open fully. The partially open blades direct the air velocity vector toward one side of the duct resulting in considerable disruption to the air flow. Consequently, it was assumed that the air velocity and tracer uniformity downstream of the dampers would not be greatly influenced by equipment upstream of the dampers. This assumption has not been tested; however, this assumption had the benefit of reducing the cost of the models by using a single fan/filter/heater arrangement and the elimination of the control damper.

Components several duct diameters downstream of the sampling point are not modeled. It was assumed that the only effect of any components downstream of the sampling probe location would be to slightly change the pressure at the sampling port. While this assumption was not tested, components generally do not influence flow patterns upstream. Figure 2.7. through Figure 2.9 show photos of the scale models for each of the three stack designs.

The same fans were used for each of the three scale models. The fans were connected to a flexible duct that was connected to the backdraft damper. The backdraft damper was subsequently connected to each of the scale models for testing.

For each of the scale model stacks, Test Port 2 represents the planned location for operational stack sampling according to the current WTP BNI designs. The distance from the end of the duct jog to the center of Test Port 2 was approximately 20, 20, and 8 duct diameters for the HV-S1, IHLW-S1, and HV-S2 models, respectively. On the HV-S1 and IHLW-S1 systems, Test Port 1 is located approximately five duct diameters downstream of Test Port 2 to allow some flexibility in testing. For the HV-S2 system, Test Port 1 is located only two duct diameters downstream of Test Port 2.

The ratio of the prototype dimensions to the scale model dimensions varies with each system. Each scale model was constructed with a primary duct diameter of 12 in. for convenience and to maintain the ability to re-use the duct sections for subsequent stack designs. Table 2.1 lists the final diameter of the actual stack with the scaling factor for the 12-in. scale model diameter. The calculations of the key scale model dimensions were performed in spreadsheets and then verified and validated in accordance with appropriate quality assurance (QA) procedures. ANSI/HPS N13.1-1999 requires that the models be geometrically similar to the actual stacks. Acceptable deviations in key dimensions of the scale model

arising from scaling and fabrication errors are within about ±5% for cross-sectional dimensions and about 25% of a duct diameter in overall length between the sampling point and the flow disturbances. These deviations would have less impact on the test results than the normal standard deviation of repeat tests. The key scale model dimensions for the as-built scale models were measured and recorded by testing staff.



Figure 2.1. HV-S1 (HLW-C3V) System Per Design

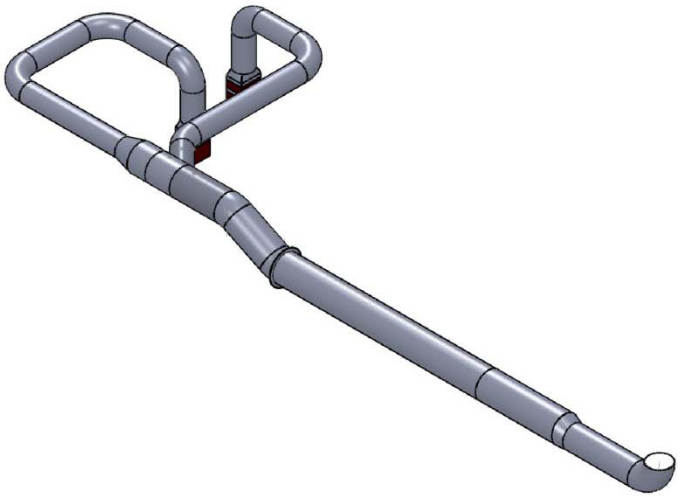


Figure 2.2. HV-S2 (HLW-C5V) System Per Design

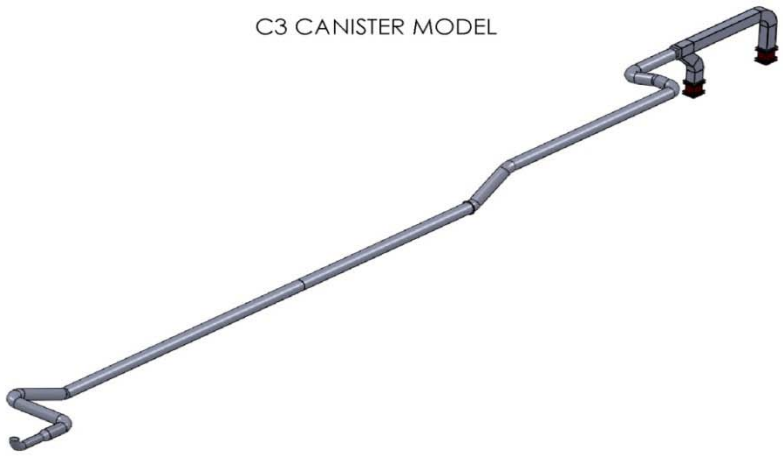


Figure 2.3. IHLW-S1 (IHLW-C3V) System Per Design

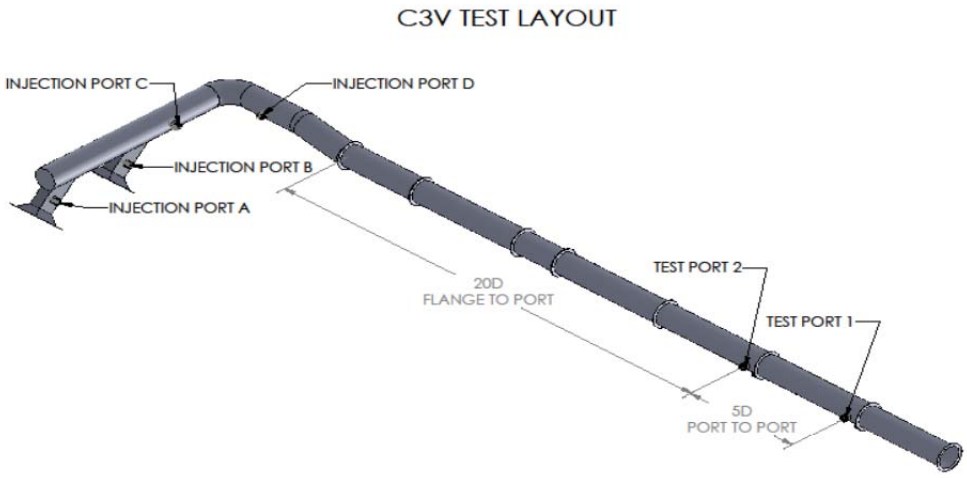


Figure 2.4. Scale Model Layout of the HV-S1 (HLW-C3V) Model

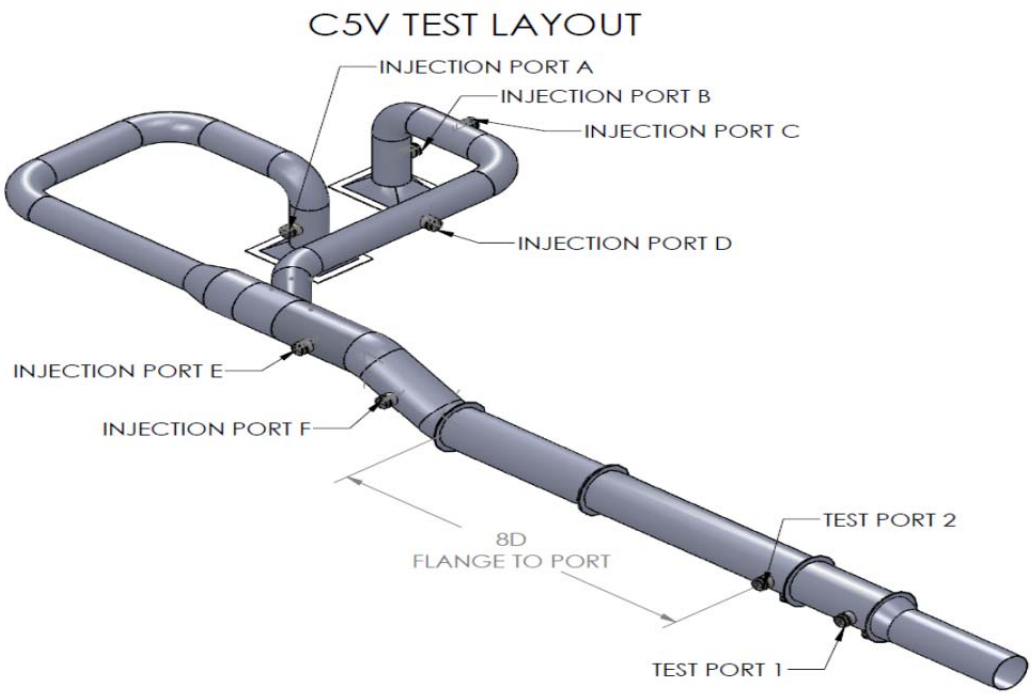


Figure 2.5. Scale Model Layout of the HV-S2 (HLW-C5V) Model

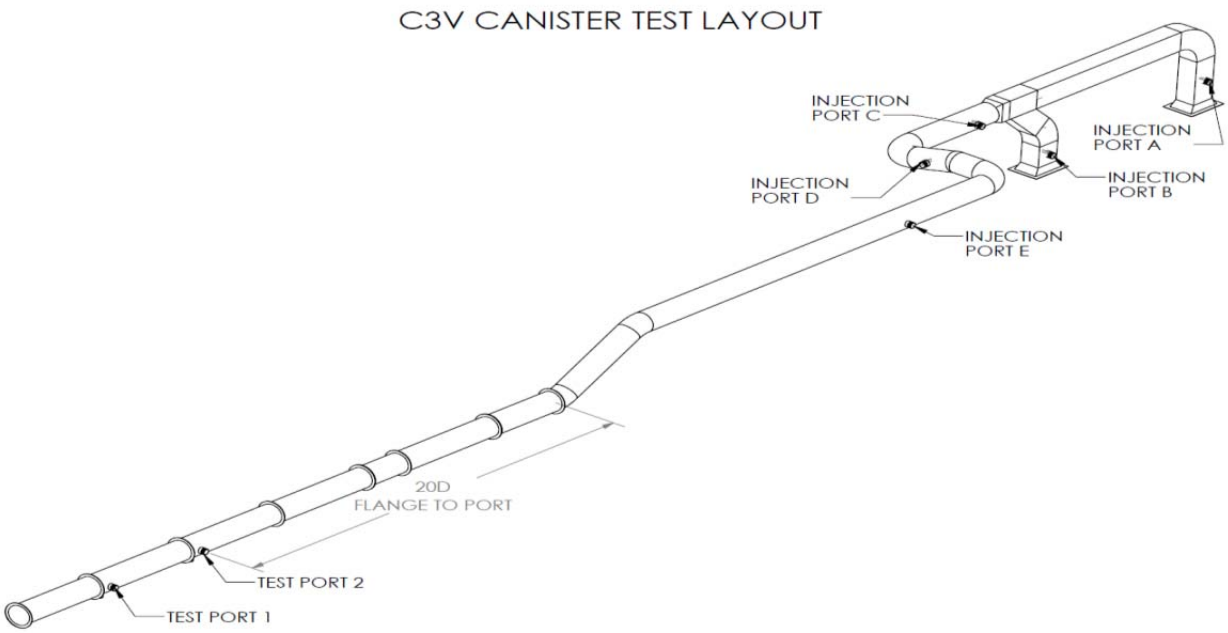


Figure 2.6. Scale Model Layout of the IHLW-S1 (IHLW-C3V-Canister) Model



Figure 2.7. Photographs of the HV-S1 Test System



Figure 2.8. Photographs of the HV-S2 Test System



Figure 2.9. Photographs of the IHLW-S1 Test System

Table 2.1. Scaling Factor for 12-in.-Diameter Scale Model Stack

	Actual Diameter	Scaling Factor
HV-S1	60 in.	5.00
HV-S2	62 in.	5.17
IHLW-S1	34 in.	2.83

2.2 Stack Flows

Tests of scale model stacks were conducted at flow rates that bracket the range of expected normal and accident flow rates and operating configurations. Various combinations of flow rates and operating fans were tested. BNI provided normal, minimum, and maximum flow rates for each of the three systems tested in this group. Maximum flow rates are 125% of the normal flow rates, whereas minimum flow rates are 50% of normal.

Additional considerations come from the ANSI/HPS N13.1-1999 standard. The standard requires that the DV of the scale model be within a factor of six of the actual stack. For stacks with a circular cross section, this is equivalent to requiring that the ratio of flow rate to stack diameter be within a factor of six of the actual stack. The standard also requires that the Reynolds number for the prototype and model stacks must both exceed 10,000.

The WTP HV-S1 air exhaust system is equipped with two fans capable of 59,300 acfm (actual cubic feet per minute) flow each. The speed of both fans will be controlled with variable frequency drives to achieve the target flow rate. Only one fan will be operated at any given time, with the second fan in standby for use when maintenance needs arise on the primary fan. Each fan is equipped with an adjustable-speed drive to compensate for upstream filter loading and pressure variations.

There are two fans available to power the WTP HV-S2 exhaust system, which exhausts air from the C5 ventilation system of the high-level waste facility. One fan will be operated at a time, and one will be on standby. Each fan is capable of providing the maximum flow rate of 63,750 acfm, and is equipped with an adjustable-speed drive to compensate for filter loading and pressure variations.

Two fans are available to power the IHLW-S1 exhaust system of the high-level waste facility, which exhausts air from the C3 ventilation system. Only one fan will be operated at a time, and one will be on standby. Each fan is capable of providing the maximum flow rate of 13,100 acfm. Each fan is equipped with an adjustable-speed drive to compensate for filter loading and pressure variations.

Table 2.2 lists the flow conditions for the actual stack as well as the scale model stack. The flow rates provided by BNI were in acfm and were converted to standard flow rates to account for temperature (see Appendix D). The minimum air flow (in standard feet per minute [scfm]) and air velocity (in standard feet per minute [sfpm]) to achieve the assumed minimum and maximum actual stack flow are listed. The tabulated values of flow and velocity in the "Scale Model Minimum" columns are the minimum scaled values that will meet the criterion listed in Section 1.1 that the DV product be within a factor of six of the prototype. The scale model Reynolds numbers are calculated for those minima. One of the qualification criteria listed in Section 1.1 was that the Reynolds number for both the actual and scale model stack must be greater than 10,000. Therefore, the Reynolds number for the actual and scale model stacks at the minimum and maximum flow rates are included in Table 2.2. The conditions prescribed for these scale model tests fulfill the criterion of a Reynolds number greater than 10,000.

Table 2.2. Summary of Flow Parameters for Scale Model Stacks

	Air Flow (scfm)		Air Velocity (sfpm)		Reynolds Number	
Fan(s)–Flow	Actual Stack	Scale Model Minimum	Actual Stack	Scale Model Minimum	Actual Stack	Scale Model Minimum
HV-S1						
Single fan—max flow	55627	1854	2833	2361	1.5E+06	2.4E+05
Single fan –norm flow	45524	1517	2319	1932	1.2E+06	2.0E+05
Single fan—min flow	24202	807	1233	1027	6.3E+05	1.1E+05
HV-S2						
Single fan—max flow	53631	1730	2558	2203	1.4E+06	2.6E+05
Single fan –norm flow	48096	1551	2294	1976	1.2E+06	2.0E+05
Single fan—min flow	26040	840	1242	1070	6.6E+05	1.1E+05
IHLW-S1						
Single fan—max flow	11198	659	1776	839	5.2E+05	8.6E+04
Single fan –norm flow	9883	581	1567	740	4.6E+05	7.6E+04
Single fan—min flow	5351	315	849	401	2.5E+05	4.1E+04

Another qualification criterion listed in Section 1.1 pertains to the DV in the scale model relative to the stack. Table 2.3 lists the DV values for the stack as well as the DV values that are acceptable for the scale model. This minimum flow for the model is selected to be the lower boundary so the DV product is within a factor of six (i.e., one-sixth) of the DV product for the actual stack. Likewise, the maximum

flow for the model is selected to be the upper boundary so the DV product is within a factor of six (i.e., six times) of the DV product for the actual stack.

Table 2.3. Summary of DV Values for Scale Model Stacks

	DV		
	Predicted for Actual	Acceptable Range for Scale Model	
System	Stack	Minimum	Maximum
HV-S1	1.42E+04	2.36E+03	8.50E+04
HV-S2	1.32E+04	2.20E+03	7.93E+04
IHLW-S1	5.03E+03	8.39E+02	3.02E+04

3.0 Testing Methods

The testing methods were based on the requirements of ANSI/HPS N13.1-1999. A test plan, TP-WTPSP-032, *Air Sampling Probe Location Tests for Waste Treatment Plant HV-S1, HV-S2, and IHLW-S-1 (Group 3-4) Air Exhaust Systems*, was prepared by PNNL and approved by BNI. This plan referenced the use of PNNL procedures, which define how the test should be conducted in general. A test instruction (TI) was prepared for each test type and for each scale model stack. These TIs contain specific instructions pertaining to the tests that are not addressed in the general procedures. Such information includes the following:

- Layout of measurement points
- Location of tracer injection points
- List of equipment and instrumentation
- Safety requirements
- List of test runs
- Test description and measurement data sheets with hand entries
- Table of preliminary results.

Because the final data sheets and a description of the test methods are included in this report, the TIs are not included here. The QA program that is implemented for this project is described in Section 3.1 and a summary of the stack testing methods used for each of the four test types is presented in Section 3.2.

3.1 Quality Assurance

The PNNL QA program is based on the requirements defined in the U.S. Department of Energy Order 414.1D, *Quality Assurance,* and 10 CFR 830, *Energy/Nuclear Safety Management*, and Subpart A—*Quality Assurance Requirements* (a.k.a., the Quality Rule). PNNL has chosen to implement the following consensus standards in a graded approach:

- ASME NQA-1-2000, *Quality Assurance Requirements for Nuclear Facility Applications*, Part I, "Requirements for Quality Assurance Programs for Nuclear Facilities".
- ASME NQA-1-2000, Part II, Subpart 2.7, *Quality Assurance Requirements for Computer Software for Nuclear Facility Applications*.
- ASME NQA-1-2000, Part IV, Subpart 4.2, *Graded Approach Application of Quality Assurance Requirements for Research and Development*.

The procedures necessary to implement the requirements are documented through PNNL's "How Do I…?" (HDI), which is a system for managing the delivery of laboratory-level policies, requirements, and procedures.

The Waste Treatment Plant Support Program (WTPSP) implements an NQA-1-2000 QA program, using a graded approach presented in NQA-1-2000, Part IV, Subpart 4.2. The WTPSP Quality Assurance manual (QA-WTPSP-002) describes the technology life cycle stages under the WTPSP QA plan

(QA-WTPSP-0001). The technology life cycle includes the progression of technology development, commercialization, and retirement in process phases of basic and applied research and development (R&D), engineering and production, and operation until process completion. The life cycle is characterized by flexible and informal QA activities in basic research, which becomes more structured and formalized through the applied R&D stages. The work described in this report has been completed under the QA Technology level of Developmental Work as the data will be used for applying air discharge permits.

- DEVELOPMENTAL WORK—Developmental work consists of research tasks moving toward technology commercialization. These tasks still require a degree of flexibility, and there is still a degree of uncertainty that exists in many cases. The role of quality on Developmental Work is to make sure that adequate controls exist to support movement into commercialization.

WTPSP addresses internal verification and validation activities by conducting an Independent Technical Review of the final data report in accordance with WTPSP's procedure QA-WTPSP-601, *Document Preparation and Change*. This review verifies that the reported results are traceable, that inferences and conclusions are soundly based, and the reported work satisfies the test plan objectives. Appendix E lists the reviewed test plan, test instructions, and calculation packages used for the tests documented in this report.

3.2 Stack Tests

The tests described in the following subsections were conducted under scale flow conditions between 50% and 125% of the design flow condition designed for each stack, which were listed in Table 2.2. The test matrix included with the test plan described the minimum number of tests that were planned for each stack. The actual number of tests typically differed from the test plan because tests were added to confirm results that had to be repeated.

Before conducting the tests to determine whether the four qualification criteria described in Section 1.1 were met for each stack, two other measurement sets were made. First, the major features of the stack were measured. The longitudinal distance from the fans to the bends, duct reducers, and ports were determined in addition to the duct diameter at each measurement port. The second set of measurements determined the fan frequency settings needed to achieve the desired flow rates. For these measurements, the location within the duct cross section that had velocity measurements closest to the mean velocity was determined for Port 2. Then, velocity measurements were made at this single measurement point at 5-Hz increments in the fan frequency setting. By developing a frequency vs. velocity relationship for the scale model stack, the frequency setting needed to achieve the flow conditions could be pre-determined.

Measurements were made at specific locations within the duct for each of the four qualification criteria tests described in the following subsections. The number and distance between measurement points was based on the U.S. Environmental Protection Agency (EPA) procedure described in 40 CFR 60, Appendix A, Method 1, for circular stacks. For a 12- to 24-in. duct diameter, eight traverse points are required at the relative positions shown in Figure 3.1. Measurements also were made at the centerpoint. In lieu of making the two measurement points nearest to the walls at 3.2% of the duct diameter from the duct walls, the minimum distance from the wall was set to 0.5 in., as prescribed by EPA Method 1. The measurement point closest to the port was Point 1, while the point farthest from the port was Point 8.

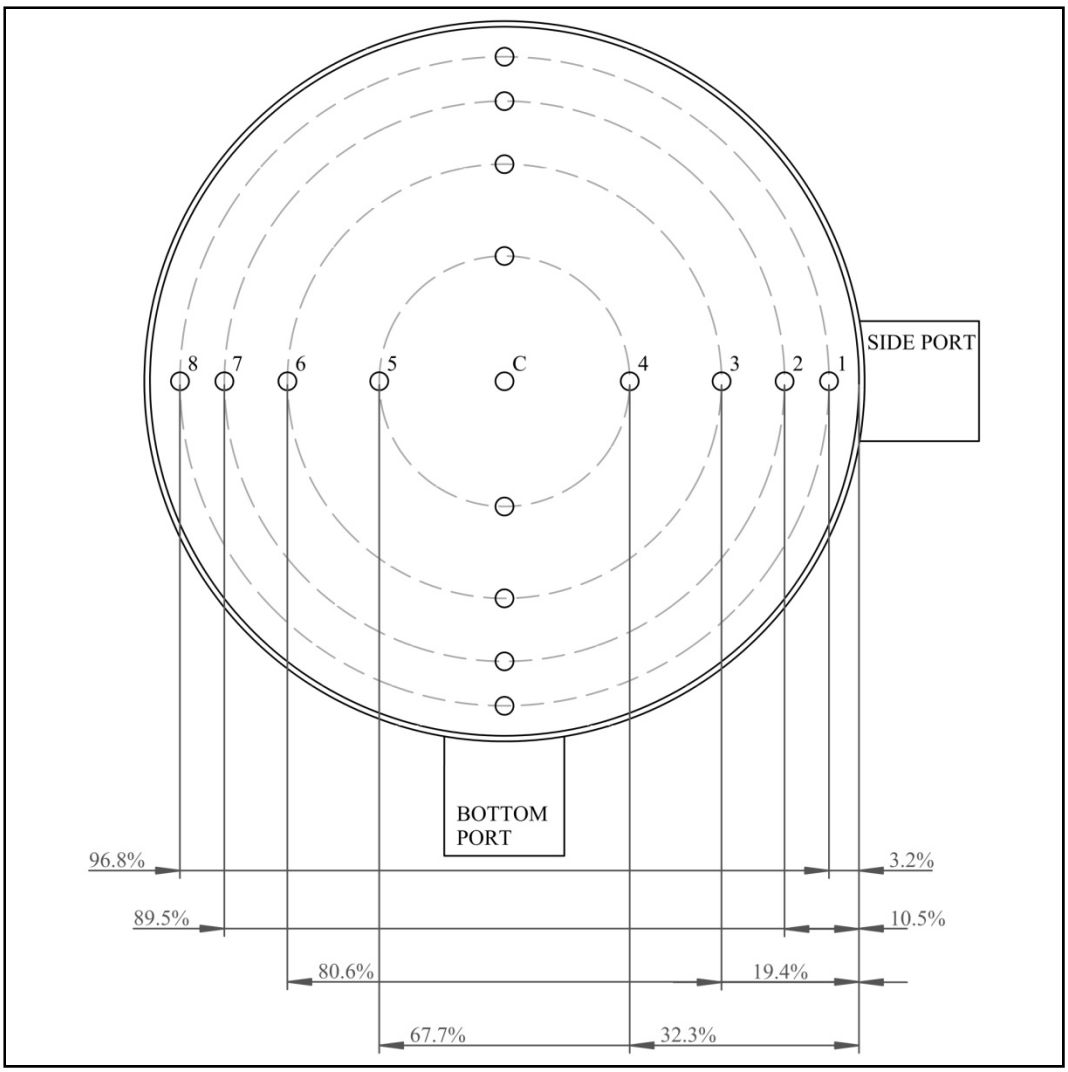


Figure 3.1. Cross Section of the Duct at the Testing Ports with Measurement Points

3.2.1 Velocity Uniformity

The uniformity of air velocity at the stack monitoring location indicates whether the momentum in the stack is well mixed. The method used to conduct the velocity uniformity tests was based on 40 CFR 60, Appendix A, Method 1. The velocity uniformity criterion is that the %COV should be less than 20% in the center two-thirds of the duct (measurement points 2 through 7).

For each run, three air velocity readings were obtained at each of the measurement points across the cross section of the duct. The measured velocity was the average of the three readings. The measured velocity for each point was used to determine the mean and standard deviation of the velocity across the cross-sectional plane. The %COV (a.k.a., the percent relative standard deviation) was calculated as 100 times the standard deviation divided by the mean.

Air velocity measurements were made using a handheld thermal anemometer (TSI, Model 9545, Shoreview, Minnesota). Duct air temperature measurements also were made with the handheld thermal

anemometer. The thermal anemometer reports velocity in standard feet per minute, with standard conditions defined as 1 atm and 70°F. Figure 3.2 shows the thermal anemometer used for this test. The procedure EMS-JAG-04 and test instructions TI-RPP-WTP-676, TI-RPP-WTP-689, and TI-WTPSP-642 were followed to conduct this test for each of the three scale models.

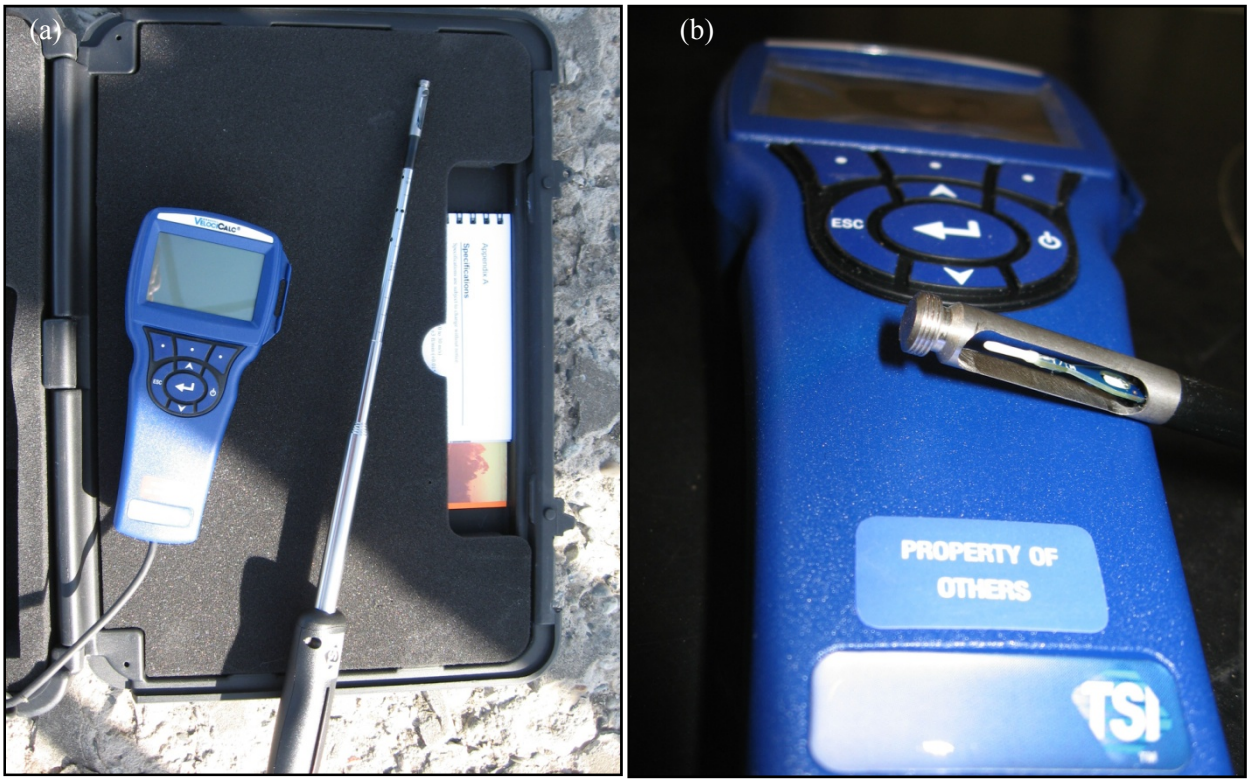


Figure 3.2. Equipment Used for the Velocity Uniformity Test: (a) Thermal Anemometer and (b) Close-Up View of Thermal Anemometer Probe Tip

3.2.2 Flow Angle

The air velocity vector approaching the sample nozzle should be aligned with the axis of the nozzle within an acceptable range so that the sample extraction performance is not degraded. The test method is based on 40 CFR 60, Appendix A, Method 1, Section 11.4, "Verification of the Absence of Cyclonic Flow." The term "flow angle" refers to the angle between the velocity vector of the flow in the duct and the axis of the sampling nozzle. For the stack testing activities, the flow angle was measured at a grid of nine points across two axes in a cross section of the duct (see Figure 3.1). The qualification criterion for the flow angle test is that the average angle should not exceed 20°.

The flow angle measurements were made using an S-type Pitot tube (Dwyer Instruments, 160S-36, Michigan City, Indiana) attached by flexible tubing to a slant-tube manometer (Dwyer Instruments, 400-5, Michigan City, Indiana) and an angle-indicating device attached to the sampling port as shown in Figure 3.3. For this test, the S-type pitot tube was rotated so that the planes of the two open ends of the two tubes are parallel to the long axis of the duct. The pitot tube is then rotated about its long axis until the differential pressure across the open ends of the tubes reads zero on the manometer. The rotation angle is read from the angle indicating device. The measured flow angle for each point is the average of

the three readings. These measured values are used to calculate the mean absolute value of the flow angle across the duct. The procedure EMS-JAG-05 and test instructions TI-RPP-WTP-677, TI-RPP-WTP-689, and TI-WTPSP-018 were used to conduct this test for each of the three scale models.

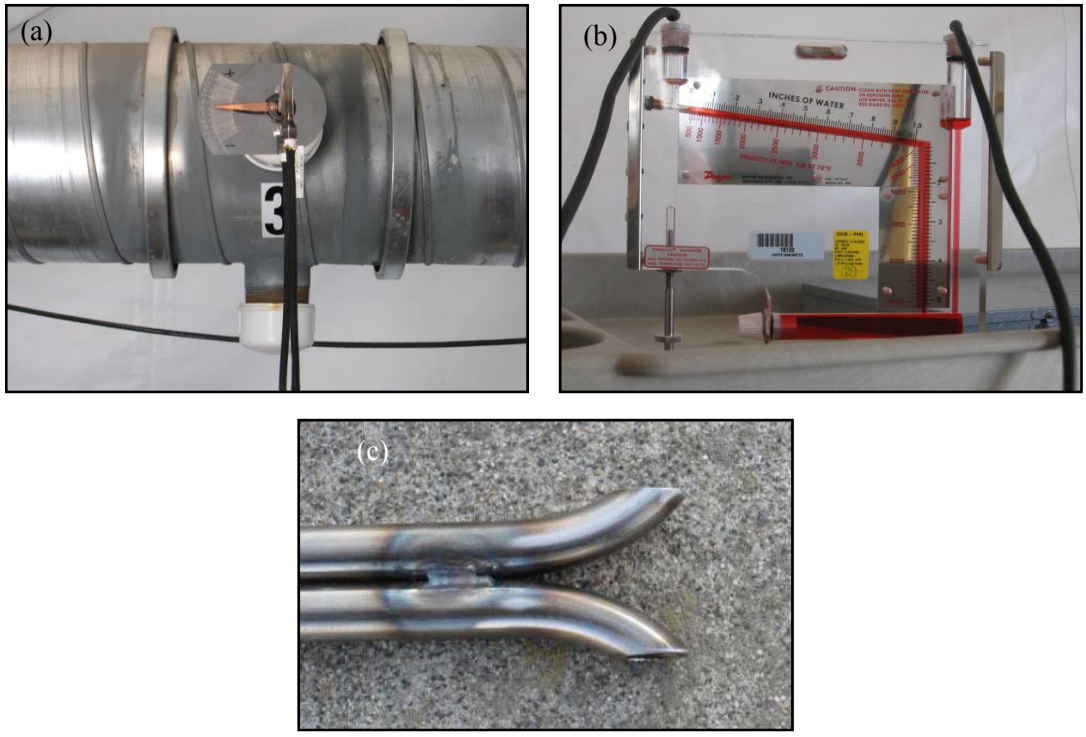


Figure 3.3. Equipment Used for the Flow Angle Test: (a) S-type Pitot Tube Inserted in a Measurement Port with the Protractor Plate, (b) Slant-Tube Manometer, and (c) Openings at Tip of S-Type Pitot Tube

3.2.3 Gaseous Tracer Uniformity

The gaseous contaminant concentration uniformity was demonstrated using the tracer gas sulfur hexafluoride (SF_6). A compressed gas cylinder and a flow controller were used to deliver a constant stream of SF_6 into the duct. The gaseous tracer was typically injected into the duct at a point downstream of the fans. Figure 3.4 shows the injection locations with an injection probe positioned in the port. For separate test runs, the injection probe is positioned at one of five different locations in the duct cross section as illustrated in Figure 3.5. For some tests, just the centerline position is used. The remaining four injection locations are within a specified distance of the duct wall. For a nominally 12-in.-diameter duct, the four "wall" injection locations were located within 2.4 in. of the wall.

For each test run, the tracer concentration was read three times at each of the measurement points across the duct. The measured concentration for each point is the average of the three readings. These measured concentrations are used to calculate the overall mean, standard deviation, and %COV. These calculations also are performed just for the measurement points in the center two-thirds of the duct. The qualification criteria for the gaseous tracer test are that 1) the %COV should be ≤20% within the center two-thirds of the duct and 2) the concentration at any measurement point should not deviate from the overall mean by more than 30%.



Figure 3.4. Equipment Used for the Gaseous Tracer Injection: (a) Injection Probe Installed in the HV-S1 Scale Model and (b) Cylinder of Pure SF_6 with Regulator

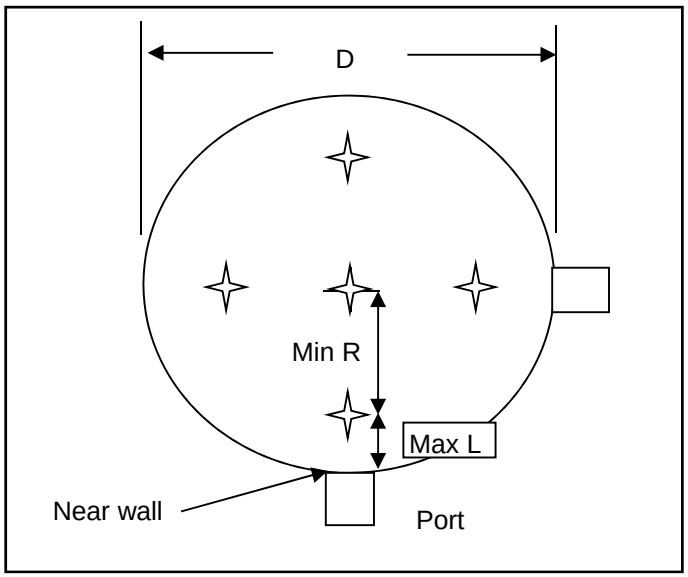


Figure 3.5. Illustration of Five Injection Points in a Circular Duct. Note: Max L is the maximum distance from the wall, which is 20% of the hydraulic diameter. Therefore, Min R, the minimum radius from the duct center, is 80% of the hydraulic diameter. In the case of a round duct, the hydraulic diameter is equal to the physical diameter (D).

A photoacoustic gas analyzer (Brüel & Kjær, Model 1302, Ballerup, Denmark) was used to measure tracer gas concentrations. The concentration variation is the important result for this test, so calibration bias is not important in the test results. However, the analyzer response was checked with calibration standards before and after conducting the test series (as well as weekly during the test series) to verify an adequate instrument response. The response was considered acceptable if the concentration from the instrument was within 10% of the calibration standard.

A simple probe was used to extract the sample and deliver it to the gas analyzer. A small pump drew air from within the stack through the probe. The gas analyzers then sampled the air from the sample line for analysis. Figure 3.6 shows the equipment setup for this test. The procedure EMS-JAG-01 and the test instructions TI-WTPSP-070, TI-WTPSP-078, and TI-WTPSP-084 were used to conduct this test for each of the three scale models.

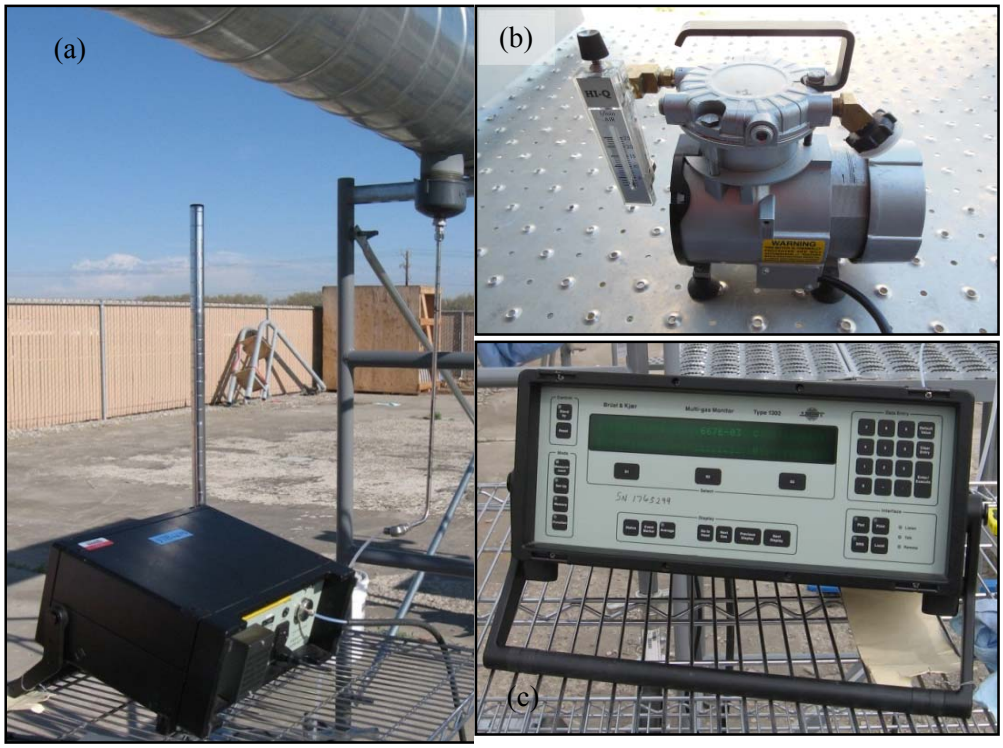


Figure 3.6. Equipment Used for the Gaseous Tracer Sampling: (a) Simple Sampling Probe Installed in a Port, (b) Sampling Pump, and (c) Gas Analyzer

3.2.4 Particle Tracer Uniformity

The uniformity of the particulate contaminant concentration was demonstrated using polydisperse pump oil particles as a particle tracer. Vacuum pump oil was drawn into a spray nozzle (driven by compressed air) housed in a plastic chamber. These aerosol particles were injected into the duct air at an injection point downstream of the fans as shown in Figure 3.7. Figure 3.7 shows the equipment setup for an aerosol injection in the IHLW-S1 scale model stack. The plastic chamber and spray nozzle assembly also is referred to as the aerosol generator. The aerosol was injected at the centerline of the duct, and this test was repeated to gain some sense of the variability of the results.

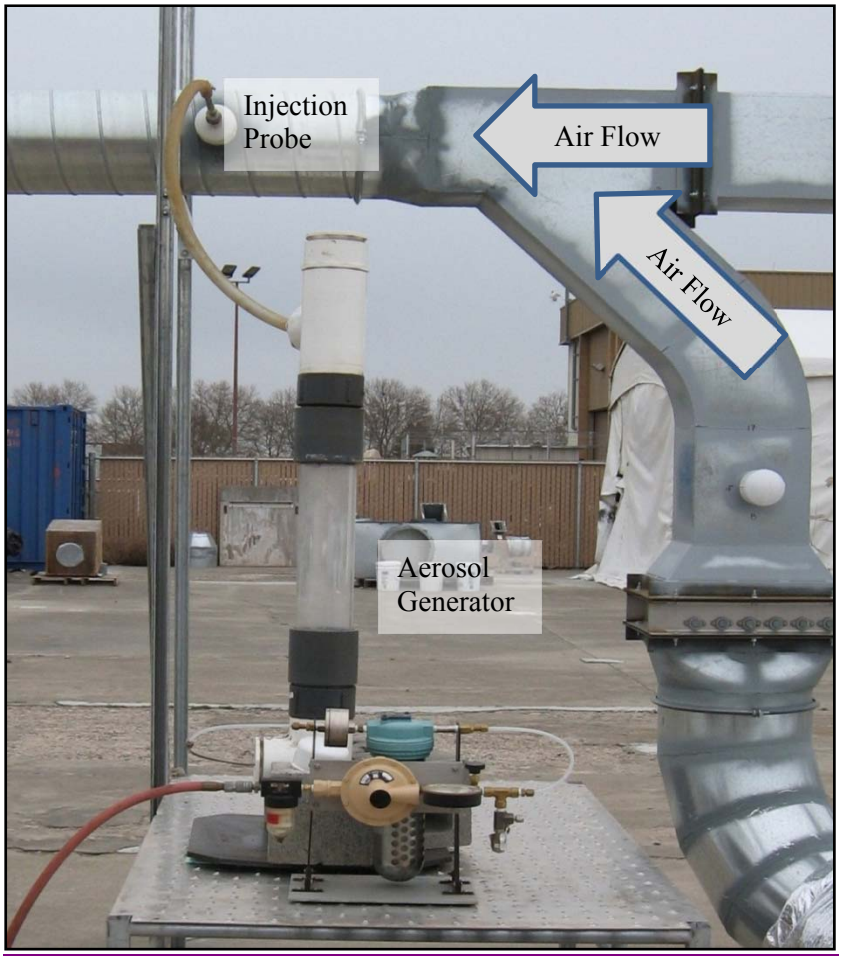


Figure 3.7. Equipment Used for Particle Injection (IHLW-S1)

The concentration of the particles is measured at the sampling grid points with a calibrated optical particle counter (OPC) (Hach, Met-One Model 3415, Loveland, Colorado). A simple probe was used to extract the sample and deliver it to the OPC. Figure 3.8 shows the sampling setup with the simple probe connected to the OPC. To identify potential inconsistencies in the aerosol output, tests were conducted with a reference instrument measuring the particle concentration at the centerpoint at a location downstream of the test port. During the first aerosol tests conducted in this group (PT-1 through PT-7 of IHLW-S1), the reference probe was slightly longer than the measurement probe, as shown in Figure 3.9. For consistency, a probe identical to the measurement probe was fabricated, and the majority of tests were conducted with probes of identical dimension for the measurement and reference locations. Figure 3.9 also shows the reference probe installed on the outlet of the HV-S2 stack, which does not have a port downstream of the measurement port. The OPC sorts the particles into six size channels. As mentioned in Section 1.1, the particles of interest have an AD of 10 μm. Therefore, only data in the 9- to 11-μm channel of the OPC were used.

The particle concentration was read three times at each of the measurement points across the cross section of the duct. The measured concentration for each point is the average of the three readings. From these measurements, the overall mean standard deviation, and %COV were calculated for all of the points

and also just for those within the center two-thirds of the duct. The qualification criterion for the particle tracer test is that the %COV should be less than or equal to 20% within the center two-thirds of the duct. The procedure EMS-JAG-02 and test instructions TI-RPP-WTP-679, TI-RPP-WTP-691, and TI-WTPSP-021 were used to conduct this test for each of the three scale models.



Figure 3.8. Particle Counters Used for the Particle Sampling: (a) Optical Particle Counters for Reference and Measurement Data in Bottom Ports and (b) Optical Particle Counter for Measurement Data in Side Port

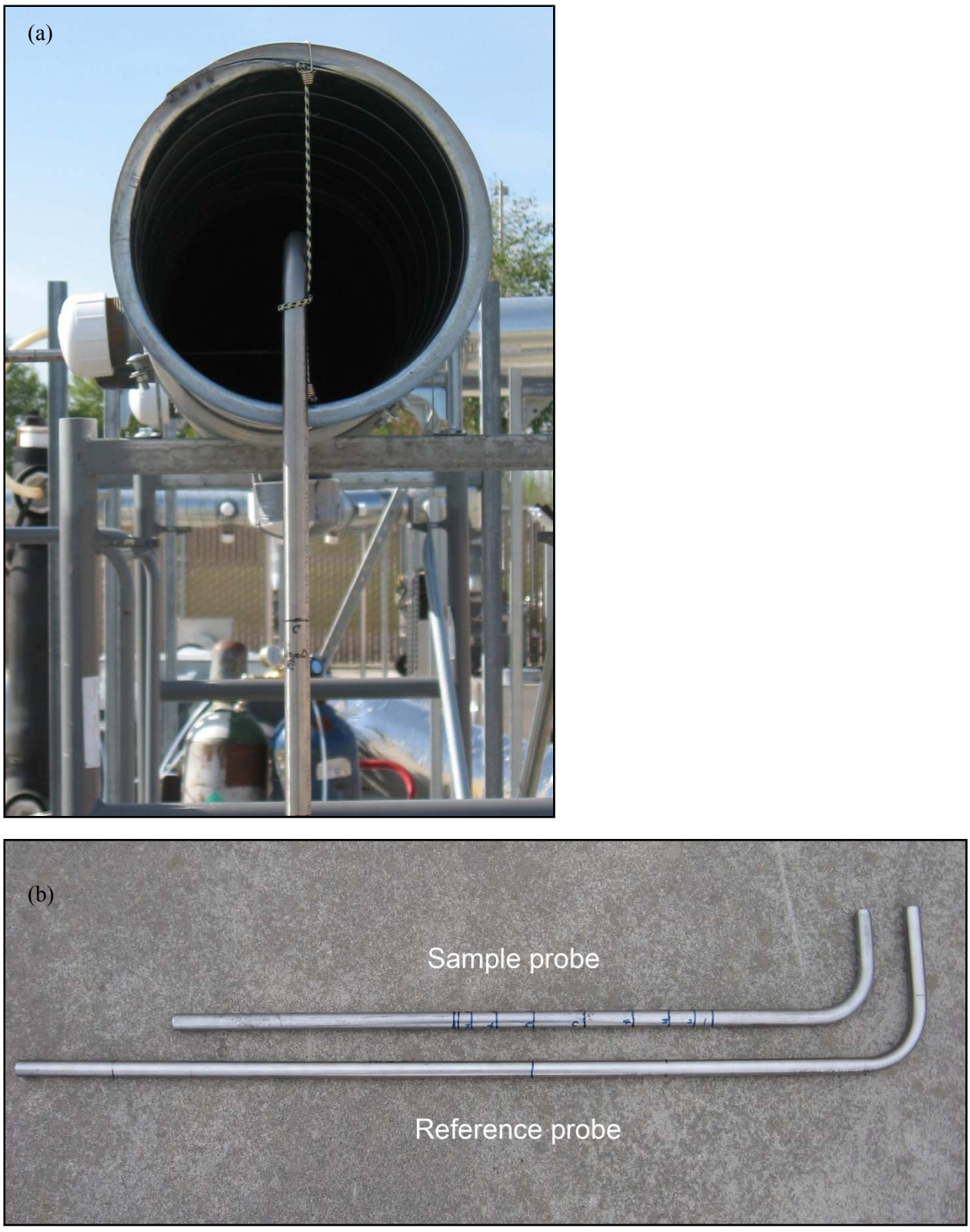


Figure 3.9. Probes Used for the Particle Sampling: (a) Reference Probe Installed in Outlet of HV-S2 Scale Model and (b) Sample and Reference Probe used in Initial Particle Tests. Subsequent tests used two probes identical to the sample probe shown here.

4.0 Stack Testing Results

This section summarizes the results of the stack testing activities for the three scale model stacks in Group 3-4 (HV-S1, HV-S2, and IHLW-S1). The primary, reportable results are the data and data calculations to confirm that the requirements of the ANSI/HPS N13.1-1999 standard have been met. Independent reviews were performed to verify the data transcription and calculations. These calculations were performed using Microsoft Excel (2007, 2010) and documented in computer-assisted calculation packages (CCPs) in accordance with WTPSP procedures. The final data sheets are included in Appendices A through C. Appendix E contains a list of supporting documentation (such as the test plan and test instructions) used with this scale model test group. Each of the Group 3-4 scale model stacks underwent a series of velocity uniformity tests (designated VT), flow angle tests (designated FA), gas tracer tests (designated GT) and particle tracer tests (designated PT). Tables summarizing the results of tests for each scale model are presented in subsections of this chapter. During some tests the, scale model velocity values were higher than the actual stack flow for the conditions the test was meant to represent. This is acceptable because the DV value was still within a factor of six of the stack design values, and the facility flow conditions are estimates and may vary significantly from the design conditions at times for a variety of reasons.

4.1 HV-S1 Stack Results

Data tables, data plots, summary tables of the data for Test Ports 1 and 2 for HV-S1 flow angle, velocity, gas tracer, and particle tracer test results are presented in the following subsections. Some test combinations were repeated (i.e., performed more than once at different times) to quantify the testing and measurement uncertainty.

4.1.1 HV-S1 Velocity Uniformity

The initial test to determine the fan frequency setting for the HV-S1 model is included in Appendix A, Subsection A.1. Table 4.1 lists the results for the velocity uniformity tests performed on the scale model HV-S1 stack. In all cases, the results were well within the criterion of %COV values ≤20%. COV (%COV) values were typically less than 5%, although they ranged from 2.4 to 6.6%. The velocity through the stack ranged from 1136 to 2782 sfpm (883 to 2162 scfm) with one fan operating.

Table 2.2 lists the desired range of minimum scale model flow rates as 1027 to 2361 sfpm (807 to 1854 scfm). The desired testing conditions were between the minimum scale model flow rate and the actual stack velocity. The scale model test conditions meet both the Reynolds number and DV criteria required to represent the actual stack with one operating fan. The completed data sheets from these tests are available in Appendix A.2.

Table 4.1. Summary of HV-S1 Velocity Uniformity Tests

Operating Fan(s)	Test Port	Flow Condition	Run No.	Flow (scfm)	Velocity (sfpm)	%COV
A	2	Max	VT-1	2009	2585	3.6
			VT-13	1939	2494	2.8
			VT-14	1963	2526	3.4
		Norm	VT-15	1787	2299	3.9
			VT-16	1778	2288	3.5
		Min	VT-2	883	1136	4.0
B	1	Min	VT-12	911	1172	5.4
	2	Max	VT-3	2105	2708	6.1
			VT-4	2128	2738	4.8
			VT-5	2162	2782	6.6
		Norm	VT-9	1900	2444	4.4
			VT-10	1952	2512	6.4
			VT-11	1881	2420	4.3
			VT-13	1939	2494	2.8
		Min	VT-6	894	1150	5.3
			VT-7	921	1184	5.1
			VT-8	940	1210	6.2

Note: Individual or replicate sets of tests are alternately shaded and unshaded.

4.1.2 HV-S1 Flow Angle

Table 4.2 lists the results for the flow angle tests performed on the scale model HV-S1 stack. The results for all tests were well within the criterion of flow angle values ≤20°. Typical results were between 3° and 5°. The completed data sheets from these two tests are available in Appendix A, Subsection A.3.

Table 4.2. Summary of HV-S1 Flow Angle Tests

Operating Fan(s)	Test Port	Flow Condition	Run No.	Approximate Air Velocity (sfpm)	Mean Absolute Flow Angle (°)
A	2	Max	FA-1	2698	3.4
		Min	FA-2	1141	3.1
B	2	Max	FA-3	2824	4.2
			FA-4	2881	3.4
		Norm	FA-5	2427	4.7
		Min	FA-6	1170	3.4
	1	Max	FA-7	2669	4.2

Note: Individual or replicate sets of tests are alternately shaded and unshaded.

4.1.3 HV-S1 Gaseous Tracer Uniformity

During the gas tracer testing, the response of the gas analyzer was checked against calibration standards of appropriate concentrations, and the results met the requirements of the procedure. Table 4.3 lists the results for the gaseous tracer uniformity tests performed on the scale model HV-S1 stack for test Ports 1 and 2 and the tracer injection at Port C. In all cases, the tracer was well mixed, with results well

within the criteria of %COV values ≤20% and absolute values of maximum deviation ≤30%. COV values were typically around 2%, with maximum deviation values typically around 4%. The "worst" mixing was observed for one of the bottom injection positions with the maximum velocity condition (GT-8). This test had nearly 5% COV and 8% maximum deviation from the mean concentration, which is still well within the bounds of the criteria. However, tests repeated at these conditions were nearly half of the GT-8 result, implying that GT-8 results may simply reveal the variability of the testing itself. Test results for GT-9 and GT-17 are not shown in Table 4.3 because the average velocity was well outside of the maximum flow conditions for the actual stack. The completed data sheets from these tests are available in Appendix A, Subsection A.4.

Table 4.3. Summary of HV-S1 Gas Tracer Uniformity Tests at Test Ports 1 and 2

Operating Fan(s)	Test Port	Flow Condition	Injection Port & Location	Run No.	Avg Velocity (sfpm)	%COV	Abs % Max Dev. from Mean
A	2	Max	C Center	GT-14	2543	1.3	3.4
		Norm		GT-1	2370	1.1	2.6
		Min		GT-2	1187	2.0	4.4
B	2	Max	C Center	GT-4	2965	1.7	3.5
			C Near	GT-5	2859	1.7	3.7
			C Far	GT-6	2900	2.3	4.6
			C Top	GT-7	3018	1.5	3.3
			C Bottom	GT-8	2958	4.7	7.9
				GT-15	2910	2.5	4.8
				GT-16	3090	2.1	3.5
	1	Max	C Center	GT-13	2863	3.2	5.7
			C Near	GT-11	3113	2.1	4.2
			C Far	GT-12	2811	1.3	5.5
			C Top	GT-10	3035	1.8	3.8
	2	Min	C Center	GT-3	1101	1.8	4.1

Note: Individual or replicate sets of tests are alternately shaded and unshaded.

4.1.4 HV-S1 Particle Tracer Uniformity

Table 4.4 lists the results for the particle tracer uniformity tests performed on the scale model HV-S1 stack. Tests were conducted with the two fans running separately. The completed data sheets from these tests are available in Appendix A, Subsection A.5.

During some runs, the output of the aerosol generator varied with time. To observe the particle generator performance during a test run, a second OPC was set up to sample from the stack centerline, at an unused test port. Figure 4.1 shows the measurement data superimposed on the reference OPC data from run PT-3. In this case, the reference OPC shows a periodic variability in the aerosol generator output. Consequently, PT-3 results are not listed in Table 4.4. PT-3 was repeated as PT-5, and the normalized %COV result for PT-5 was well within 20%.

Previous testing has shown that the measured particle concentration was usually higher through the bottom port. A series of troubleshooting tests was unsuccessful in determining a consistent cause of this behavior. However, to mitigate errors, the concentration bias encountered between the two traverse

directions at the measurement ports was removed by adjusting the data from the traverse with the lower concentration upward by a factor to match the concentrations at the center of the duct (the common point between the two traverses). These results were then termed "normalized."

The result of normalization is illustrated in Figure 4.2 for PT-6, the side traverse data were adjusted up by a factor of 1.28. For tests where there was a large discrepancy between the concentrations measured by the two traverses, the %COV without normalization applied may exceed the qualification criterion. However, normalizing the data, helps meet the particle-tracer uniformity criterion of %COV ≤20%. Table 4.4 shows the %COV values both with and without normalization applied.

Table 4.4. Summary of HV-S1 Particle Tracer Uniformity Tests

Operating Fan	Injection Port & Location	Test Port	Flow Condition	Run No.	Avg Velocity (sfpm)	Non-Normalized %COV	Normalized %COV
A	C Center	2	Max	PT-5	2546	23.3	8.4
			Min	PT-4	1066	20.6	11.7
B	C Center	1	Max	PT-8	2933	25.1	14.8
		2	Max	PT-1	2613	16.5	11.1
			Norm	PT-7	2396	17.0	9.5
			Min	PT-2	931	12.7	4.4
				PT-6	1298	13.5	4.6

Note: Individual and replicate sets of tests are alternately shaded and unshaded.

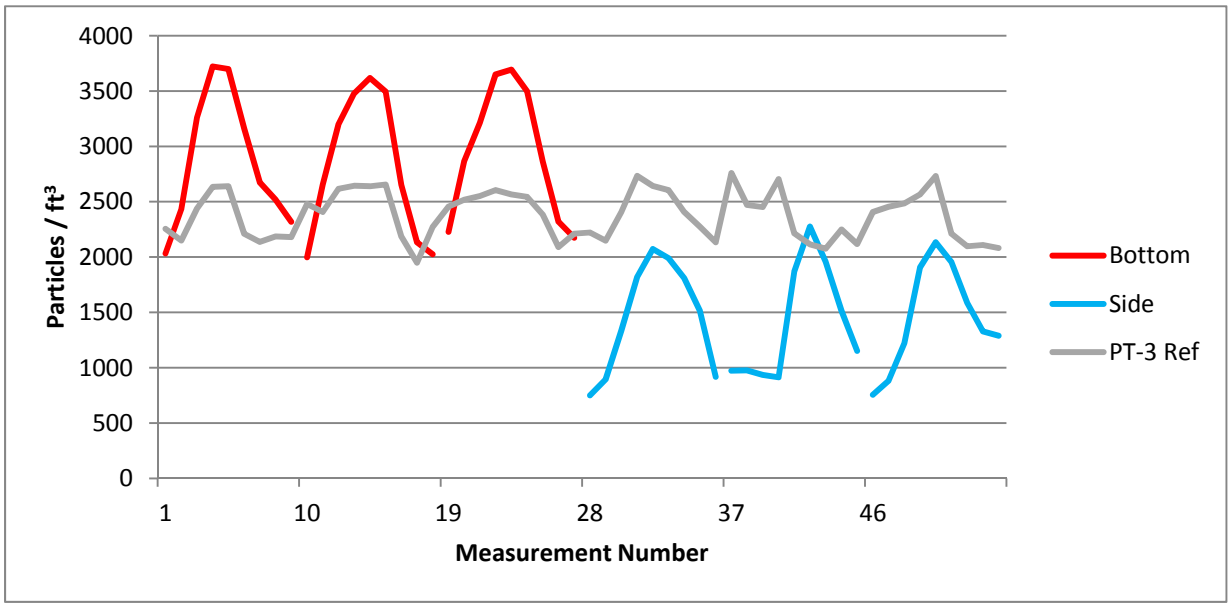


Figure 4.1. Measurement and Reference Particle Test Data from PT-3 on the HV-S1 Stack. Colored lines represent measurement traverses from the side and bottom ports, while the grey line represents the reference concentration at the centerpoint at a downstream location. This plot is an example of variability in the aerosol production and a systematic bias between the bottom and side port measurements.

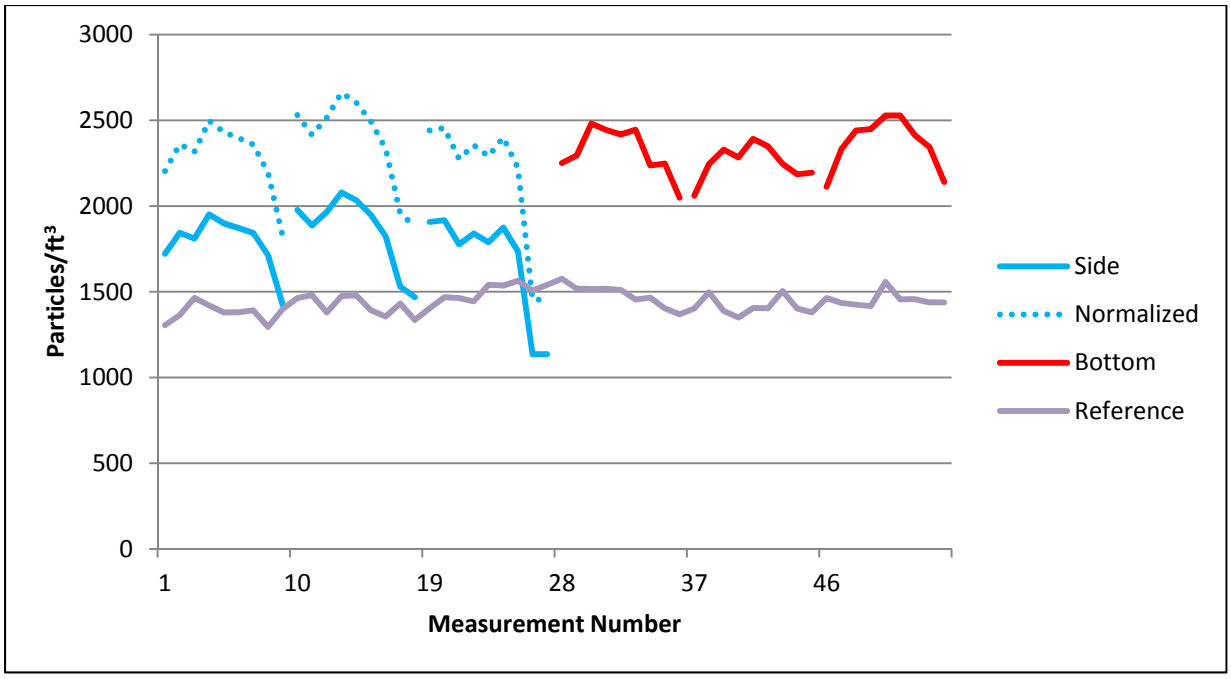


Figure 4.2. Measurement and Reference Particle Test Data from PT-6 on the HV-S1 Stack. Non-normalized data are shown with solid lines while normalized data are shown with dotted lines. Data collected from the side port have been adjusted up by a factor of 1.28.

4.2 HV-S2 Stack Results

Data tables, data plots, and summary tables of the data for Test Ports 1 and 2 for HV-S2 flow angle, velocity, gas tracer, and particle tracer test results are presented in the following subsections. Some test combinations were repeated (i.e., performed more than once at different times) to provide for quantifying the testing and response measurement uncertainty.

4.2.1 HV-S2 Velocity Uniformity

Table 4.5 lists the results for the velocity uniformity tests performed on the scale model HV-S2 stack. In all cases, the results were well within the criterion of %COV values >20%. The velocity in the stack ranged from 1077 to 2877 sfpm (837 to 2236 scfm). Table 2.2 lists the desired range of minimum scale model flow rates as 1047 to 2203 sfpm (840 to 1730 scfm). The desired testing conditions were between the minimum scale model flow rate and the actual stack velocity. With these flow conditions, the scale model meets both the Reynolds number and DV criteria required to represent the actual stack. The completed data sheets from these tests are available in Appendix B, Subsection B.2.

Table 4.5. Summary of HV-S2 Velocity Uniformity Tests

Operating Fan(s)	Test Port	Flow Condition	Run No.	Flow (scfm)	Velocity (sfpm)	%COV
A	2	Max	VT-10	2236	2877	2.5
		Normal	VT-1	1810	2329	2.7
		Min	VT-3	838	1078	3.5
			VT-4	940	1210	3.5
B	2	Max	VT-2	2028	2609	4.7
			VT-9	2174	2796	4.5
		Normal	VT-6	1909	2456	7.8
			VT-7	1895	2437	6.2
			VT-8	1873	2409	4.7
		Min	VT-5	837	1077	5.1

Note: Individual and replicate sets of tests are alternately shaded and unshaded.

4.2.2 HV-S2 Flow Angle

Table 4.6 lists the results for the flow angle tests performed on the scale model HV-S2 stack. The results for all tests were well within the criterion of flow angle values ≤20°. Flow angles when Fan A was operating were markedly smaller than when Fan B was operating. Fan A flow angles ranged from 3.9° to 7.1°, while Fan B flow angles range from 10.3° to 12.5°. The geometry of the stack, in which the Fan B duct intersects the main stack ducting at a horizontal angle, followed immediately by a jog in the stack, is likely the source of the higher flow angles. The completed data sheets from these tests are available in Appendix B, Subsection B.3.

Table 4.6. Summary of HV-S2 Flow Angle Tests

Test Port	Operating Fan	Flow Condition	Run	Approx. Air Velocity (sfpm)	Flow Angle (Degrees)
		Max	FA-5	3065	7.1
		Norm	FA-2	2443	3.9
		Min	FA-1	1063	6.1
	B	Max	FA-4	2627	11.0
			FA-8	3008	12.5
		Norm	FA-3	2471	10.3
		Min	FA-6	1084	11.5
			FA-7	1195	11.1

Note: Individual or replicate sets of tests are alternately shaded and unshaded.

4.2.3 HV-S2 Gaseous Tracer Uniformity

During the gas tracer testing, the response of the gas analyzers was checked against calibration standards of appropriate concentrations, and the results met the requirements of the procedure.

Table 4.7 lists the results for all of the gaseous tracer uniformity tests performed on the scale model HV-S2 stack. No contingency port was tested for this scale model; all tests were performed at Test Port 2.

In all cases, the tracer was well mixed, with results well within the qualification criteria of %COV values less than 20% and absolute value of maximum deviation less than 30%. COV values were typically less than 4%, with maximum deviation values typically less than 10%. The least amount of mixing was observed for the Fan A maximum flow conditions. For this condition, the COV ranged from 4.0% to 7.2%, while the deviation from the mean ranged from 8.5% to 14.2%. It is likely that Fan B conditions had increased mixing compared with similar Fan A conditions because of the geometry of the stack; the flow from Fan B enters the main stack from an angle, thus increasing the turbulence and mixing of the tracer near the injection point. The completed data sheets are available in Appendix B, Subsection B.4.

Table 4.7. Summary of HV-S2 Gas Tracer Uniformity Tests at Test Port 2

Test Port	Operating Fan	Flow Condition (%)	Injection Port & Location	Run No.	Avg Velocity (sfpm)	%COV	Absolute % Max. Dev. from Mean
2	A	Max	E Center	GT-9	3103	7.2	14.2
				GT-10	3052	5.0	11.9
				GT-11	3060	4.2	10.5
				GT-12	3094	4.0	8.5
	A	Min	E Center	GT-1	1084	4.0	12.5
	B	Max	E Center	GT-3	2651	2.2	4.6
			E Bottom	GT-4	2573	3.5	5.9
				GT-13	2934	4.5	7.2
			E Top	GT-5	2602	3.4	6.7
				GT-14	2999	3.1	6.0
			E Near	GT-6	2660	2.8	6.1
				GT-15	2973	2.7	5.2
			E Far	GT-7	2661	3.0	7.2
				GT-16	2943	1.7	5.4
	B	Norm	E Center	GT-8	2467	2.1	4.5
	B	Min	E Center	GT-2	1065	1.8	4.3

Note: Individual or replicate sets of tests are alternately shaded and unshaded.

4.2.4 HV-S2 Particle Tracer Uniformity

Table 4.8 lists the normalized and non-normalized %COV for each run at Test Port 2. In all cases, the uniformity criterion was met. As was the case for the gaseous tracer uniformity, the poorest mixing was observed under the Fan A Max condition. The %COVs for this condition were 12.1% and 13.0%. Other test conditions had COV values between 5.3 and 10.7%. The completed data sheets from these tests are available in Appendix B, Subsection B.5.

Table 4.8. Summary of HV-S2 Particle Tracer Uniformity Tests

Operating Fan	Injection Port & Location	Test Port	Flow Condition	Run No.	Avg Velocity (sfpm)	Non-Normalized %COV	Normalized %COV
A	E Center	2	Max	PT-1	3069	15.5	13.0
			Norm	PT-8	2434	18.6	10.7
			Min	PT-4	1151	9.8	9.3
B	E Center	2	Max	PT-2	3073	18.0	8.7
			Norm	PT-5	2413	25.3	10.0
				PT-6	2403	34.9	6.1
			Min	PT-3	1034	18.4	5.3

Note: Individual or replicate sets of tests are alternately shaded and unshaded

As was discussed for the HV-S1 scale model tests, the instrument response would change as it was moved between the bottom and side ports. Figure 4.3 shows the concentration profiles for the six traverses (trials) for PT-1. The concentration profile was clearly much lower for the side port as compared to the bottom port. The data were normalized as described in Section 4.1.4.

Although the aerosol generator was operated for 30 to 60 min prior to collecting measurements to allow aerosol output to stabilize, there were instances where the aerosol generator output changed during a run. For example, Figure 4.4 shows that the concentration declined by 50% during Run PT-7. The decline occurred during the side port measurements and then remained fairly constant for the bottom traverse. The PT-7 results have been omitted from Table 4.8 because of the decreasing aerosol output during the side traverses.

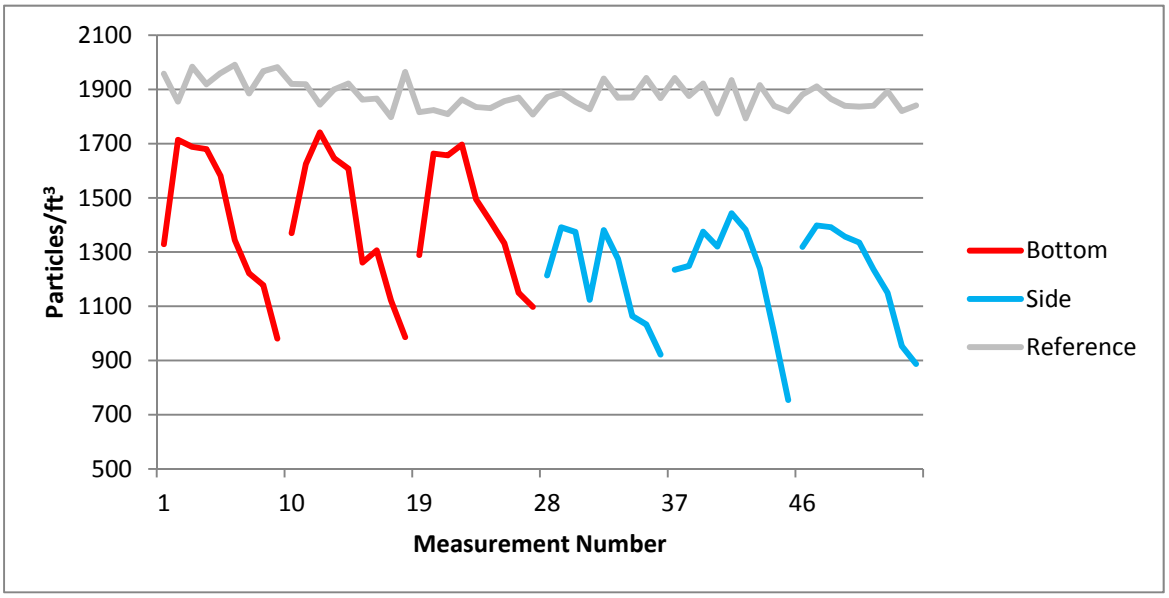


Figure 4.3. Measurement and Reference Particle Tracer Test Data from PT-1 of HV-S2. Colored lines represent measurement traverses from the side and bottom ports, while the grey line represents the reference concentration at the centerpoint at a downstream location. This plot is an example of very stable aerosol production and a small systematic bias between bottom and side port measurements.

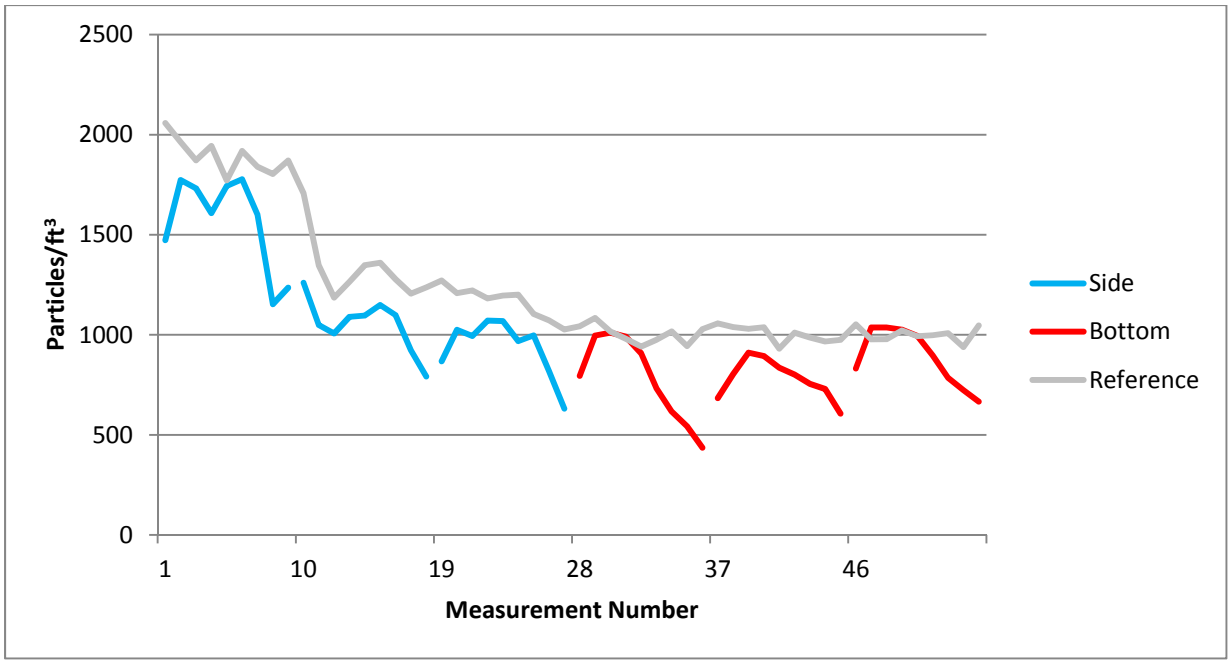


Figure 4.4. Measurement and Reference Particle Tracer Test Data from PT-7 of HV-S2. Colored lines represent measurement traverses from the side and bottom ports, while the grey line represents the reference concentration at the centerpoint at a downstream location. This plot is an example of a typical decline in aerosol production.

4.3 IHLW-S1 Stack Results

Data listings, data plots, and summary tables for IHLW-S1 flow angle, velocity, gas tracer, and particle tracer test results are presented in the following subsections. Some test combinations were repeated (performed more than once at different times) to provide for quantifying the testing and response measurement uncertainty.

4.3.1 Velocity Uniformity

The initial test to determine the fan frequency setting for the IHLW-S1 model to achieve the desired flow conditions is included in Appendix C, Subsection C.1. Fifteen velocity uniformity runs were performed for the IHLW-S1 model. Table 4.9 lists the results for all of the runs. Table 2.2 lists the range of minimum scale model flow rates as 401 to 839 sfpm (315 to 659 scfm). The desired testing conditions were between the minimum scale model flow rate and the actual stack velocity. With these flow conditions, the scale model meets both the Reynolds number and DV criteria required to represent the actual stack with one operating fan.

All results were within the qualification criterion of %COV values ≤20%. COV values were typically less than 8%, with values ranging from 4.2 to 10.0%COV. The largest COV value occurred for a minimum flow condition. The completed data sheets from these tests are available in Appendix C, Subsection C.2.

Table 4.9. Summary of IHLW-S1 Velocity Uniformity Tests

Operating Fan(s)	Test Port	Flow Condition	Run No.	Flow (scfm)	Velocity (sfpm)	%COV
A	2	Max	VT-1	1725	2219	4.6
			VT-11	1321	1700	4.7
			VT-12	1541	1983	4.2
		Norm	VT-2	724	931	6.1
B	2	Max	VT-4	1853	2384	8.5
			VT-7	1605	2065	7.4
			VT-8	1605	2065	7.8
			VT-9	1606	2066	6.3
			VT-13	1390	1788	5.3
			VT-14	1410	1814	5.0
		Norm	VT-5	750	965	8.2
			VT-10	1294	1664	5.9
		Min	VT-6	341	439	10.0
	1	Max	VT-3	1881	2420	4.6
			VT-15	1557	2004	5.2

Note: Individual and replicate sets of tests are alternately shaded and unshaded.

4.3.2 IHLW-S1 Flow Angle

Table 4.10 lists the results of the flow angle tests for the IHLW-S1 scale model. The qualification criterion of ≤20° was met in all cases. The largest results of 9.3° and 7.3° occurred during tests of moderate flow rates representing maximum flow conditions for both Fan A and Fan B. The completed data sheets from these tests are available in Appendix C, Subsection C.3.

Table 4.10. Summary of IHLW-S1 Flow Angle Tests

Operating Fan	Test Port	Flow Condition	Run No.	Approx. Air Velocity (sfpm)	Mean Absolute Flow Angle (°)
A	2	Max	FA-1	2500	4.0
			FA-8	1797	9.3
		Min	FA-2	500	4.4
B	2	Max	FA-3	2570	3.3
			FA-6	1800	1.9
			FA-7	1775	7.3
		Min	FA-5	500	1.3
	1	Max	FA-4	2590	1.9

Note: Individual and replicate sets of tests are alternately shaded and unshaded.

4.3.3 IHLW-S1 Gaseous Tracer Uniformity

Twenty-seven gaseous tracer tests were conducted on the IHLW-S1 scale model. Table 4.11 lists the test results for the tests that are considered to have valid results. Test run results GT-2 through GT-8 were excluded from the table because the injection probe possibly was possibly positioned improperly. Many of the test results have very low %COV values, which indicates a high level of tracer mixing at

Test Port 2. This result was expected, given the number of bends and duct runs between the injection and sampling points. The completed data sheets from the IHLW-S1 gas tracer tests are available in Appendix C, Subsection C.4.

Table 4.11. Summary of IHLW-S1 Gas Tracer Uniformity at Test Ports 1 and 2

Operating Fan	Test Port	Flow Condition	Injection Point	Run No.	Avg Velocity (sfpm)	%COV	Abs. % Max. Dev. from Mean
A	2	Max	C Center	GT-22	1997	0.9	2.5
		Normal	C Center	GT-21	1630	0.9	1.9
		Min	C Center	GT-23	406	4.0	7.5
B	2	Max	C Center	GT-1	2926	1.3	3.5
			C Far	GT-20	2137	0.9	1.8
			C Near	GT-19	2113	0.9	1.8
			C Top	GT-10	2215	3.4	6.2
			C Bottom	GT-9	2200	3.1	8.2
				GT-16	2058	5.8	11.2
				GT-17	2192	3.4	8.1
				GT-18	2179	3.4	7.5
	1	Max	C Top	GT-11	2303	3.1	5.8
			C Bottom	GT-12	2228	3.3	6.1
			C Near	GT-13	2355	0.7	1.2
			C Far	GT-14	2454	0.6	1.3
			C Center	GT-15	2386	1.0	1.9
	2	Normal	C Center	GT-25	1617	1.2	2.6
		Min	C Center	GT-24	360	4.8	17.7
			C Center	GT-26	411	1.8	3.5
			C Center	GT-27	832	1.5	3.5

Note: Individual or replicate sets of tests are alternately shaded and unshaded.

4.3.4 IHLW-S1 Particle Tracer Uniformity

Table 4.11 shows the particle tracer uniformity test results without and with normalization applied for the IHLW-S1 scale model. The normalized data show that the qualification criterion (≤20%COV) is met for all of the runs. The completed data sheets from these tests are available in Appendix C, Subsection C.5.

As was observed in most particle tracer tests, the tracer aerosol output can vary with time during the run, and the OPC response can change when the instrument is reoriented. To track the output of the aerosol generator, a second OPC was used as the reference instrument sampling from the stack centerline at another test port throughout the run. PT-3 results were omitted from the table because of highly inconsistent aerosol production. Figure 4.5 shows the data collected from the measurement port during PT-3 along with the concurrent measurement at the center point at Port 1, downstream of the measurement port as a reference. The aerosol production was highly erratic, and the measurement data across the traverses track with the reference data, and does not provide useful information about the stack cross-sectional mixing of particulate tracer. PT-8 has also been omitted from the summary of results

tabulated in Table 4.12 because of a consistent decline in aerosol production throughout the test. PT-8 results are driven primarily by the aerosol production rate, and is not a reliable measure of the stack mixing.

Table 4.12. Summary of IHLW-S1 Particle Tracer Uniformity Tests

Test Port	Operating Fan	Injection Port & Location	Flow Condition (%)	Run No.	Avg Velocity (sfpm)	Non-normalized %COV	Normalized %COV
2	A	C Center	Max	PT-1	2033	15.1	15.2
			Min	PT-7	398	16.7	5.3
	B	C Center	Max	PT-2	2085	8.3	8.5
			Norm	PT-9	849	5.5	3.3
			Min	PT-4	378	9.0	7.9
				PT-6	324	7.7	6.0
1	B	C Center	Max	PT-5	2104	16.6	9.2

Note: Individual or replicate sets of tests are alternately shaded and unshaded.

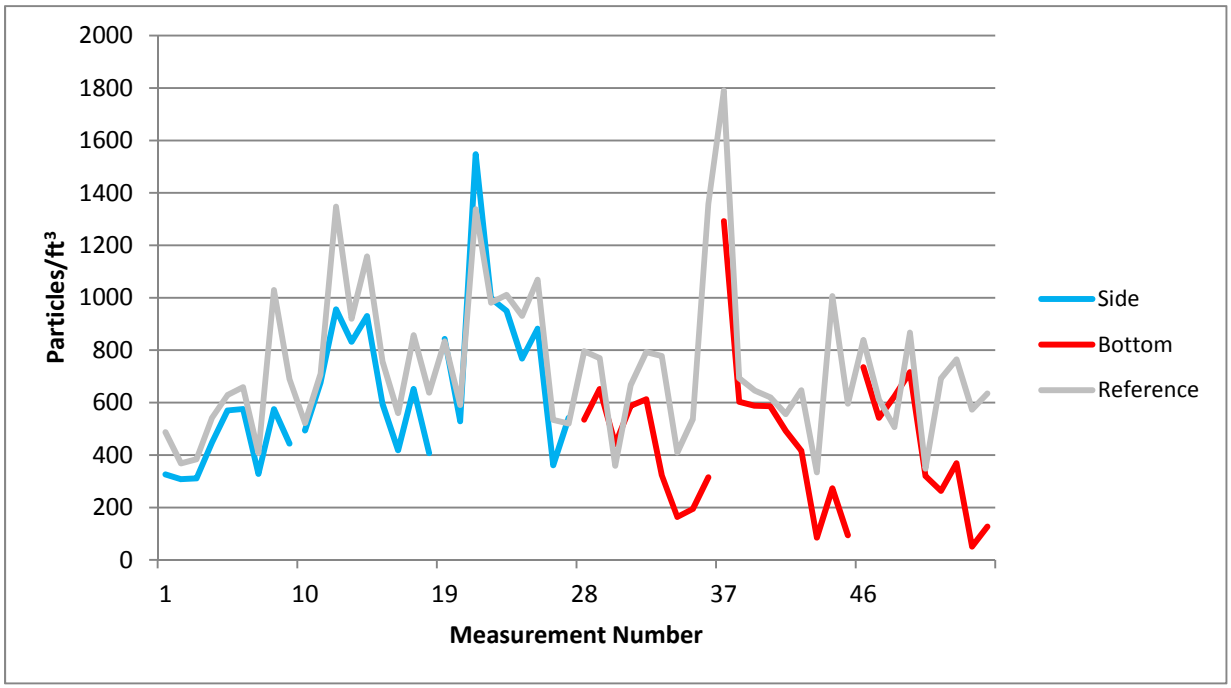


Figure 4.5. Measurement and Reference Particle Tracer Test Data from PT-3 of IHLW-S1. Colored lines represent measurement traverses from the side and bottom ports, while the grey line represents the reference concentration at the center point at a downstream location. This plot is an example of highly erratic aerosol production.

5.0 Conclusions

The results of the tests for each scale model stack in Group 3-4 are summarized in Table 5.1 and Table 5.2. The criteria for sampling probe locations given in ANSI/HPS N13.1-1999, *Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stack and Ducts of Nuclear Facilities,* were met in all cases. These criteria address the capability of the sampling probe to extract a sample that represents the effluent stream. The range of results presented in Table 5.1 for the Group 3-4 stacks covers the designed location for the air sampling probe, Test Port 2.

For the HV-S1 and IHLW-S1 stacks, a limited number of tests were also conducted at a location five duct diameters downstream of the primary location, Test Port 1. This allows for some variability that may occur because of design or construction changes. HV-S2 tests were conducted only at Test Port 2 because of client input that stated that no contingency ports are available for this stack. The results for Test Port 1 are included in Table 5.2. With the exception of the HV-S1 velocity uniformity test, the Test Port 1 conditions represent maximum stack flow conditions. The HV-S1 velocity uniformity test at Test Port 1 was conducted as a minimum flow case.

Table 5.1. Summary of Test Port 2 Results for the Group 3-4 Scale Model Stacks

	Acceptance Criteria	Units	HV-S1	HV-S2	IHLW-S1
Velocity Uniformity	≤20	%COV	2.8 – 6.6	2.5 – 7.8	4.2 – 10
Flow Angle	≤20	Degrees	3.1 – 4.7	3.9 – 12.5	1.3 – 9.3
Gas Tracer Uniformity	≤20	%COV	1.1 – 4.7	1.8 – 7.2	0.9 – 5.8
	≤30	Maximum % Deviation from Mean	2.6 – 7.9	4.3 – 14.2	1.8 – 11.2
Particle Tracer Uniformity	≤20	Normalized %COV	4.4 – 11.7	5.3 – 13	3.3 – 15.2

Table 5.2. Summary of Test Port 1 Results for the Group 3-4 Scale Model Stacks

	Acceptance Criteria	Units	HV-S1	IHLW-S1
Velocity Uniformity	≤20	%COV	5.4[a]	4.6 – 5.2
Flow Angle	≤20	Degrees	4.2	1.9
Gas Tracer Uniformity	≤20	%COV	1.3 – 3.2	0.6 – 3.3
	≤30	Maximum % Deviation from Mean	3.8 – 5.7	1.2 – 6.1
Particle Tracer Uniformity	≤20	Normalized %COV	14.8	9.2

[a] HV-S1 Velocity Uniformity conducted at minimum flow condition. All other tests conducted at maximum flow conditions.

The results at Test Port 1, which is 5 duct diameters downstream of the anticipated sampling location at Test Port 2 tend to be fairly similar to the Test Port 2 results. Without more extensive testing and statistical analysis to determine the effect of distance on the ANSI/HPS N13.1-1999 testing results, quantitative commentary cannot be made. However, qualitatively, the results indicate that there is minor difference between the two locations, and that either location (as well as locations in between) should be sufficient as a qualified sampling location.

Based on these scale model tests, the locations proposed for the air sampling probes in each of the three Group 3-4 stacks meet the requirements of the ANSI/HPS N13.1-1999 standard. Additional velocity uniformity and flow angle tests on the actual stacks will be necessary during cold startup to confirm the validity of the scale model results in representing the actual stacks. In particular, the velocity uniformity test results for the actual stacks must be within 5%COV of the range of results listed above for the scale model so that scale model results can be said to be representative of the stack. For example, if the actual IHLW-S1 stack sampling probe is located in a position corresponding to Test Port 2, the measured velocity uniformity %COV should be between 0.0 and 15%COV (non-negative value for 4.3 - 5 = 0.0, and 10 + 5 = 15). The velocity uniformity test results summarized in Table 5.1 cover a range of flow conditions that are expected to bracket the conditions of the actual stack. For cold startup tests, the DV value and Reynolds number should meet the criteria listed in Section 1 (i.e., DV within a factor of six and Reynolds number >10,000). The velocity uniformity acceptance range would be constructed using the scale model results that correspond to the probe location and fan operating conditions present during the test on the actual stack.

6.0 References

10 CFR 830, Subpart A. 2008. "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, Virginia (reaffirmed in 2011 as ANSI/HPS N13.1-2011).

American Society of Mechanical Engineers (ASME). 2001. *Quality Assurance Requirements for Nuclear Facility Applications*. NQA-1-2000, New York, New York.

DOE Order 414.1D. April 25, 2011. "Quality Assurance." U.S. Department of Energy, Washington, D.C.

Appendix A

HV-S1 Data Sheets

A.1 HV-S1 Calibration of Ventilation Flow Controller

VELOCITY TRAVERSE DATA FORM

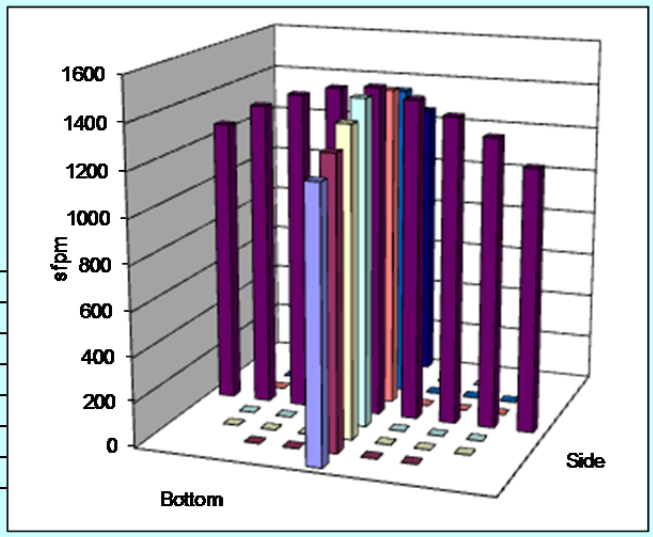
Site	HV-S1 Model	Run No.	FC-1
Date	3/23/12	Fan Configuration	Fan A
Testers	XY EA	Fan Setting	32 Hz
Stack Dia.	11.938 in.	Stack Temp	65.6 deg F
Stack X-Area	111.9 in.2	Start/End Time	1300 / 1400
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

Order →		1st				2nd			
Traverse→		Side				Bottom			
Trial →		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	1181	1079	1207	1155.7	1186	1247	1201	1211.3
2	1.25	1283	1282	1254	1273.0	1267	1304	1308	1293.0
3	2.32	1373	1327	1352	1350.7	1354	1392	1396	1380.7
4	3.86	1436	1399	1395	1410.0	1466	1444	1465	1458.3
Center	5.97	1488	1482	1392	1454.0	1509	1447	1469	1475.0
5	8.08	1445	1460	1414	1439.7	1450	1416	1437	1434.3
6	9.62	1406	1435	1362	1401.0	1417	1372	1419	1402.7
7	10.68	1319	1391	1315	1341.7	1335	1342	1340	1339.0
8	11.44	1253	1276	1215	1248.0	1277	1221	1261	1253.0
Averages →		1353.8	1347.9	1322.9	1341.5	1362.3	1353.9	1366.2	1360.8

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	1351.2		Mean	1381.4	1397.6	1389.5
Min Point	1155.7	-14.5%	Std. Dev.	63.4	65.5	62.5
Max Point	1475.0	9.2%	COV as %	4.6	4.7	4.5

Flow w/o C-Pt	1039 scfm	Instuments Used:		Cal Due
Vel Avg w/o C-Pt	1337 sfpm	TSI VelociCalc	SN T95351203001	01/12/13
		Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Stack temp	69.7	61.4	F
Equipment temp	N/A	N/A	F
Ambient temp	58.4	59.9	F
Stack static	N/A	N/A	mbars
Ambient pressure	29.71	29.71	in Hg
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	20%	28.00	RH



Notes: Bottom 7 is determined to be the point representative of the average velocity of the traverse.

XY 3/23/12

Entries made by:	EA/XY	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	3/23/2012	Signature/date	6/26/2012
			On file with original

VELOCITY TRAVERSE DATA FORM

Site	HV-S1 Model	Run No.	FC-2
Date	3/23/12	Fan Configuration	Fan B
Testers	XY EA	Fan Setting	32 Hz
Stack Dia.	11.938 in.	Stack Temp	62.6 deg F
Stack X-Area	111.9 in.2	Start/End Time	1400 / 1430
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

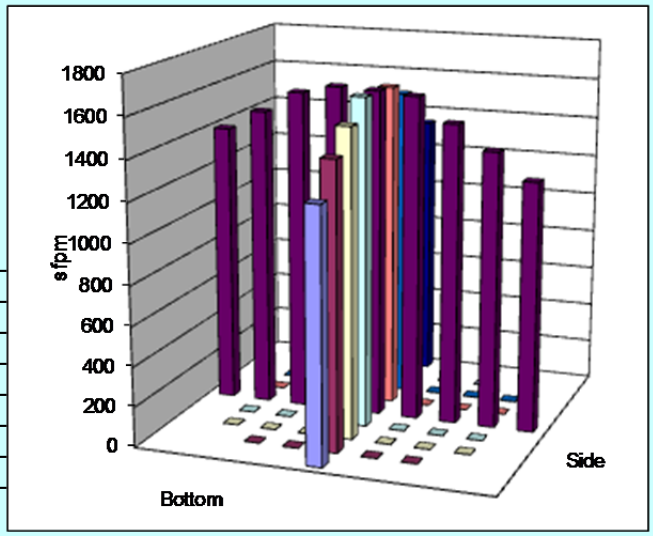
Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	1249	1251	1245	1248.3	1252	1225	1278	1251.7
2	1.25	1387	1377	1376	1380.0	1420	1423	1409	1417.3
3	2.32	1496	1506	1500	1500.7	1514	1541	1539	1531.3
4	3.86	1604	1633	1628	1621.7	1653	1634	1618	1635.0
Center	5.97	1630	1632	1651	1637.7	1638	1630	1627	1631.7
5	8.08	1624	1684	1630	1646.0	1621	1618	1611	1616.7
6	9.62	1593	1619	1605	1605.7	1553	1497	1606	1552.0
7	10.68	1511	1514	1471	1498.7	1505	1458	1424	1462.3
8	11.44	1389	1390	1423	1400.7	1324	1322	1353	1333.0
Averages ---------->		1498.1	1511.8	1503.2	1504.4	1497.8	1483.1	1496.1	1492.3

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	1498.4		Mean	1555.8	1549.5	1552.6
Min Point	1248.3	-16.7%	Std. Dev.	99.1	85.6	89.0
Max Point	1646.0	9.9%	COV as %	6.4	5.5	5.7

Flow w/o C-Pt	1151	scfm	
Vel Avg w/o C-Pt	1481	sfpm	

Instuments Used:		Cal Due
TSI VelociCalc	SN T95351203001	01/12/13
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Stack temp	63	62.2	F
Equipment temp	N/A	N/A	F
Ambient temp	61.7	57.2	F
Stack static	N/A	N/A	mbars
Ambient pressure	29.71	29.71	in Hg
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	27%	31.00	RH



Notes: Side 7 is determined to be the point representative of the average velocity of the traverse.

XY 3/23/12

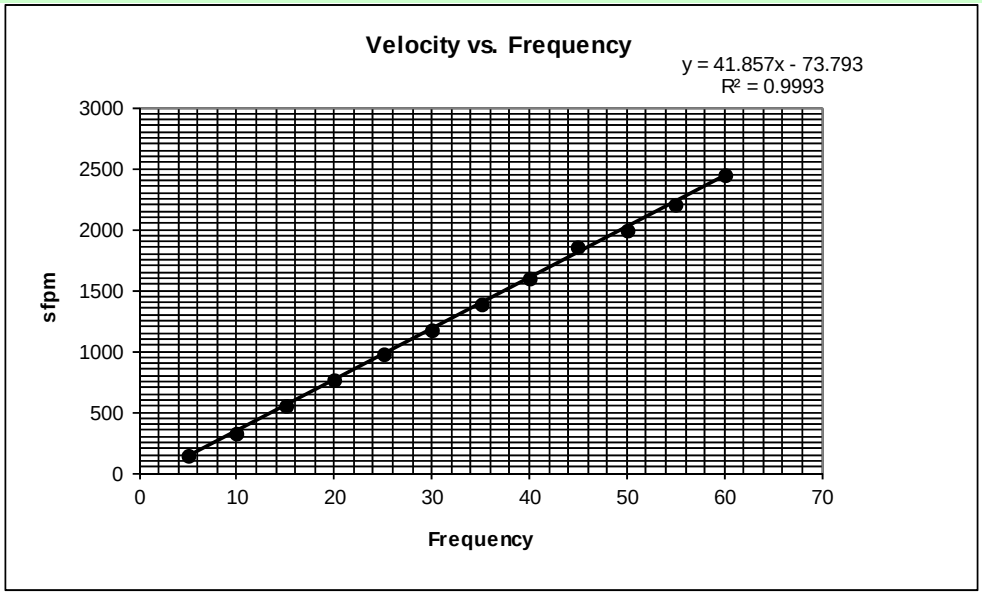
Entries made by:	EA/XY	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	3/23/2012	Signature/date	6/26/2012
			On file with original

VELOCITY vs. FREQUENCY DATA FORM

Site	**HV-S1 model**	Run No.	**VF-1**
Date	3/23/2012	Stack Temp	63.0 F/62.0 F
Tester	EA, XY	Stack RH%	30%
Stack Dia.	11.938 in.	Baro Press	29.71 in Hg
Stack X-Area	111.9 in2	Fan Configuration	A only
Test Port	2	Start/End Time	15:53/16:10
Dist. from disturbance	240 inches	Reference point from velocity test VC :	Bottom 7
Velocity Readings, units	actual fpm		

					Target scfm	Target sfpm	Estmtd Hz
					55,627	2,833	69
	fpm				24,202	1,233	31
Hz	1	2	3	Mean	StDev	2 StDev	cfm
5	132	159	142	144.33	13.65	27.30	112.19
10	327	327	326	326.67	0.58	1.15	253.92
15	529	567	564	553.33	21.13	42.25	430.11
20	744	799	754	765.67	29.30	58.59	595.16
25	983	957	997	979.00	20.30	40.60	760.98
30	1186	1173	1176	1178.33	6.81	13.61	915.92
35	1373	1383	1400	1385.33	13.65	27.30	1076.82
40	1611	1568	1619	1599.33	27.43	54.86	1243.17
45	1859	1862	1861	1860.67	1.53	3.06	1446.30
50	1989	1982	2018	1996.33	19.09	38.18	1551.76
55	2205	2217	2189	2203.67	14.05	28.10	1712.92
60	2404	2455	2479	2446.00	38.30	76.60	1901.28

Instuments Used:		**Cal Exp. Date:**
TSI VelociCalc	SN T95351203001	01/12/13
Fisher Scientific	SN 90936818	12/7/2012



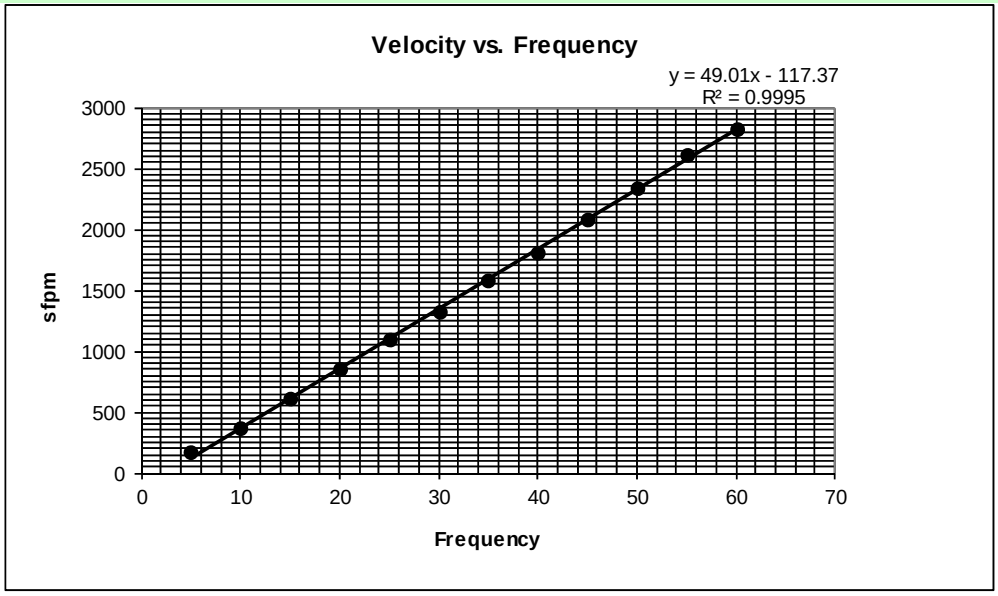
Entries made by:	XY/EA	Technical Data Review performed by:	
Signature/date	3/23/2012	Signature/date	Elizabeth Golovich 6/26/2012
			Signaure on file with original

VELOCITY vs. FREQUENCY DATA FORM

Site	**HV-S1 model**	Run No.	**VF-2**
Date	3/23/2012	Stack Temp	64.8F/60.9F
Tester	EA, XY	Stack RH%	26%
Stack Dia.	11.938 in.	Baro Press	29.71 in Hg
Stack X-Area	111.9 in2	Fan Configuration	B Only
Test Port	2	Start/End Time	1525/1550
Dist. from disturbance	240 inches	Reference point from velocity test VC :	Side 7
Velocity Readings, units	actual fpm		

					Target scfm	Target sfpm	Estmtd Hz
					55,627	2,833	60
	fpm				24,202	1,233	28
Hz	1	2	3	Mean	StDev	2 StDev	cfm
5	141	184	182	169.00	24.27	48.54	131.36
10	369	360	372	367.00	6.24	12.49	285.27
15	606	608	642	618.67	20.23	40.46	480.89
20	858	864	839	853.67	13.05	26.10	663.56
25	1087	1119	1097	1101.00	16.37	32.74	855.81
30	1317	1349	1321	1329.00	17.44	34.87	1033.04
35	1594	1581	1583	1586.00	7.00	14.00	1232.80
40	1802	1819	1822	1814.33	10.79	21.57	1410.29
45	2079	2083	2089	2083.67	5.03	10.07	1619.64
50	2335	2354	2335	2341.33	10.97	21.94	1819.93
55	2601	2591	2635	2609.00	23.07	46.13	2027.98
60	2826	2803	2869	2832.67	33.50	67.00	2201.84

Instuments Used:		**Cal Exp. Date:**
TSI VelociCalc	SN T95351203001	01/12/13
Fisher Scientific	SN 90936818	12/7/2012



Entries made by:	XY/EA	Technical Data Review performed by:	
Signature/date	3/23/2012	Signature/date	Elizabeth Golovich 6/26/2012
			Signaure on file with original

A.2 HV-S1 Velocity Uniformity Data Sheets

VELOCITY TRAVERSE DATA FORM

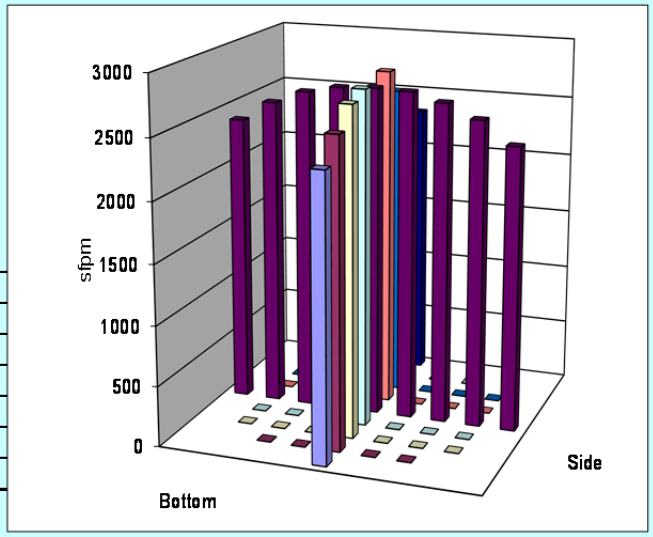
Site	HV-S1 Model	Run No.	VT-1
Date	3/26/12	Fan Configuration	Fan A Only
Testers	CA, XY	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	57 deg F
Stack X-Area	111.9 in.2	Start/End Time	1000 / 1045
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	2527	2275	2269	2357.0	2323	2330	2387	2346.7
2	1.25	2693	2502	2443	2546.0	2521	2537	2600	2552.7
3	2.30	2765	2575	2645	2661.7	2660	2684	2836	2726.7
4	3.84	2720	2761	2712	2731.0	2726	2680	2963	2789.7
Center	5.94	2683	2760	2782	2741.7	2669	2648	2911	2742.7
5	8.04	2689	2749	2746	2728.0	2661	3000	2817	2826.0
6	9.57	2641	2700	2674	2671.7	2576	2596	2659	2610.3
7	10.63	2490	2616	2584	2563.3	2566	2463	2566	2531.7
8	11.38	2339	2449	2402	2396.7	2363	2305	2290	2319.3
Averages ---->		2616.3	2598.6	2584.1	2599.7	2562.8	2582.6	2669.9	2605.1

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	2602.4		Mean	2663.3	2682.8	2673.1
Min Point	2319.3	-10.9%	Std. Dev.	80.3	117.2	97.1
Max Point	2826.0	8.6%	COV as %	3.0	4.4	3.6

Flow w/o C-Pt	2009 scfm	Instuments Used:	Cal Due
Vel Avg w/o C-Pt	2585 sfpm	Fisher Scientific Barometer SN 90936818	12/07/12
		TSI VelociCalc SN T95351203001	12/17/2012

	Start	Finish	
Stack temp	57.1	57.1	F
Equipment temp	N/A	N/A	F
Ambient temp	66.2	67.1	F
Stack static	N/A	N/A	mbars
Ambient pressure	29.38	29.38	in Hg
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	28%	27%	RH



Notes:

CA
3/26/2012

Entries made by:	XY, CA	Technical Data Review performed by:	Susan Sande
Signature/date	3/26/2012	Signature/date	7/13/2012
	On file with Original		On file with Original

VELOCITY TRAVERSE DATA FORM

Site	HV-S1 Model	Run No.	VT-2
Date	3/26/12	Fan Configuration	Fan A Only
Testers	CA, XY	Fan Setting	27 Hz
Stack Dia.	11.938 in.	Stack Temp	58 deg F
Stack X-Area	111.9 in.2	Start/End Time	1050 / 1115
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

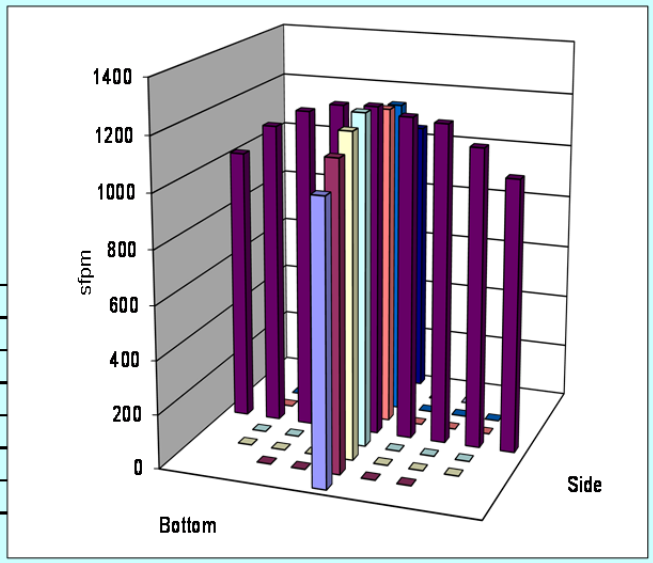
Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	1027	987	1011	1008.3	1015	1046	1052	1037.7
2	1.25	1111	1113	1102	1108.7	1136	1175	1095	1135.3
3	2.30	1160	1213	1180	1184.3	1201	1193	1203	1199.0
4	3.84	1181	1191	1222	1198.0	1234	1242	1234	1236.7
Center	5.94	1217	1217	1245	1226.3	1211	1256	1229	1232.0
5	8.04	1242	1197	1227	1222.0	1221	1187	1181	1196.3
6	9.57	1171	1168	1231	1190.0	1205	1161	1189	1185.0
7	10.63	1116	1125	1135	1125.3	1129	1029	1110	1089.3
8	11.38	1007	988	1043	1012.7	1046	1040	1039	1041.7
Averages ---->		1136.9	1133.2	1155.1	1141.7	1155.3	1147.7	1148.0	1150.3

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	1146.0		Mean	1179.2	1182.0	1180.6
Min Point	1008.3	-12.0%	Std. Dev.	45.5	52.8	47.4
Max Point	1236.7	7.9%	COV as %	3.9	4.5	4.0

Flow w/o C-Pt	883	scfm
Vel Avg w/o C-Pt	1136	sfpm

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012

	Start	Finish	
Stack temp	58.1	58.1	F
Equipment temp	N/A	N/A	F
Ambient temp	68	65.3	F
Stack static	N/A	N/A	mbars
Ambient pressure	29.38	29.38	in Hg
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	27%	29%	RH



Notes:

CA

3/26/2012

Entries made by:	CA, XY	Technical Data Review performed by:	Susan Sande
Signature/date	3/26/2012	Signature/date	7/13/2012
	On file with Original		On file with Original

VELOCITY TRAVERSE DATA FORM

Site	HV-S1 Model	Run No.	VT-3
Date	3/26/12	Fan Configuration	Fan B Only
Testers	CA, XY	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	62 deg F
Stack X-Area	111.9 in.2	Start/End Time	1120 / 1137
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

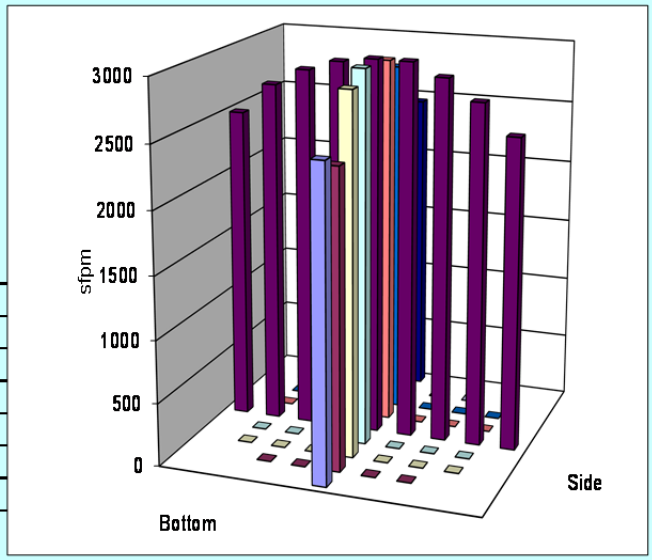
Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	2401	2445	2447	2431.0	2524	2470	2419	2471.0
2	1.25	2632	2702	2676	2670.0	2730	2686	1678	2364.7
3	2.30	2847	2819	2839	2835.0	2939	2812	2868	2873.0
4	3.84	2962	2931	2920	2937.7	3101	2917	2917	2978.3
Center	5.94	2952	2934	2935	2940.3	3137	2921	2942	3000.0
5	8.04	2904	2916	2894	2904.7	3040	2900	2888	2942.7
6	9.57	2800	2847	2824	2823.7	2969	2746	2804	2839.7
7	10.63	2731	2696	2647	2691.3	2694	2663	2647	2668.0
8	11.38	2517	2430	2412	2453.0	2523	2386	2439	2449.3
Averages ---->		2749.6	2746.7	2732.7	2743.0	2850.8	2722.3	2622.4	2731.9

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	2737.4		Mean	2829.0	2809.5	2819.2
Min Point	2364.7	-13.6%	Std. Dev.	111.2	225.6	171.2
Max Point	3000.0	9.6%	COV as %	3.9	8.0	6.1

Flow w/o C-Pt	2105	scfm	
Vel Avg w/o C-Pt	2708	sfpm	

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012

	Start	Finish	
Stack temp	60.5	63.3	F
Equipment temp	N/A	N/A	F
Ambient temp	68	68	F
Stack static	N/A	N/A	mbars
Ambient pressure	29.38	29.38	in Hg
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	27%	24%	RH



Notes:

CA
3/26/2012

Entries made by:	CA, XY	Technical Data Review performed by:	Susan Sande
Signature/date	3/26/2012	Signature/date	7/13/2012
	On file with Original		On file with Original

VELOCITY TRAVERSE DATA FORM

Site	HV-S1 Model	Run No.	VT-4
Date	3/26/12	Fan Configuration	Fan B Only
Testers	XY , CA	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	64 deg F
Stack X-Area	111.9 in.2	Start/End Time	1140 / 1210
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	2393	2413	2364	2390.0	2382	2382	2493	2419.0
2	1.25	2661	2644	2702	2669.0	2586	2636	2643	2621.7
3	2.30	2872	2862	2883	2872.3	2801	2856	2885	2847.3
4	3.84	2991	2982	3031	3001.3	2930	2965	3019	2971.3
Center	5.94	3020	3005	3075	3033.3	2945	3008	2991	2981.3
5	8.04	2955	2930	2996	2960.3	2880	2985	2964	2943.0
6	9.57	2872	2898	2870	2880.0	2813	2886	2835	2844.7
7	10.63	2764	2722	2743	2743.0	2683	2669	2619	2657.0
8	11.38	2609	2588	2516	2571.0	2420	2434	2408	2420.7
Averages ---->		2793.0	2782.7	2797.8	2791.1	2715.6	2757.9	2761.9	2745.1

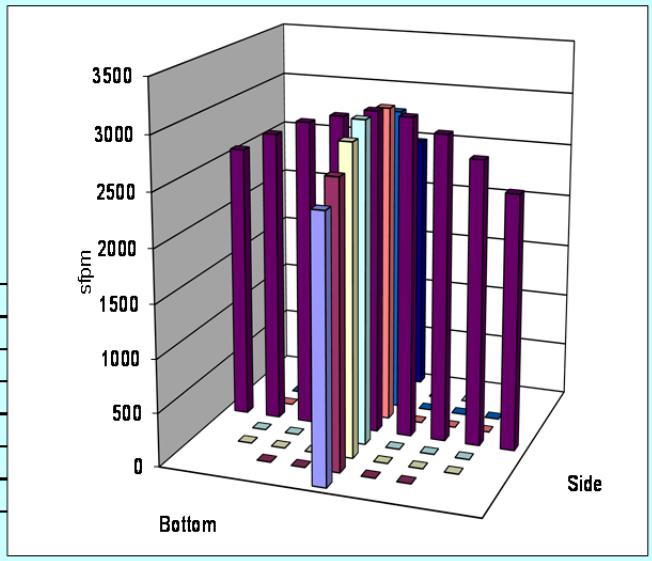
All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	2768.1		Mean	2879.9	2838.0	2859.0
Min Point	2390.0	-13.7%	Std. Dev.	134.2	146.7	136.8
Max Point	3033.3	9.6%	COV as %	4.7	5.2	4.8

Flow w/o C-Pt	2128	scfm	
Vel Avg w/o C-Pt	2738	sfpm	

Instuments Used: Cal Due

Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012

	Start	Finish	
Stack temp	65	63.8	F
Equipment temp	N/A	N/A	F
Ambient temp	63.2	62.6	F
Stack static	N/A	N/A	mbars
Ambient pressure	29.38	29.38	in Hg
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	24%	29%	RH



Notes:

CA
3/26/2012

Entries made by:	XY, CA	Technical Data Review performed by:	Susan Sande
Signature/date	3/26/2012	Signature/date	7/13/2012
	On file with Original		On file with Original

VELOCITY TRAVERSE DATA FORM

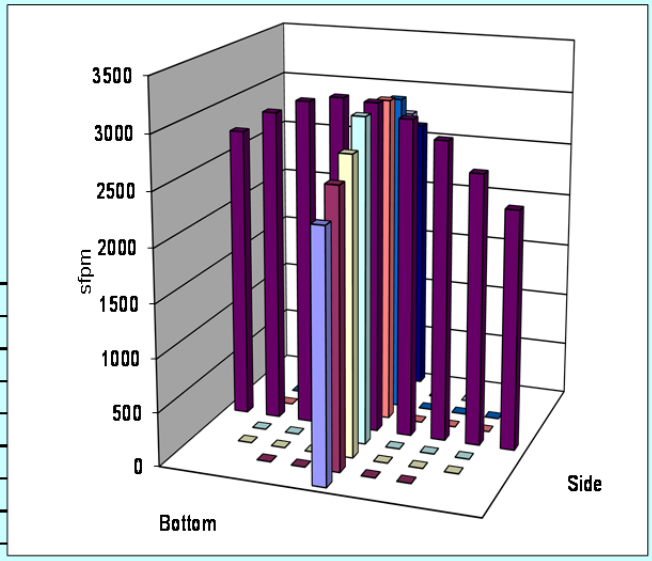
Site	HV-S1 Model	Run No.	VT-5
Date	3/27/12	Fan Configuration	FAN B ONLY
Testers	CA, XY	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	49 deg F
Stack X-Area	111.9 in.2	Start/End Time	947/ 1015
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	2202	2253	2264	2239.7	2376	2251	2316	2314.3
2	1.25	2507	2497	2609	2537.7	2598	2574	2553	2575.0
3	2.30	2866	2773	2785	2808.0	2789	2769	2741	2766.3
4	3.84	2984	2938	3003	2975.0	2978	3093	3004	3025.0
Center	5.94	3116	3084	3103	3101.0	3093	3087	3065	3081.7
5	8.04	3120	3120	3133	3124.3	3031	3067	3018	3038.7
6	9.57	3053	3085	3062	3066.7	2971	3027	2956	2984.7
7	10.63	2903	2929	2984	2938.7	2739	2865	2741	2781.7
8	11.38	2804	2677	2730	2737.0	2604	2661	2528	2597.7
Averages ---->		2839.4	2817.3	2852.6	2836.4	2797.7	2821.6	2769.1	2796.1

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	2816.3		Mean	2935.9	2893.3	2914.6
Min Point	2239.7	-20.5%	Std. Dev.	206.7	188.1	191.1
Max Point	3124.3	10.9%	COV as %	7.0	6.5	6.6

Flow w/o C-Pt	2162 scfm	Instuments Used:	Cal Due
Vel Avg w/o C-Pt	2782 sfpm	Fisher Scientific Barometer SN 90936818	12/07/12
		TSI VelociCalc SN T95351203001	12/17/2012

	Start	Finish	
Stack temp	50.3	48.6	F
Equipment temp	N/A	N/A	F
Ambient temp	58.9	47.3	F
Stack static	N/A	N/A	mbars
Ambient pressure	29.58	29.53	in Hg
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	62%	84%	RH



Notes

CA
3/27/2012

Entries made by:	CA, XY	Technical Data Review performed by:	Susan Sande
Signature/date	3/27/2012	Signature/date	7/13/2012
	On File w/ Original		On file with Original

VELOCITY TRAVERSE DATA FORM

Site	HV-S1 Model	Run No.	VT-6
Date	2/27/12	Fan Configuration	FAN B ONLY
Testers	XY, CA	Fan Setting	28 Hz
Stack Dia.	11.938 in.	Stack Temp	48 deg F
Stack X-Area	111.9 in.2	Start/End Time	1019/ 1030
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

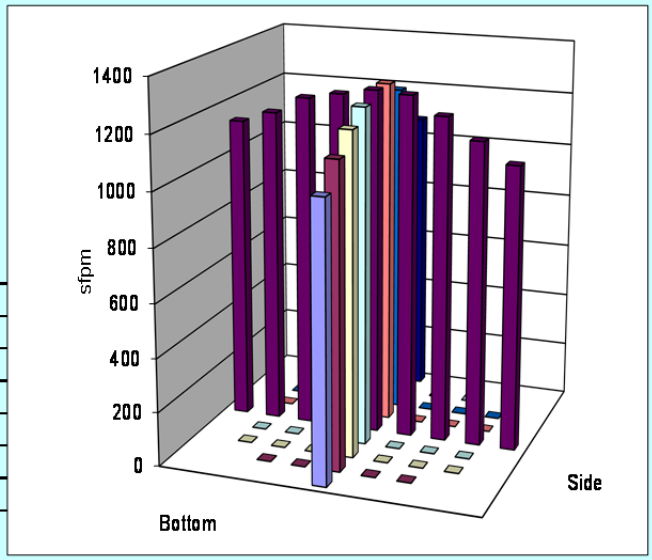
Order -->	2nd				1st			
Traverse-->	Side				Bottom			
Trial --->	1	2	3	Mean	1	2	3	Mean
Point / Depth, in.	Velocity				Velocity			
1 / 0.50	1023	981	1007	1003.7	1026	1020	1042	1029.3
2 / 1.25	1090	1067	1071	1076.0	1110	1149	1121	1126.7
3 / 2.30	1168	1135	1150	1151.0	1199	1192	1210	1200.3
4 / 3.84	1217	1215	1214	1215.3	1240	1260	1260	1253.3
Center / 5.94	1243	1216	1212	1223.7	1282	1288	1294	1288.0
5 / 8.04	1200	1201	1204	1201.7	1271	1288	1301	1286.7
6 / 9.57	1183	1198	1156	1179.0	1242	1224	1250	1238.7
7 / 10.63	1120	1108	1127	1118.3	1165	1171	1171	1169.0
8 / 11.38	1076	1079	1081	1078.7	1078	1070	1070	1072.7
Averages ---->	1146.7	1133.3	1135.8	1138.6	1179.2	1184.7	1191.0	1185.0

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	1161.8		Mean	1166.4	1223.2	1194.8
Min Point	1003.7	-13.6%	Std. Dev.	54.5	60.8	62.8
Max Point	1288.0	10.9%	COV as %	4.7	5.0	5.3

Flow w/o C-Pt	894	scfm	
Vel Avg w/o C-Pt	1150	sfpm	

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012

	Start	Finish	
Stack temp	47.8	47.6	F
Equipment temp	N/A	N/A	F
Ambient temp	47.3	48.2	F
Stack static	N/A	N/A	mbars
Ambient pressure	29.53	29.53	in Hg
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	85%	83%	RH



Notes

CA
3/27/2012

Entries made by:	CA, XY	Technical Data Review performed by:	Susan Sande
Signature/date	3/27/2012	Signature/date	7/13/2012
	On File w/ Original		On file with Original

VELOCITY TRAVERSE DATA FORM

Site	HV-S1 Model	Run No.	VT-7
Date	2/27/12	Fan Configuration	FAN B ONLY
Testers	XY, CA	Fan Setting	28 Hz
Stack Dia.	11.938 in.	Stack Temp	49 deg F
Stack X-Area	111.9 in.2	Start/End Time	1040/ 1115
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

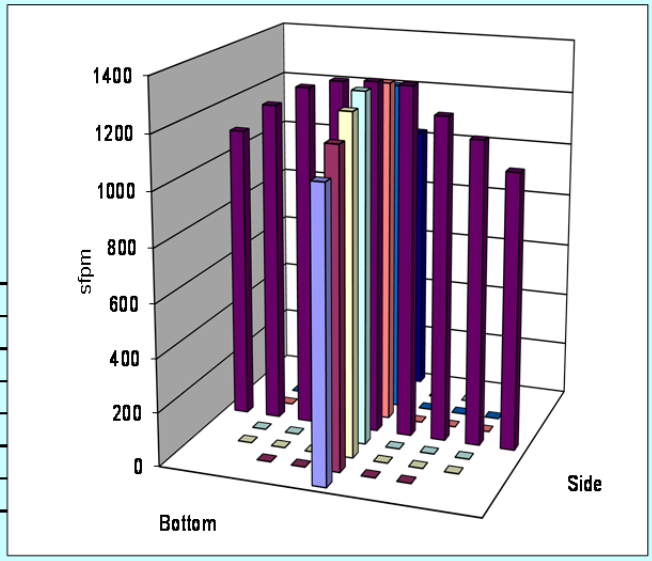
Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	1032	1007	995	1011.3	1074	1116	1047	1079.0
2	1.25	1116	1112	1115	1114.3	1136	1214	1182	1177.3
3	2.30	1210	1164	1191	1188.3	1247	1298	1242	1262.3
4	3.84	1274	1328	1257	1286.3	1314	1317	1293	1308.0
Center	5.94	1297	1285	1293	1291.7	1319	1318	1313	1316.7
5	8.04	1290	1283	1280	1284.3	1276	1294	1293	1287.7
6	9.57	1258	1261	1239	1252.7	1264	1235	1261	1253.3
7	10.63	1173	1175	1191	1179.7	1171	1149	1187	1169.0
8	11.38	1079	1068	1079	1075.3	1049	1008	1002	1019.7
Averages ---->		1192.1	1187.0	1182.2	1187.1	1205.6	1216.6	1202.2	1208.1

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	1197.6		Mean	1228.2	1253.5	1240.8
Min Point	1011.3	-15.6%	Std. Dev.	68.4	59.4	62.9
Max Point	1316.7	9.9%	COV as %	5.6	4.7	5.1

Flow w/o C-Pt	921	scfm
Vel Avg w/o C-Pt	1184	sfpm

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012

	Start	Finish	
Stack temp	48.3	49.9	F
Equipment temp	N/A	N/A	F
Ambient temp	49	50.9	F
Stack static	N/A	N/A	mbars
Ambient pressure	29.53	29.50	in Hg
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	80%	75%	RH



Notes

CA
3/27/2012

Entries made by:	CA, XY	Technical Data Review performed by:	Susan Sande
Signature/date	3/27/2012	Signature/date	7/13/2012
	On File w/ Original		On file with Original

VELOCITY TRAVERSE DATA FORM

Site	HV-S1 Model	Run No.	VT-8
Date	3/27/12	Fan Configuration	FAN B ONLY
Testers	CA, XY	Fan Setting	28 Hz
Stack Dia.	11.938 in.	Stack Temp	51 deg F
Stack X-Area	111.9 in.2	Start/End Time	1120/ 1135
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	1051	1002	1039	1030.7	1049	1055	1088	1064.0
2	1.25	1170	1138	1199	1169.0	1150	1211	1146	1169.0
3	2.30	1260	1265	1262	1262.3	1268	1263	1250	1260.3
4	3.84	1289	1291	1298	1292.7	1279	1302	1316	1299.0
Center	5.94	1324	1313	1308	1315.0	1311	1313	1319	1314.3
5	8.04	1298	1316	1219	1277.7	1327	1213	1299	1279.7
6	9.57	1273	1243	1275	1263.7	1254	1256	1256	1255.3
7	10.63	1189	1216	1996	1467.0	1161	1141	1140	1147.3
8	11.38	1059	1082	1055	1065.3	1064	1042	1042	1049.3
Averages ------>		1212.6	1207.3	1294.6	1238.1	1207.0	1199.6	1206.2	1204.3

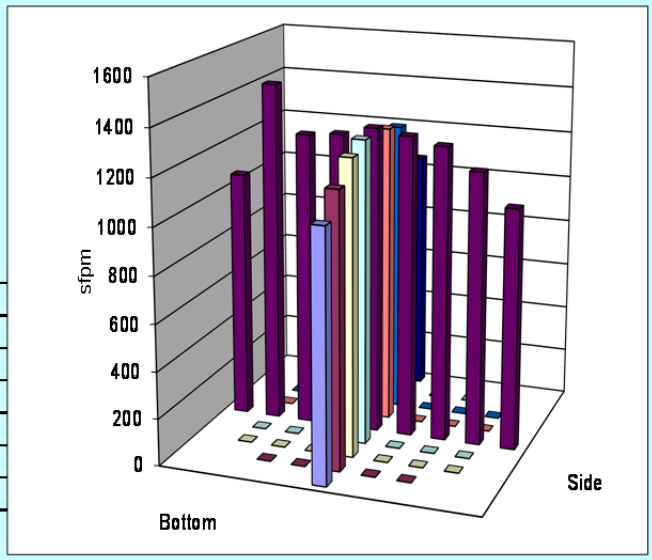
All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	1221.2		Mean	1292.5	1246.4	1269.5
Min Point	1030.7	-15.6%	Std. Dev.	89.6	64.0	78.5
Max Point	1467.0	20.1%	COV as %	6.9	5.1	6.2

Flow w/o C-Pt 940 scfm
Vel Avg w/o C-Pt 1210 sfpm

Instuments Used:

	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012

	Start	Finish	
Stack temp	50.8	51.8	F
Equipment temp	N/A	N/A	F
Ambient temp	52.7	53.6	F
Stack static	N/A	N/A	mbars
Ambient pressure	29.50	29.50	in Hg
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	70%	65%	RH



Notes

CA
3/27/2012

Entries made by:	CA, XY	Technical Data Review performed by:	Susan Sande
Signature/date	3/27/2012	Signature/date	7/13/2012
	On File w/ Original		On file with Original

VELOCITY TRAVERSE DATA FORM

Site	HV-S1 Model	Run No.	VT-9
Date	3/27/12	Fan Configuration	FAN B ONLY
Testers	XY, CA	Fan Setting	55 Hz
Stack Dia.	11.938 in.	Stack Temp	54 deg F
Stack X-Area	111.9 in.2	Start/End Time	1140/ 1200
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

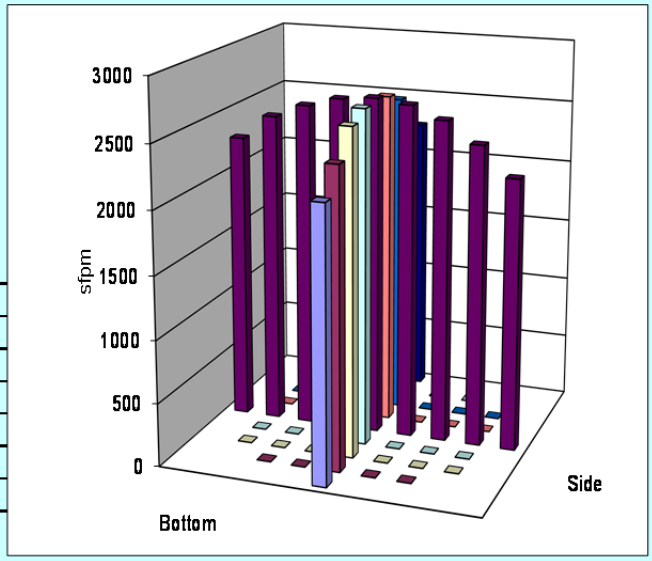
Order -->	1st				2nd			
Traverse-->	Side				Bottom			
Trial --->	1	2	3	Mean	1	2	3	Mean
Point / Depth, in.	Velocity				Velocity			
1 / 0.50	2092	2103	2143	2112.7	2182	2148	2159	2163.0
2 / 1.25	2302	2405	2323	2343.3	2349	2369	2406	2374.7
3 / 2.30	2496	2513	2511	2506.7	2549	2604	2629	2594.0
4 / 3.84	2590	2613	2605	2602.7	2677	2652	2681	2670.0
Center / 5.94	2641	2629	2638	2636.0	2720	2647	2714	2693.7
5 / 8.04	2603	2609	2619	2610.3	2619	2651	2681	2650.3
6 / 9.57	2541	2539	2538	2539.3	2551	2566	2599	2572.0
7 / 10.63	2433	2456	2417	2435.3	2396	2421	2493	2436.7
8 / 11.38	2181	2270	2280	2243.7	2258	2250	2228	2245.3
Averages ---->	2431.0	2459.7	2452.7	2447.8	2477.9	2478.7	2510.0	2488.9

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	2468.3		Mean	2524.8	2570.2	2547.5
Min Point	2112.7	-14.4%	Std. Dev.	105.8	121.3	111.9
Max Point	2693.7	9.1%	COV as %	4.2	4.7	4.4

Flow w/o C-Pt	1900	scfm	
Vel Avg w/o C-Pt	2444	sfpm	

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012

	Start	Finish	
Stack temp	53.1	55	F
Equipment temp	N/A	N/A	F
Ambient temp	55.4	56.3	F
Stack static	N/A	N/A	mbars
Ambient pressure	29.53	29.50	in Hg
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	63%	56%	RH



Notes

CA
3/27/2012

Entries made by:	CA, XY	Technical Data Review performed by:	Susan Sande
Signature/date	3/27/2012	Signature/date	7/13/2012
	On File w/ Original		On file with Original

VELOCITY TRAVERSE DATA FORM

Site	HV-S1 Model	Run No.	VT-10
Date	3/27/12	Fan Configuration	FAN B ONLY
Testers	CA, XY	Fan Setting	55 Hz
Stack Dia.	11.938 in.	Stack Temp	56 deg F
Stack X-Area	111.9 in.2	Start/End Time	1205/ 1230
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

Order -->	2nd				1st			
Traverse-->	Side				Bottom			
Trial --->	1	2	3	Mean	1	2	3	Mean
Point / Depth, in.	Velocity				Velocity			
1 / 0.50	2187	2129	2044	2120.0	2107	2125	2139	2123.7
2 / 1.25	2390	2367	2382	2379.7	2419	2418	2379	2405.3
3 / 2.30	2620	2635	2578	2611.0	2569	2514	2568	2550.3
4 / 3.84	2826	2800	2733	2786.3	2658	2625	2669	2650.7
Center / 5.94	2938	2886	2863	2895.7	2630	2669	2703	2667.3
5 / 8.04	2934	2874	2812	2873.3	2585	2602	2656	2614.3
6 / 9.57	2832	2779	2778	2796.3	2531	2539	2558	2542.7
7 / 10.63	2667	2594	2641	2634.0	2407	2364	2426	2399.0
8 / 11.38	2525	2486	2466	2492.3	2193	2171	2264	2209.3
Averages ---->	2657.7	2616.7	2588.6	2621.0	2455.4	2447.4	2484.7	2462.5

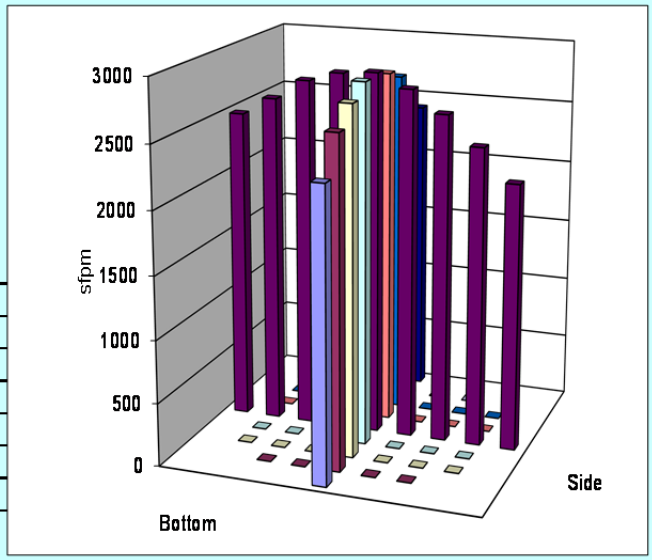
All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	2541.7		Mean	2710.9	2547.1	2629.0
Min Point	2120.0	-16.6%	Std. Dev.	182.2	109.4	167.5
Max Point	2895.7	13.9%	COV as %	6.7	4.3	6.4

Flow w/o C-Pt 1952 scfm
Vel Avg w/o C-Pt 2512 sfpm

Instuments Used:

	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012

	Start	Finish	
Stack temp	54.8	57.3	F
Equipment temp	N/A	N/A	F
Ambient temp	57.2	60.8	F
Stack static	N/A	N/A	mbars
Ambient pressure	29.50	29.47	in Hg
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	53%	48%	RH



Notes

CA
3/27/2012

Entries made by:	CA, XY	Technical Data Review performed by:	Susan Sande
Signature/date	3/27/2012	Signature/date	7/13/2012
	On File w/ Original		On file with Original

VELOCITY TRAVERSE DATA FORM

Site	HV-S1 Model	Run No.	VT-11
Date	3/27/12	Fan Configuration	FAN B ONLY
Testers	CA, EA	Fan Setting	55 Hz
Stack Dia.	11.938 in.	Stack Temp	59 deg F
Stack X-Area	111.9 in.2	Start/End Time	1354/ 1415
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

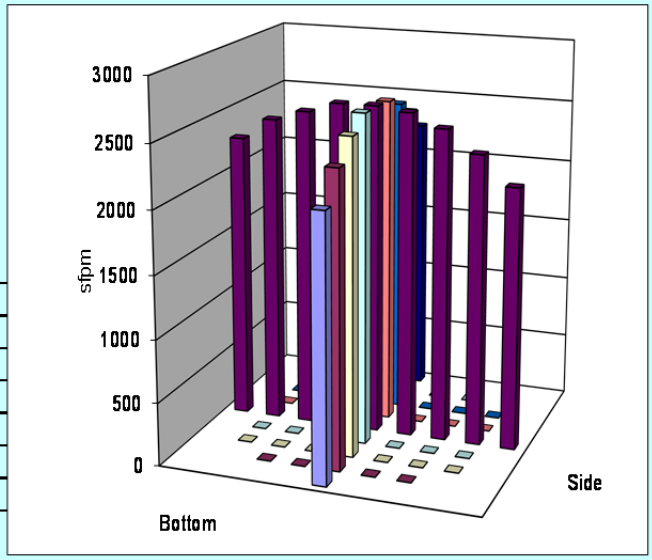
Order -->	1st				2nd			
Traverse-->	Side				Bottom			
Trial --->	1	2	3	Mean	1	2	3	Mean
Point / Depth, in.	Velocity				Velocity			
1 / 0.50	2067	2082	2117	2088.7	2026	2140	2111	2092.3
2 / 1.25	2349	2338	2270	2319.0	2325	2338	2341	2334.7
3 / 2.30	2469	2512	2500	2493.7	2521	2505	2493	2506.3
4 / 3.84	2564	2612	2619	2598.3	2645	2627	2592	2621.3
Center / 5.94	2621	2619	2658	2632.7	2637	2610	2614	2620.3
5 / 8.04	2622	2631	2632	2628.3	2608	2610	2578	2598.7
6 / 9.57	2518	2548	2567	2544.3	2542	2502	2522	2522.0
7 / 10.63	2457	2452	2470	2459.7	2390	2402	2422	2404.7
8 / 11.38	2255	2290	2320	2288.3	2255	2212	2213	2226.7
Averages ---->	2435.8	2453.8	2461.4	2450.3	2438.8	2438.4	2431.8	2436.3

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	2443.3		Mean	2525.1	2515.4	2520.3
Min Point	2088.7	-14.5%	Std. Dev.	112.3	111.2	107.5
Max Point	2632.7	7.7%	COV as %	4.4	4.4	4.3

Flow w/o C-Pt	1881	scfm	
Vel Avg w/o C-Pt	2420	sfpm	

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012

	Start	Finish	
Stack temp	59	58	F
Equipment temp	N/A	N/A	F
Ambient temp	59.9	59	F
Stack static	N/A	N/A	mbars
Ambient pressure	29.44	29.44	in Hg
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	46%	50%	RH



Notes

CA
3/27/2012

Entries made by:	CA, EA	Technical Data Review performed by:	Susan Sande
Signature/date	3/27/2012	Signature/date	7/13/2012
	On File w/ Original		On file with Original

VELOCITY TRAVERSE DATA FORM

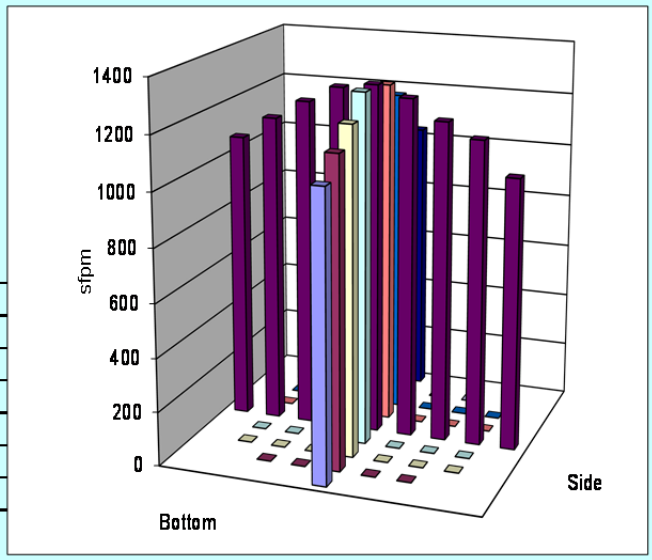
Site	HV-S1 Model	Run No.	VT-12
Date	3/27/12	Fan Configuration	FAN B ONLY
Testers	CA, EA	Fan Setting	28 Hz
Stack Dia.	11.938 in.	Stack Temp	57 deg F
Stack X-Area	111.9 in.2	Start/End Time	1418/ 1440
Test Port	1	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	300 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	1024	973	1027	1008.0	1041	1082	1077	1066.7
2	1.25	1121	1142	1141	1134.7	1142	1155	1148	1148.3
3	2.30	1183	1185	1202	1190.0	1182	1252	1230	1221.3
4	3.84	1269	1252	1271	1264.0	1294	1318	1313	1308.3
Center	5.94	1311	1291	1312	1304.7	1291	1331	1306	1309.3
5	8.04	1289	1289	1281	1286.3	1288	1283	1282	1284.3
6	9.57	1242	1211	1223	1225.3	1247	1208	1205	1220.0
7	10.63	1154	1145	1163	1154.0	1139	1153	1129	1140.3
8	11.38	1084	1066	1066	1072.0	1030	1040	1028	1032.7
Averages ------>		1186.3	1172.7	1187.3	1182.1	1183.8	1202.4	1190.9	1192.4

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	1187.2		Mean	1222.7	1233.1	1227.9
Min Point	1008.0	-15.1%	Std. Dev.	65.9	70.9	66.0
Max Point	1309.3	10.3%	COV as %	5.4	5.8	5.4

Flow w/o C-Pt	911 scfm	
Vel Avg w/o C-Pt	1172 sfpm	
Instuments Used:		Cal Due
Fisher Scientific Barometer SN 90936818		12/07/12
TSI VelociCalc SN T95351203001		12/17/2012

	Start	Finish	
Stack temp	57.2	57	F
Equipment temp	N/A	N/A	F
Ambient temp	58.1	58.1	F
Stack static	N/A	N/A	mbars
Ambient pressure	29.44	29.44	in Hg
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	50%	52%	RH



Notes

CA
3/27/2012

Entries made by:	EA, CA	Technical Data Review performed by:	Susan Sande
Signature/date	3/27/2012	Signature/date	7/13/2012
	On File w/ Original		On file with Original

VELOCITY TRAVERSE DATA FORM

Site	HV-S1 Model	Run No.	VT-13
Date	3/28/12	Fan Configuration	Fan A Only
Testers	YFS, EA	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	67 deg F
Stack X-Area	111.9 in.2	Start/End Time	1330 / 1413
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	2234	2201	2262	2232.3	2236	2231	2223	2230.0
2	1.25	2459	2412	2455	2442.0	2500	2475	2461	2478.7
3	2.30	2568	2632	2637	2612.3	2542	2590	2602	2578.0
4	3.84	2617	2656	2662	2645.0	2440	2658	2613	2570.3
Center	5.94	2679	2646	2668	2664.3	2611	2606	2613	2610.0
5	8.04	2697	2660	2681	2679.3	2564	2570	2574	2569.3
6	9.57	2600	2641	2654	2631.7	2516	2546	2563	2541.7
7	10.63	2544	2570	2555	2556.3	2464	2469	2501	2478.0
8	11.38	2365	2328	2415	2369.3	2330	2249	2303	2294.0
Averages ---->		2529.2	2527.3	2554.3	2537.0	2467.0	2488.2	2494.8	2483.3

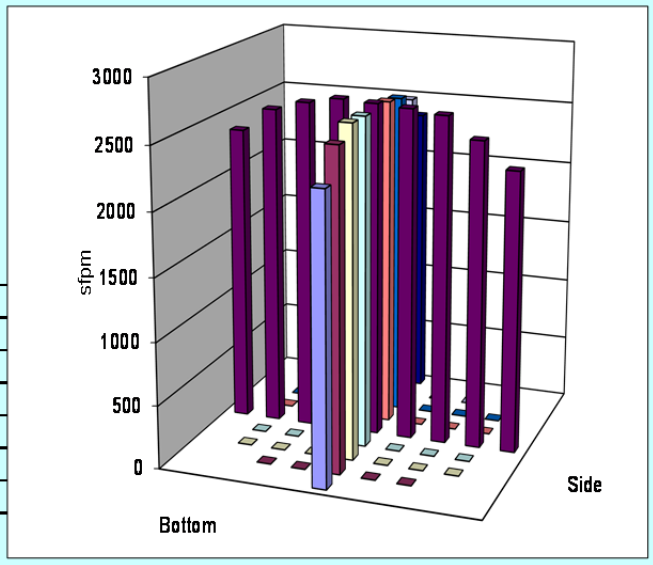
All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	2510.1		Mean	2604.4	2546.6	2575.5
Min Point	2230.0	-11.2%	Std. Dev.	82.0	50.7	72.1
Max Point	2679.3	6.7%	COV as %	3.1	2.0	2.8

Flow w/o C-Pt	1939	scfm
Vel Avg w/o C-Pt	2494	sfpm

Instuments Used:

	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012

	Start	Finish	
Stack temp	66.7	67.6	F
Equipment temp	N/A	N/A	F
Ambient temp	70	77	F
Stack static	N/A	N/A	mbars
Ambient pressure	29.47	29.47	in Hg
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	26%	24%	RH



Notes: Barometer in direct sun. Overcast skies.

EA
3/28/2012

Entries made by:	EA, YFS	Technical Data Review performed by:	Susan Sande
Signature/date	3/28/2012	Signature/date	7/13/2012
	On File w/ Original		On file with Original

VELOCITY TRAVERSE DATA FORM

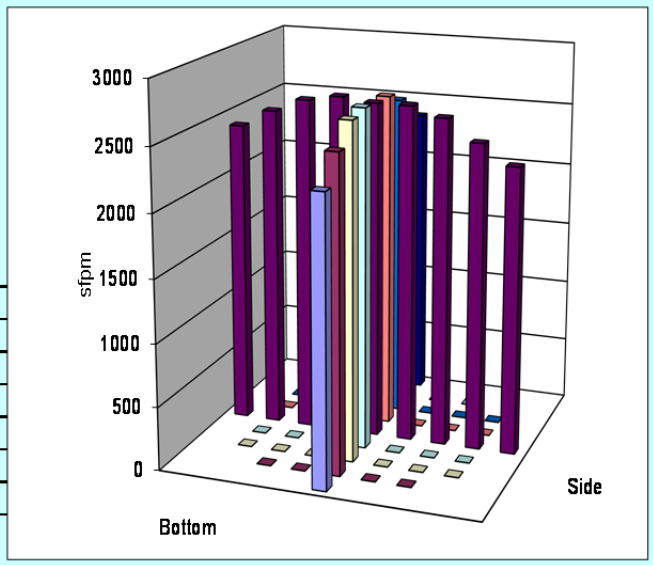
Site	HV-S1 Model	Run No.	VT-14
Date	3/28/12	Fan Configuration	Fan A Only
Testers	YFS EA	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	67 deg F
Stack X-Area	111.9 in.2	Start/End Time	1415 / 1441
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	2293	2260	2226	2259.7	2231	2270	2291	2264.0
2	1.25	2463	2393	2391	2415.7	2479	2507	2477	2487.7
3	2.30	2585	2608	2563	2585.3	2662	2675	2646	2661.0
4	3.84	2689	2686	2606	2660.3	2695	2711	2685	2697.0
Center	5.94	2661	2682	2637	2660.0	2678	2668	2680	2675.3
5	8.04	2689	2716	2667	2690.7	2655	2692	2674	2673.7
6	9.57	2643	2682	2610	2645.0	2565	2594	2608	2589.0
7	10.63	2526	2532	2557	2538.3	2524	2466	2495	2495.0
8	11.38	2456	2346	2401	2401.0	2330	2364	2354	2349.3
Averages ---->		2556.1	2545.0	2517.6	2539.6	2535.4	2549.7	2545.6	2543.6

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	2541.6		Mean	2599.3	2611.2	2605.3
Min Point	2259.7	-11.1%	Std. Dev.	96.2	88.6	89.0
Max Point	2697.0	6.1%	COV as %	3.7	3.4	3.4

Flow w/o C-Pt	1963 scfm	Instuments Used:	Cal Due
Vel Avg w/o C-Pt	2526 sfpm	Fisher Scientific Barometer SN 90936818	12/07/12
		TSI VelociCalc SN T95351203001	12/17/2012

	Start	Finish	
Stack temp	66.9	66.6	F
Equipment temp	N/A	N/A	F
Ambient temp	77.9	76.1	F
Stack static	N/A	N/A	mbars
Ambient pressure	29.47	29.47	in Hg
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	23%	23%	RH



Notes: Overcast skies. Getting windy.

EA
3/28/2012

Entries made by:	EA	Technical Data Review performed by:	Susan Sande
Signature/date	3/28/2012	Signature/date	7/13/2012
	On File w/ Original		On file with Original

VELOCITY TRAVERSE DATA FORM

Site	HV-S1 Model	Run No.	VT-15
Date	4/5/12	Fan Configuration	Fan A Only
Testers	JEF/XY	Fan Setting	55 Hz
Stack Dia.	11.938 in.	Stack Temp	62 deg F
Stack X-Area	111.9 in.2	Start/End Time	1119/ 1139
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	1921	1998	2005	1974.7	2127	2120	2094	2113.7
2	1.25	2261	2247	2177	2228.3	2308	2299	2299	2302.0
3	2.30	2424	2394	2441	2419.7	2489	2471	2495	2485.0
4	3.84	2524	2538	2469	2510.3	2474	2445	2509	2476.0
Center	5.94	2435	2471	2445	2450.3	2428	2455	2461	2448.0
5	8.04	2395	2450	2420	2421.7	2405	2441	2406	2417.3
6	9.57	2354	2386	2359	2366.3	2359	2346	2337	2347.3
7	10.63	2312	2246	2269	2275.7	2249	2234	2220	2234.3
8	11.38	2134	2167	2143	2148.0	2044	2090	2066	2066.7
Averages ---->		2306.7	2321.9	2303.1	2310.6	2320.3	2322.3	2320.8	2321.1

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	2315.9		Mean	2381.8	2387.1	2384.5
Min Point	1974.7	-14.7%	Std. Dev.	99.4	95.1	93.5
Max Point	2510.3	8.4%	COV as %	4.2	4.0	3.9

Flow w/o C-Pt 1787 scfm

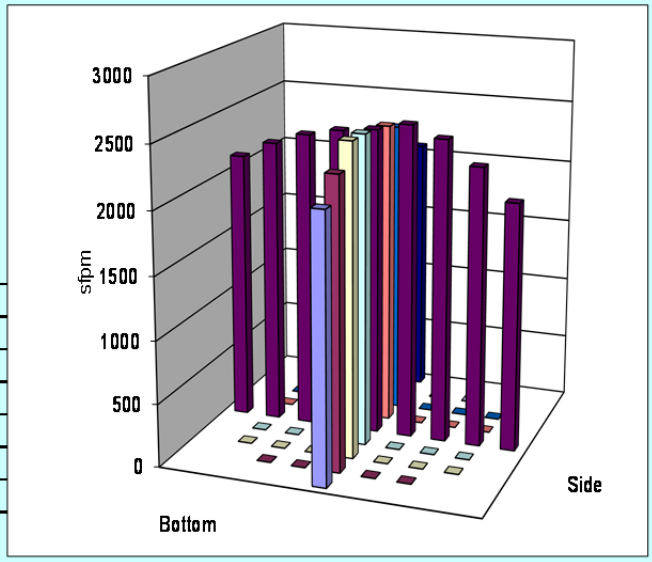
Vel Avg w/o C-Pt 2299 sfpm

Instuments Used:

	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012

JF 4/5/12

	Start	Finish	
Stack temp	61.7	62	F
Equipment temp	N/A	N/A	F
Ambient temp	71	67.1	F
Stack static	N/A	N/A	mbars
Ambient pressure	29.74	29.74	in Hg
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	24%	25%	RH



Notes: Light winds.
Warming up aerosol generator during test. Shut off after complete.

JF
4/5/2012

Entries made by:	JEF, XY
Signature/date	4/5/2012
Technical Data Review performed by:	Susan Sande
Signature/date	7/13/2012
	On file with Original

VELOCITY TRAVERSE DATA FORM

Site	HV-S1 Model	Run No.	VT-16
Date	4/5/12	Fan Configuration	Fan A Only
Testers	JEF, XY	Fan Setting	55 Hz
Stack Dia.	11.938 in.	Stack Temp	62 deg F
Stack X-Area	111.9 in.2	Start/End Time	1140 / 1155
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	1938	2101	2057	2032.0	2015	2118	2082	2071.7
2	1.25	2194	2261	2265	2240.0	2278	2287	2234	2266.3
3	2.30	2344	2381	2348	2357.7	2486	2434	2409	2443.0
4	3.84	2552	2475	2446	2491.0	2469	2436	2459	2454.7
Center	5.94	2457	2446	2455	2452.7	2426	2461	2423	2436.7
5	8.04	2421	2402	2417	2413.3	2408	2405	2368	2393.7
6	9.57	2333	2383	2356	2357.3	2349	2377	2307	2344.3
7	10.63	2288	2316	2330	2311.3	2248	2235	2259	2247.3
8	11.38	2091	2129	2197	2139.0	2017	2059	2058	2044.7
Averages ---->		2290.9	2321.6	2319.0	2310.5	2299.6	2312.4	2288.8	2300.3

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	2305.4		Mean	2374.8	2369.4	2372.1
Min Point	2032.0	-11.9%	Std. Dev.	85.5	85.6	82.2
Max Point	2491.0	8.1%	COV as %	3.6	3.6	3.5

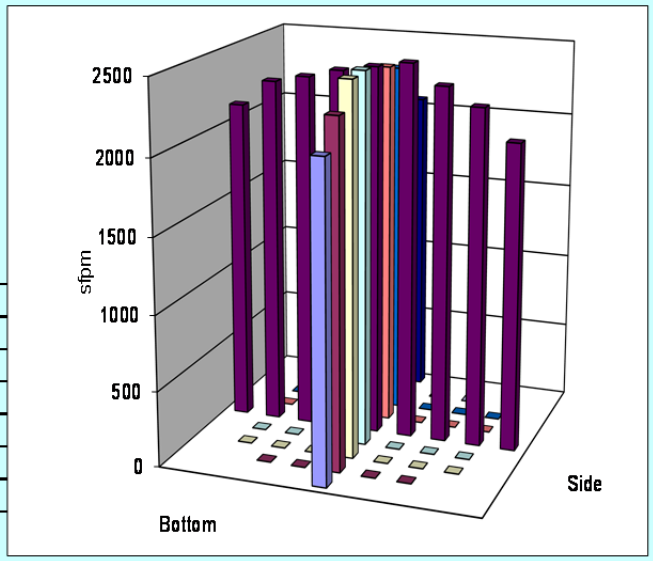
Flow w/o C-Pt 1778 scfm
Vel Avg w/o C-Pt 2288 sfpm

Instuments Used:

	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012

JF 4/5/12

	Start	Finish	
Stack temp	62	61.1	F
Equipment temp	N/A	N/A	F
Ambient temp	65.3	65.3	F
Stack static	N/A	N/A	mbars
Ambient pressure	29.74	29.74	in Hg
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	24%	25%	RH



Notes: Light winds.

JF
4/5/2012

Entries made by:	JF, XY
Signature/date	4/5/2012
Technical Data Review performed by:	Susan Sande
Signature/date	7/13/2012
	On file with Original

A.3 HV-S1 Flow Angle Data Sheets

FLOW ANGLE DATA FORM HV-S1_FlowAngle.xls

Site	HV-S1 scale model	Run No.	FA-1
Date	3/28/2012	Fan Setting	60 Hz
Tester	CA, XY	Fan configuration	Fan A only
Stack Dia.	11.938 in	Approx. air vel.	2698 sfpm at point >> 1 bottom 7, XY3/28/12
Stack X-Area	111.9 in2	Units	degrees (clockwise > pos. nos.)
Elevation	N.A. ft	Port	2
Distance to disturbance	240 in	Stack Temp	63.5 °F
Start/End Time	10:15/11:00		

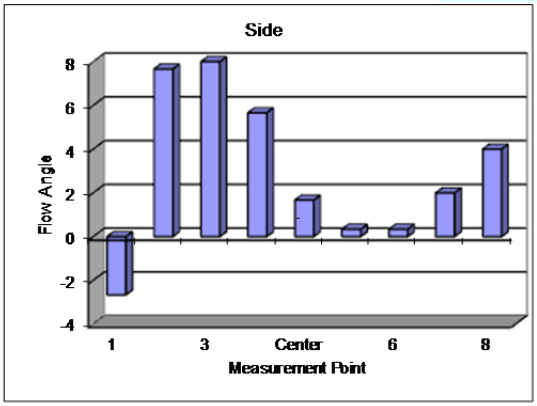
Order -->	2nd				1st			
Traverse-->	Side				Bottom			
Trial -->	1	2	3		1	2	3	
Point	Depth, in.	deg. cw	deg. cw	deg. cw	Avg.	deg. cw	deg. cw	deg. cw	Avg.
1	0.50	-3	-4	-1	-2.7	-6	-5	-4	-5.0
2	1.25	7	8	8	7.7	-7	-6	-7	-6.7
3	2.30	8	8	8	8.0	-7	-6	-6	-6.3
4	3.84	5	6	6	5.7	-2	-2	-3	-2.3
Center	5.94	2	0	3	1.7	-2	2	-1	-0.3
5	8.04	0	0	1	0.3	2	1	2	1.7
6	9.57	1	0	0	0.3	-1	0	-1	-0.7
7	10.63	2	1	3	2.0	-1	-2	-2	-1.7
8	11.38	4	4	4	4.0	-4	-2	-5	-3.7
Mean of absolute values:					3.6				3.1
" " w/o points by wall:					3.7				2.8
								Grand mean ABS	3.4
								" " w/o wall pts	3.2

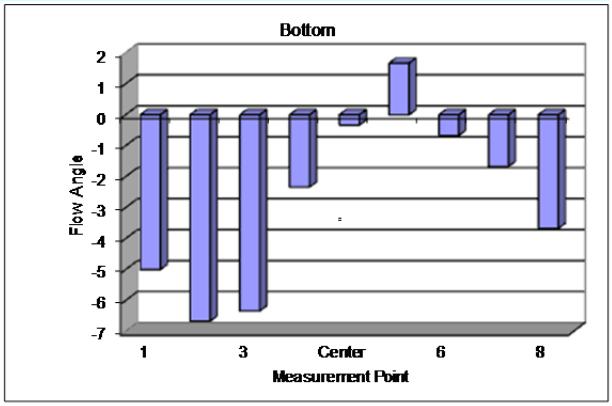
Instruments Used:			Cal. Due
S-type pitot	Dwyer 24-inch S-type Pitot#10		Cert. of conformance
Velocity sensor	TSI Velocicalc SN#T95351203001		17-Dec-12
Angle indicator	Shop built		Cat. 3
Manometer	Dwyer 400-5, S36N	MAN-5	Cat. 3
Fisher Scientific	S/N 90936818		12/7/2012

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: 2586 fpm, 66.3 F. This were the ending conditions.

CA 3/28/12





Entries made by:	XY, CA	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	3/28/2012	Signature/date	6/27/2012
	on file w/original		On file with original

FLOW ANGLE DATA FORM

HV-S1_FlowAngle.xls

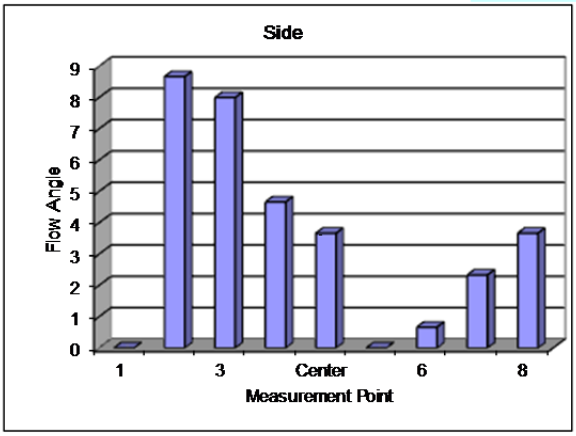
Site	HV-S1 scale model	Run No.	FA-2
Date	3/28/2012	Fan Setting	28 Hz
Tester	XY, CA	Fan configuration	Fan A only
Stack Dia.	11.938 in	Approx. air vel.	1141 sfpm at point >> 1 bottom 7
Stack X-Area	111.9 in2	Units	degrees (clockwise > pos. nos. XY 3/28/12
Elevation	N.A. ft	Port	2
Distance to disturbance	240 in	Stack Temp	62.7 °F
Start/End Time	11:02/11:50		

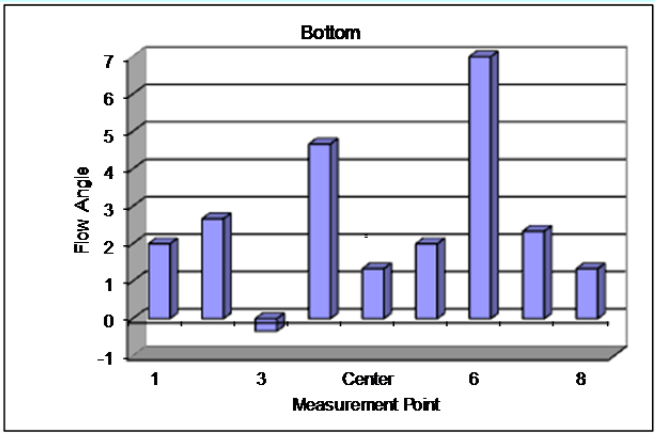
Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3		1	2	3	
Point	Depth, in.	deg. cw	deg. cw	deg. cw	Avg.	deg. cw	deg. cw	deg. cw	Avg.
1	0.50	2	-2	0	0.0	7	5	-6	2.0
2	1.25	8	9	9	8.7	7	5	-4	2.7
3	2.30	8	8	8	8.0	12	-7	-6	-0.3
4	3.84	-3	9	8	4.7	17	-2	-1	4.7
Center	5.94	0	5	6	3.7	-3	1	6	1.3
5	8.04	2	-2	0	0.0	-3	5	4	2.0
6	9.57	1	0	1	0.7	5	7	9	7.0
7	10.63	1	4	2	2.3	-3	6	4	2.3
8	11.38	3	4	4	3.7	2	-1	3	1.3
Mean of absolute values:					3.5				2.6
" "w/o points by wall:					4.0				2.9
								Grand mean ABS	3.1
								" "w/o wall pts	3.5

Instruments Used:			Cal. Due
S-type pitot	Dwyer 24-inch S-type Pitot#10		Cert. of conformance
Velocity sensor	TSI Velocicalc SN#T95351203001		17-Dec-12
Angle indicator	Shop built		Cat. 3
Manometer	Dwyer 400-5, S36N	MAN-5	Cat. 3
Fisher Scientific	S/N 90936818		12/7/2012

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:
XY 3/28/12





Entries made by:	CA, XY	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	*on file w/ original* 3/28/2012	Signature/date	6/27/2012 On file with original

FLOW ANGLE DATA FORM

HV-S1_FlowAngle.xls

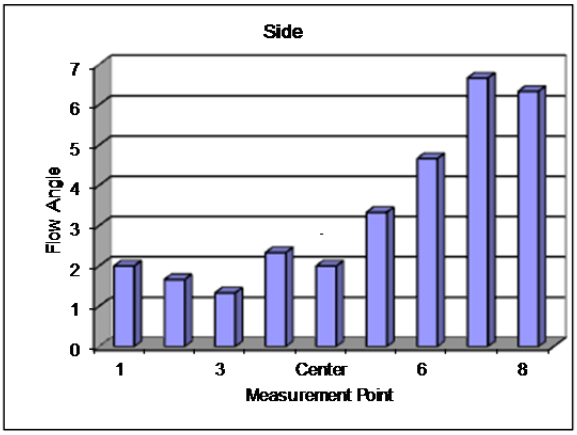
Site	HV-S1 scale model	Run No.	FA-3
Date	3/28/2012	Fan Setting	60 Hz
Tester	CA, XY	Fan configuration	B only
Stack Dia.	11.938 in	Approx. air vel.	2824 sfpm at point >> 1 side 7
Stack X-Area	111.9 in2	Units	degrees (clockwise > pos. nos.)
Elevation	N.A. ft	Port	2
Distance to disturbance	240 in	Stack Temp	66.1 °F
Start/End Time	12:00/12:45		

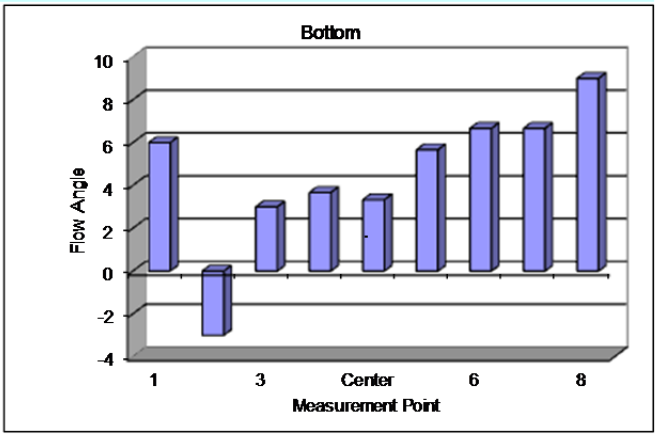
Order -->	2nd				1st			
Traverse-->	Side				Bottom			
Trial -->	1	2	3		1	2	3	
Point	Depth, in.	deg. cw	deg. cw	deg. cw	Avg.	deg. cw	deg. cw	deg. cw	Avg.
1	0.50	6	-1	1	2.0	9	3	6	6.0
2	1.25	1	2	2	1.7	1	1	-11	-3.0
3	2.30	1	2	1	1.3	2	3	4	3.0
4	3.84	1	3	3	2.3	-3	7	7	3.7
Center	5.94	0	3	3	2.0	5	1	4	3.3
5	8.04	4	3	3	3.3	7	4	6	5.7
6	9.57	5	5	4	4.7	7	6	7	6.7
7	10.63	8	6	6	6.7	8	5	7	6.7
8	11.38	6	6	7	6.3	9	9	9	9.0
Mean of absolute values:					3.4				5.2
" " w/o points by wall:					3.1				4.6
								Grand mean ABS	4.3
								" " w/o wall pts	3.9

Instruments Used:			Cal. Due
S-type pitot	Dwyer 24-inch S-type Pitot#10		Cert. of conformance
Velocity sensor	TSI Velocicalc SN#T95351203001		17-Dec-12
Angle indicator	Shop built		Cat. 3
Manometer	Dwyer 400-5, S36N	MAN-5	Cat. 3
Fisher Scientific	S/N 90936818		12/7/2012

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:
XY 3/28/12





Entries made by:	XY, CA		Technical Data Review performed by:	Elizabeth Golovich
Signature/date	*on file w/ original*	3/28/2012	Signature/date	6/27/2012 On file with original

FLOW ANGLE DATA FORM

HV-S1_FlowAngle.xls

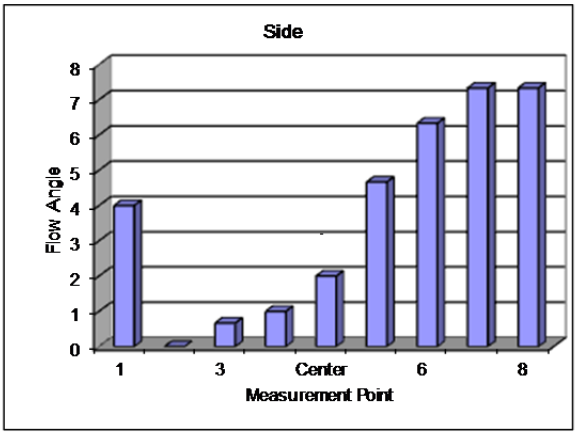
Site	HV-S1 scale model	Run No.	FA-4
Date	3/3/0/2012	Fan Setting	60 Hz
Tester	XY, JEF	Fan configuration	Fan B only
Stack Dia.	11.938 in	Approx. air vel.	2881 sfpm at point >> 1 side 7
Stack X-Area	111.9 in2	Units	degrees (clockwise > pos. nos.)
Elevation	N.A. ft	Port	2
Distance to disturbance	240 in	Stack Temp	55.5 °F
Start/End Time	10:50/11:30		

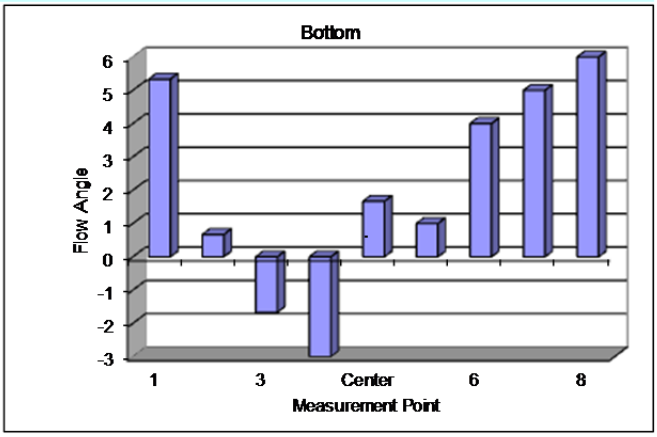
Order -->	2nd				1st			
Traverse-->	Side				Bottom			
Trial -->	1	2	3		1	2	3	
Point	Depth, in.	deg. cw	deg. cw	deg. cw	Avg.	deg. cw	deg. cw	deg. cw	Avg.
1	0.50	6	2	4	4.0	7	0	9	5.3
2	1.25	1	-1	0	0.0	-2	2	2	0.7
3	2.30	1	0	1	0.7	2	-9	2	-1.7
4	3.84	2	0	1	1.0	-4	0	-5	-3.0
Center	5.94	3	3	0	2.0	-2	2	5	1.7
5	8.04	5	5	4	4.7	-1	1	3	1.0
6	9.57	6	6	7	6.3	5	3	4	4.0
7	10.63	7	7	8	7.3	5	6	4	5.0
8	11.38	7	8	7	7.3	6	6	6	6.0
Mean of absolute values:					3.7				3.1
" " w/o points by wall:					3.1				2.4
								Grand mean ABS	3.4
								" " w/o wall pts	2.8

Instruments Used:			Cal. Due
S-type pitot	Dwyer 24-inch S-type Pitot#10		Cert. of conformance
Velocity sensor	TSI Velocicalc SN#T95351203001		17-Dec-12
Angle indicator	Shop built		Cat. 3
Manometer	Dwyer 400-5, S36N	MAN 5	Cat. 3
Fisher Scientific	S/N 90936818		12/7/2012

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: Equipment delays yesterday.
Redo today. Rainy, moderate winds (~15 mph).
XY 3/30/12





Entries made by:	JF	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	*on file w/ original* 3/30/2012	Signature/date	6/27/2012 On file with original

FLOW ANGLE DATA FORM

HV-S1_FlowAngle.xls

Site	HV-S1 scale model	Run No.	FA-5
Date	3/30/2012	Fan Setting	55 Hz
Tester	JEF, XY	Fan configuration	Fan B only
Stack Dia.	11.938 in	Approx. air vel.	2427 sfpm at point >>
Stack X-Area	111.9 in2	Units	degrees (clockwise > pos. nos.)
Elevation	N.A. ft	Port	2
Distance to disturbance	240 in	Stack Temp	55.3 °F
Start/End Time	11:30/12:00		

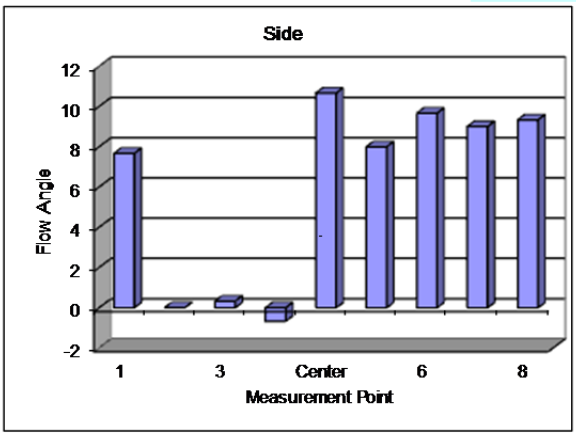
1side 7 JF 3/30/12

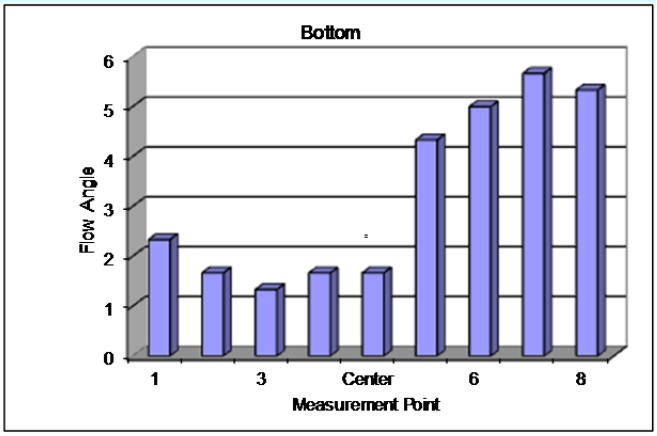
Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3		1	2	3	
Point	Depth, in.	deg. cw	deg. cw	deg. cw	Avg.	deg. cw	deg. cw	deg. cw	Avg.
1	0.50	8	7	8	7.7	-2	9	0	2.3
2	1.25	1	0	-1	0.0	1	2	2	1.7
3	2.30	1	-1	1	0.3	1	2	1	1.3
4	3.84	-1	-3	2	-0.7	2	2	1	1.7
Center	5.94	10	11	11	10.7	5	0	0	1.7
5	8.04	8	7	9	8.0	4	4	5	4.3
6	9.57	10	10	9	9.7	4	5	6	5.0
7	10.63	8	9	10	9.0	5	6	6	5.7
8	11.38	10	10	8	9.3	5	4	7	5.3
Mean of absolute values:					6.1				3.2
" "w/o points by wall:					5.5				3.0
								Grand mean ABS	4.7
								" "w/o wall pts	4.3

Instruments Used:			Cal. Due
S-type pitot	Dwyer 24-inch S-type Pitot#10		Cert. of conformance
Velocity sensor	TSI Velocicalc SN#T95351203001		17-Dec-12
Angle indicator	Shop built		Cat. 3
Manometer	Dwyer 400-5, S36N	MAN 5	Cat. 3
Fisher Scientific	S/N 90936818		12/7/2012

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: Side center takes a lot to get to zero, even though the oil level is pretty close.
XY 3/30/12





Entries made by:	XY	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	*on file w/ original* 3/30/2012	Signature/date	6/27/2012 On file with original

FLOW ANGLE DATA FORM

HV-S1_FlowAngle.xls

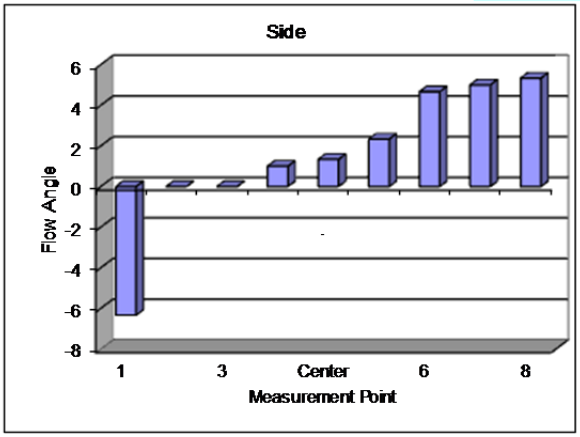
Site	HV-S1 scale model	Run No.	FA-6
Date	4/2/2012	Fan Setting	28 Hz
Tester	XY, CA	Fan configuration	FAN B ONLY
Stack Dia.	11.938 in	Approx. air vel.	1170 sfpm at point >> 1side 7 XY 4/2/12
Stack X-Area	111.9 in2	Units	degrees (clockwise > pos. nos.)
Elevation	N.A. ft	Port	2
Distance to disturbance	240 in	Stack Temp	49.5 °F
Start/End Time	940/ 1020		

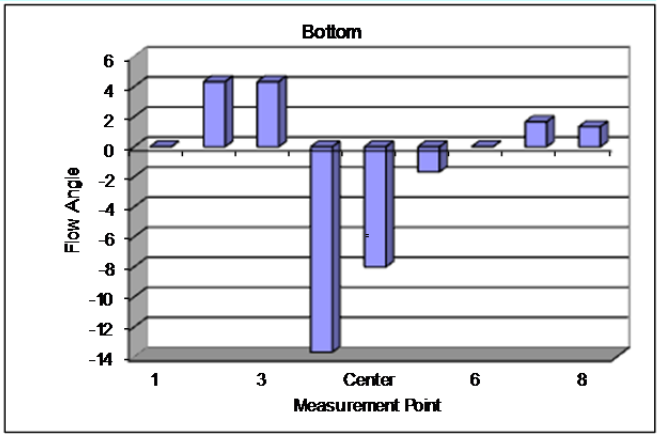
Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3		1	2	3	
Point	Depth, in.	deg. cw	deg. cw	deg. cw	Avg.	deg. cw	deg. cw	deg. cw	Avg.
1	0.50	-9	-5	-5	-6.3	-7	-1	8	0.0
2	1.25	1	-1	0	0.0	2	3	8	4.3
3	2.30	1	-1	0	0.0	4	4	5	4.3
4	3.84	2	3	-2	1.0	-14	-15	-12	-13.7
Center	5.94	3	1	0	1.3	-9	-8	-7	-8.0
5	8.04	1	4	2	2.3	-1	-2	-2	-1.7
6	9.57	5	5	4	4.7	0	-1	1	0.0
7	10.63	5	5	5	5.0	2	1	2	1.7
8	11.38	6	5	5	5.3	2	0	2	1.3
Mean of absolute values:					2.9				3.9
" " w/o points by wall:					2.0				4.8
								Grand mean ABS	3.4
								" " w/o wall pts	3.4

Instruments Used:			Cal. Due
S-type pitot	Dwyer 24-inch S-type Pitot#10		Cert. of conformance
Velocity sensor	TSI Velocicalc SN#T95351203001		17-Dec-12
Angle indicator	Shop built		Cat. 3
Manometer	Dwyer 400-5, S36N	MAN-5	Cat. 3
Fisher Scientific	S/N 90936818		12/7/2012

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).

CA , XY 4/2/2012





Entries made by:	CA, XY	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	*on file w/ original* 4/2/2012	Signature/date	6/27/2012 On file with original

FLOW ANGLE DATA FORM

HV-S1_FlowAngle.xls

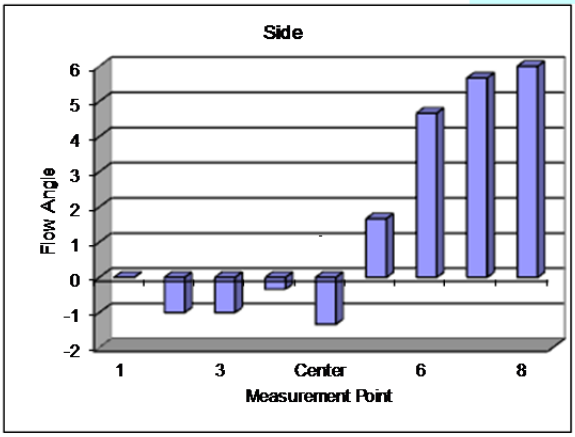
Site	HV-S1 scale model	Run No.	FA-7
Date	4/2/2012	Fan Setting	60 Hz
Tester	CA, XY	Fan configuration	FAN B ONLY
Stack Dia.	11.938 in	Approx. air vel.	2669 sfpm at point >> 1 side 7 XY 4/2/12
Stack X-Area	111.9 in2	Units	degrees (clockwise > pos. nos.)
Elevation	N.A. ft	Port	1
Distance to disturbance	300 in	Stack Temp	51.7 °F
Start/End Time	1030/1130		

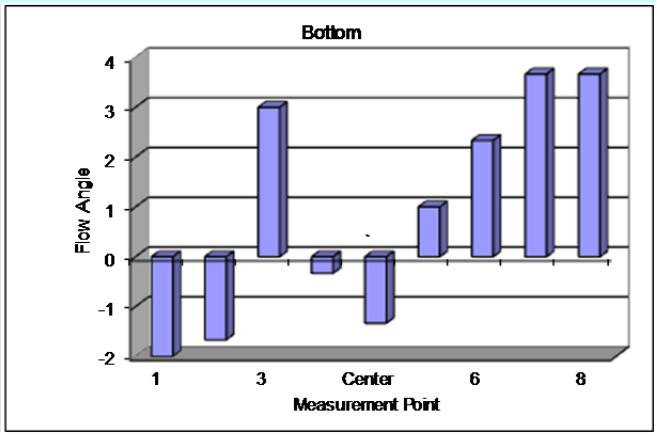
Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3		1	2	3	
Point	Depth, in.	deg. cw	deg. cw	deg. cw	Avg.	deg. cw	deg. cw	deg. cw	Avg.
1	0.50	0	-5	5	0.0	-3	-2	-1	-2.0
2	1.25	-1	-1	-1	-1.0	-4	2	-3	-1.7
3	2.30	-2	-1	0	-1.0	11	-1	-1	3.0
4	3.84	-1	0	0	-0.3	-2	2	-1	-0.3
Center	5.94	-1	-1	-2	-1.3	-5	2	-1	-1.3
5	8.04	1	2	2	1.7	-1	3	1	1.0
6	9.57	5	5	4	4.7	3	2	2	2.3
7	10.63	6	5	6	5.7	4	4	3	3.7
8	11.38	6	6	6	6.0	3	4	4	3.7
Mean of absolute values:					2.4				2.1
" " w/o points by wall:					2.2				1.9
								Grand mean ABS	2.3
								" " w/o wall pts	2.1

Instruments Used:			Cal. Due
S-type pitot	Dwyer 24-inch S-type Pitot#10		Cert. of conformance
Velocity sensor	TSI Velocicalc SN#T95351203001		17-Dec-12
Angle indicator	Shop built		Cat. 3
Manometer	Dwyer 400-5, S36N	MAN-5	Cat. 3
Fisher Scientific	S/N 90936818		12/7/2012

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:
CA 4/2/2012





Entries made by:	CA, XY		Technical Data Review performed by:	Elizabeth Golovich	
Signature/date	*on file w/ original*	4/2/2012	Signature/date	6/27/2012	
				On file with original	

A.4 HV-S1 Gas Tracer Calibration and Uniformity Data Sheets

SULFUR HEXAFLUORIDE GAS INSTRUMENT CALIBRATION

Site	HV-S1 Model	Instrument	B&K Model 1302
Date/Time	4/9/2012 14:35	Serial No.	1765299
Testers	CA, JEF, YS, XY	Property No.	WD17210

Setup:
- 7.7 ft B&K sample inlet tube length
- 1008 mbar station pressure
- 77.00 deg F ambient temp — analyzer corrects to 20 deg C
- 22% percent RH ambient humidity

Pre-Test background, ppb

Not compensating for water vapor, monitoring task 2

17.9,17.4,20.7,20.1,15.1

Compensating for water vapor, monitoring task 1

8.25,6.09,5.39,6.88,1.15

	100	ppb		4.97	ppm
Cylinder	CAL11936		Cylinder	FF34346	
start P =	2000	psi	start P =	1750	psi
end P =	2000	psi	end P =	1650	psi

B&K Calibration readings: (ppb)	B&K Calibration readings: (ppm)
Compensating for water vapor	**Compensating for water vapor**
105	5.17
105	5.16
102	5.15
104	5.14
102	5.13
Not compensating for water vapor	**Not compensating for water vapor**
103	5.02
99.8	5.11
99.0	5.17
100	5.18
100	5.18
102 = avg	**5.14** = avg
1.02 = avg/standard	**1.03** = avg/standard

Standards Used:	Expiration date:
Air Liquide 0.1 ppm SF6 in air, CAL11936	3/19/2013
Air Liquide 4.97 ppm SF6 in air, FF34346	3/19/2014
Weather Station Used:	
Fisher Scientific S/N 90936818	12/7/2012

Entries made by: Carmen Arimescu	Technical Data Review performed by: Susan Sande
Signature/date 4/9/2012	Signature/date 7/16/2012
Signature on file with original	Signature on file with Original
	TI-WTPSP-070

SULFUR HEXAFLUORIDE GAS INSTRUMENT CALIBRATION

Site	HV-S1 Model	Instrument	B&K Model 1302
Date/Time	4/16/2012 9:00am	Serial No.	1765299
Testers	CA, XY	Property No.	WD17210

Setup:
- 7.7 ft B&K sample inlet tube length
- 1004 mbar station pressure
- 59.9 deg F ambient temp analyzer corrects to 20 deg C
- 43% percent RH ambient humidity

Pre-Test background, ppb

Not compensating for water vapor, monitoring task 2

29.8,31.8,36.6,31.3,32.5

Compensating for water vapor, monitoring task 1

5.41,5.27,1.94,4.71,4.28

	100 ppb		4.97 ppm
Cylinder	CAL11936	Cylinder	FF34346
start P =	1710 psi	start P =	1600 psi
end P =	1710 psi	end P =	1600 psi

B&K Calibration readings: (ppb)	B&K Calibration readings: (ppm)
Compensating for water vapor	**Compensating for water vapor**
104	5.15
103	5.13
101	5.13
101	5.13
102	5.13
Not compensating for water vapor	**Not compensating for water vapor**
103	5.12
101	5.11
101	5.11
101	5.10
101	5.10
102 = avg	**5.12** = avg
1.02 = avg/standard	**1.03** = avg/standard

Standards Used:	Expiration date:
Air Liquide 0.1 ppm SF6 in air, CAL11936	3/19/2013
Air Liquide 4.97 ppm SF6 in air, FF34346	3/19/2014
Weather Station Used:	
Fisher Scientific S/N 90936818	12/7/2012

Entries made by: Carmen Arimescu	Technical Data Review performed by: Susan Sande
Signature/date 4/16/2012	Signature/date 7/16/2012
Signature on file with original	Signature on file with Original TI-WTPSP-070

SULFUR HEXAFLUORIDE GAS INSTRUMENT CALIBRATION

Site	HV-S1 Model	Instrument	B&K Model 1302
Date/Time	4/16/2012 12:35 PM	Serial No.	1765299
Testers	CA, XY, EA	Property No.	WD17210

Setup:
- 7.7 ft — B&K sample inlet tube length
- 1004 mbar station pressure
- 59.9 deg F ambient temp — analyzer corrects to 20 deg C
- 65% percent RH ambient humidity

Pre-Test background, ppb

Not compensating for water vapor, monitoring task 2

34,33,32,29,34

Compensating for water vapor, monitoring task 1

-3,.6,-5,0,0

	100 ppb		4.97 ppm
Cylinder	CAL11936	Cylinder	FF34346
start P =	1600 psi	start P =	1500 psi
end P =	1600 psi	end P =	1500 psi

B&K Calibration readings: (ppb)

Compensating for water vapor

108
110
106
105
104

Not compensating for water vapor

108
108
110
107
107

107 = avg

1.07 = avg/standard

B&K Calibration readings: (ppm)

Compensating for water vapor

5.04
5.03
5.02
5.01
5.04

Not compensating for water vapor

5.01
5.01
5.00
5.00
5.00

5.02 = avg

1.01 = avg/standard

Standards Used:	Expiration date:
Air Liquide 0.1 ppm SF6 in air, CAL11936	3/19/2013
Air Liquide 4.97 ppm SF6 in air, FF34346	3/19/2014
Weather Station Used:	
Fisher Scientific S/N 90936818	12/7/2012

Entries made by: Carmen Arimescu	Technical Data Review performed by: Susan Sande
Signature/date 4/16/2012	Signature/date 7/16/2012
Signature on file with original	Signature on file with Original
	TI-WTPSP-070

SULFUR HEXAFLUORIDE GAS INSTRUMENT CALIBRATION

Site	HV-S1 Model	Instrument	B&K Model 1302
Date/Time	6/27/2012 1145	Serial No.	1765299
Testers	JEF,CA	Property No.	WO17210

Setup:
- 7.7 ft B&K sample inlet tube length
- 1005 mbar station pressure
- 72 deg F ambient temp analyzer corrects to 20 deg C
- 35 percent RH ambient humidity

Pre-Test background, ppb

Not compensating for water vapor, monitoring task 2

38.4, 36.1, 34.3, 35.5, 33.8

Compensating for water vapor, monitoring task 1

2.6, 1.6, 2.80,1.83, 4.50

100 ppb		4.97 ppm	
Cylinder	CAL11936	Cylinder	FF34346
start P =	1100 psi	start P =	1100 psi
end P =	1100 psi	end P =	1100 psi

B&K Calibration readings: (ppb)	B&K Calibration readings: (ppm)
Compensating for water vapor	**Compensating for water vapor**
100	4.86
95	4.86
99	4.86
99	4.87
101	4.87
Not compensating for water vapor	**Not compensating for water vapor**
101	4.81
103	4.86
99	4.86
103	4.84
102	4.85
100.2000 = avg	**4.85** = avg
1.002 = avg/standard	**0.97665996** = avg/standard

Standards Used:	Expiration date:
Air Liquide 0.1 ppm SF6 in air, CAL11936	3/19/2013
Air Liquide 4.97 ppm SF6 in air, FF34346	3/19/2014
Weather Station Used:	
Fisher Scientific S/N 90936818	12/7/2012

Entries made by: Flaherty, Julia E	Technical Data Review performed by: Susan Sande
Signature/date 6/27/2012	Signature/date 7/16/2012
Signature on file with original	Signature on file with Original
	TI-WTPSP-070

SULFUR HEXAFLUORIDE GAS INSTRUMENT CALIBRATION

Site	HV-S1 Model	Instrument	B&K Model 1302
Date/Time	6/29/12 2:30 - 4:00	Serial No.	1765299
Testers	CA EA	Property No.	WD17210

Setup:
- 7.7 ft B&K sample inlet tube length
- 1003 mbar station pressure
- 71.6 deg F ambient temp analyzer corrects to 20 deg C
- 42 percent RH ambient humidity

Pre-Test background, ppb

Not compensating for water vapor, monitoring task 2

51.6, 47.4, 46.5, 46.1, 52.3

Compensating for water vapor, monitoring task 1

4.82, 5.45, 5.51, 2.82, 4.40

100	ppb	4.97	ppm
Cylinder	CAL11936	Cylinder	FF34346
start P =	1100 psi	start P =	psi
end P =	1100 psi	end P =	psi

B&K Calibration readings: (ppb)

Compensating for water vapor

91.4
90.5
88.0
83.6
83.3

Not compensating for water vapor

87.4
84.2
80.8
79.0

B&K Calibration readings: (ppm)

Compensating for water vapor

4.66
4.69
4.70
4.68
4.69

Not compensating for water vapor

4.24
4.46
4.56
4.58

Data invalid due to improper set up on B&K Gas Analyzer.
Do not use. EA 7/3/12

= avg

= avg/standard

Standards Used:	Expiration date:
Air Liquide 0.1 ppm SF6 in air, CAL11936	3/19/2013
Air Liquide 4.97 ppm SF6 in air, FF34346	3/19/2014
Weather Station Used:	
Fisher Scientific S/N 90936818	12/7/2012

Entries made by: CA	Technical Data Review performed by: Susan Sande
Signature/date Signature on file with original 6/26/2012	Signature/date 7/16/2012 Signature on file with Original TI-WTPSP-070

SULFUR HEXAFLUORIDE GAS INSTRUMENT CALIBRATION

Site	HV-S1 Model	Instrument	B&K Model 1302
Date/Time	7/2/12 1050	Serial No.	1765299
Testers	JEF, EA	Property No.	WD17210

Setup:
- 7.7 ft B&K sample inlet tube length
- 1000 mbar station pressure
- 75 deg F ambient temp analyzer corrects to 20 deg C
- 33 percent RH ambient humidity

Pre-Test background, ppb

Not compensating for water vapor, monitoring task 2

45, 46, 45, 47, 47

Compensating for water vapor, monitoring task 1

5, 3, 4, 4, 9

	100 ppb		4.97 ppm
Cylinder	CAL11936	Cylinder	FF34346
start P =	1000 psi	start P =	1100 psi
end P =	990 psi	end P =	1100 psi

B&K Calibration readings: (ppb)

Compensating for water vapor

99.6
98.2
97.8
99.3
95.7

Not compensating for water vapor

99.7
101.0
105.0
103.0
102.0

100.1300 = avg

1.0013 = avg/standard

B&K Calibration readings: (ppm)

Compensating for water vapor

4.86
4.86
4.87
4.86
4.85

Not compensating for water vapor

4.85
4.85
4.85
4.85
4.85

4.86 = avg

0.976861167 = avg/standard

Standards Used:		Expiration date:
Air Liquide	0.1 ppm SF6 in air, CAL11936	3/19/2013
Air Liquide	4.97 ppm SF6 in air, FF34346	3/19/2014
Weather Station Used:		
Fisher Scientific	S/N 90936818	12/7/2012

Entries made by:	Ernest Antonio	Technical Data Review performed by:	Susan Sande
Signature/date	Signature on file with original 7/2/2012	Signature/date	7/16/2012 Signature on file with Original TI-WTPSP-070

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S1 Model	Run No.	GT-1
Date	4/10/2012	Fan Configuration	Fan A only
Testers	CA, XY	Fan Setting	55 Hz
Stack Dia.	11.938 in.	Stack Temp	63.55 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	930/ 1120
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C center

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	596	609	614	**606.3**	603	628	618	**616.3**
2	1.25	633	588	614	**611.7**	606	601	641	**616.0**
3	2.30	593	620	622	**611.7**	607	617	602	**608.7**
4	3.84	600	579	613	**597.3**	633	605	603	**613.7**
Center	5.94	612	608	605	**608.3**	616	614	612	**614.0**
5	8.04	639	612	619	**623.3**	601	617	607	**608.3**
6	9.57	614	619	618	**617.0**	611	607	621	**613.0**
7	10.63	638	621	614	**624.3**	621	604	604	**609.7**
8	11.38	600	615	615	**610.0**	632	619	636	**629.0**
Averages ---->		**613.9**	**607.9**	**614.9**	**612.2**	**614.4**	**612.4**	**616.0**	**614.3**

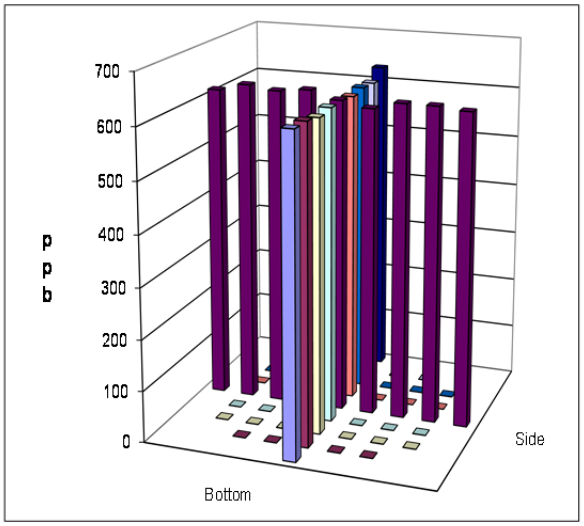
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	613.26		Mean	613.38	611.90	612.64
Min Point	597.33	-2.6%	Std. Dev.	9.32	2.99	6.69
Max Point	629.00	2.6%	COV as %	1.5	0.5	1.1

Avg. Conc. 613.521 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN	1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001		1/17/2013
Fisher Scientific	SN 90936818		12/7/2012

	Start	Finish	
Tracer tank pressure	100	100	psig
Injection flowmeter	30	30	sccm
Stack Temp	59.4	67.7	°F
Mean stack velocity	2322	2418	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	999	1000	mbar
Ambient humidity	31%	25%	RH
Ambient Temp	64.4	72.5	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	10, 7, 10, 10, 8	14, 9, 10, 9, 8	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/9/2012 CA 4/10/12

Notes:

CA 4/10/2012

Entries made by:	CA, XY	Technical Data Review performed by:	Susan Sande
Signature/date	4/10/2012	Signature/date	7/16/2012
	Signature on file with Original		Signature on file with original
			TI-WTPSP-070

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S1 Model	Run No.	GT-2
Date	4/10/2012	Fan Configuration	Fan A only
Testers	CA, XY	Fan Setting	28 Hz
Stack Dia.	11.938 in.	Stack Temp	69.3 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	1120/ 110
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C center

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	660	639	616	638.3	640	632	612	628.0
2	1.25	623	644	643	636.7	622	615	619	618.7
3	2.30	574	601	597	590.7	608	634	607	616.3
4	3.84	597	604	597	599.3	620	621	618	619.7
Center	5.94	616	604	614	611.3	603	608	602	604.3
5	8.04	627	623	620	623.3	614	611	607	610.7
6	9.57	622	604	615	613.7	643	641	616	633.3
7	10.63	620	619	628	622.3	640	615	612	622.3
8	11.38	617	570	610	599.0	652	609	625	628.7
Averages ---->		617.3	612.0	615.6	615.0	626.9	620.7	613.1	620.2

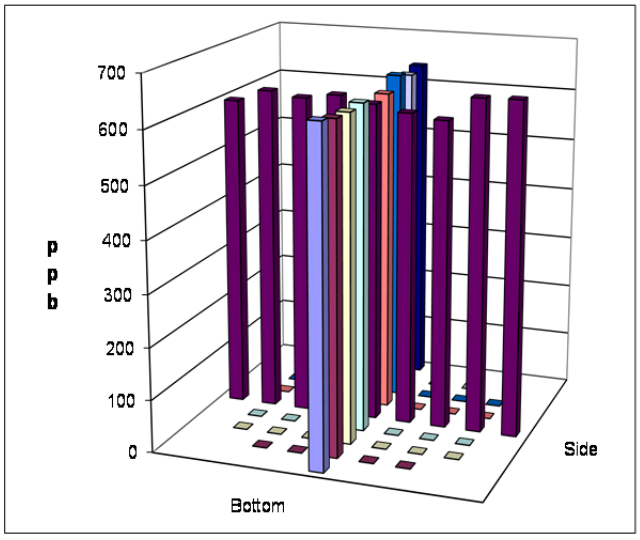
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	617.59		Mean	613.90	617.90	615.90
Min Point	590.67	-4.4%	Std. Dev.	15.48	9.13	12.38
Max Point	638.33	3.4%	COV as %	2.5	1.5	2.0

Avg. Conc. 618.813 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN	1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001		1/17/2013
Fisher Scientific	SN 90936818		12/7/2012

	Start	Finish	
Tracer tank pressure	125	125	psig
Injection flowmeter	15	14.5	sccm
Stack Temp	66.7	71.9	°F
Mean stack velocity	1209	1165	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	997	997	mbar
Ambient humidity	27%	23%	RH
Ambient Temp	74.3	79.7	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	12, 14, 14, 10, 13	15, 19, 17, 16, 17	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/9/2012 CA 4/10/12

Notes:

CA 4/10/2012

Entries made by:	CA,XY	Technical Data Review performed by:	Susan Sande
Signature/date	4/10/2012	Signature/date	7/16/2012
	Signature on file with Original		Signature on file with original
			TI-WTPSP-070

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S1 Model	Run No.	GT-3
Date	4/11/2012	Fan Configuration	Fan B only
Testers	CA, XY	Fan Setting	26 Hz
Stack Dia.	11.938 in.	Stack Temp	62.35 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	936/ 1110
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C center

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	609	597	621	**609.0**	620	626	623	**623.0**
2	1.25	629	627	613	**623.0**	602	628	628	**619.3**
3	2.30	632	605	608	**615.0**	613	623	640	**625.3**
4	3.84	635	647	605	**629.0**	616	635	608	**619.7**
Center	5.94	629	605	597	**610.3**	619	608	615	**614.0**
5	8.04	596	598	631	**608.3**	646	627	621	**631.3**
6	9.57	591	596	587	**591.3**	639	646	584	**623.0**
7	10.63	611	590	599	**600.0**	625	639	606	**623.3**
8	11.38	649	616	588	**617.7**	623	626	608	**619.0**
Averages ---->		620.1	609.0	605.4	611.5	622.6	628.7	614.8	622.0

All	ppb	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	616.76		Mean	611.00	622.29	616.64
Min Point	591.33	-4.1%	Std. Dev.	12.91	5.43	11.17
Max Point	631.33	2.4%	COV as %	2.1	0.9	1.8

Avg. Conc. 617.333 ppb

Instuments Used:

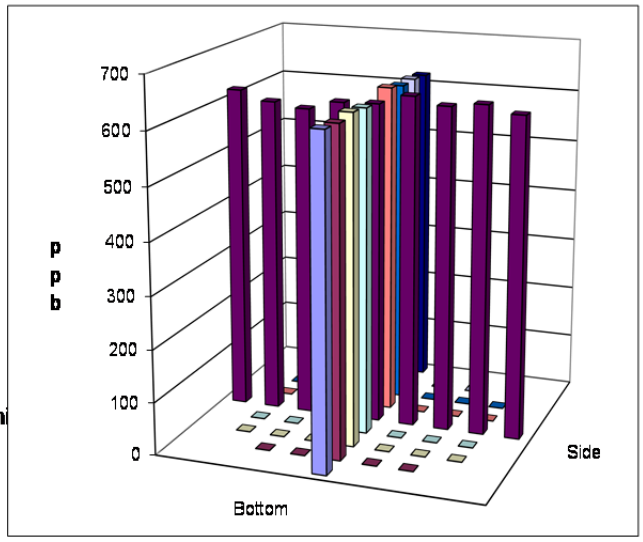
B&K 1302 Gas Analyzer	SN	1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001		1/17/2013
Fisher Scientific	SN 90936818		12/7/2012

	Start	Finish	
Tracer tank pressure	100	100	psig
Injection flowmeter	15	15	sccm
Stack Temp	59.7	65.0	°F
Mean stack velocity	1174	1028	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	990	989	mbar
Ambient humidity	39%	36%	RH
Ambient Temp	63.5	65.3	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	7,7,3,1,2	17, 16, 17, 16, 14	ppb
No. Bk-Gd samples	5	5	n

Gas analyzer checked: 4/9/2012 CA 4/11/12

Notes: The B&K analizer may periodicaly show an error message. We push the measurement buttom to get rid of the message and resume measurement. We need to note that thi result in loss of the last data point before the error message occurs. One can redo that point and continue with testing.

XY 4/11/12



Entries made by: CA, XY
Signature/date 4/11/2012
Signature on file with Original

Technical Data Review performed by: Susan Sande
Signature/date 7/16/2012
Signature on file with original
TI-WTPSP-070

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S1 Model	Run No.	GT-4
Date	4/11/2012	Fan Configuration	Fan B only
Testers	XY, CA	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	65.2 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	1110/ 1210
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C center

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	481	505	512	**499.3**	500	507	513	**506.7**
2	1.25	465	528	515	**502.7**	535	503	501	**513.0**
3	2.30	521	498	514	**511.0**	523	515	523	**520.3**
4	3.84	498	520	522	**513.3**	515	547	535	**532.3**
Center	5.94	504	510	525	**513.0**	518	540	520	**526.0**
5	8.04	516	502	502	**506.7**	520	506	518	**514.7**
6	9.57	516	508	535	**519.7**	533	506	500	**513.0**
7	10.63	494	499	530	**507.7**	523	528	539	**530.0**
8	11.38	507	526	522	**518.3**	502	536	496	**511.3**
Averages ---->		**500.2**	**510.7**	**519.7**	**510.2**	**518.8**	**520.9**	**516.1**	**518.6**

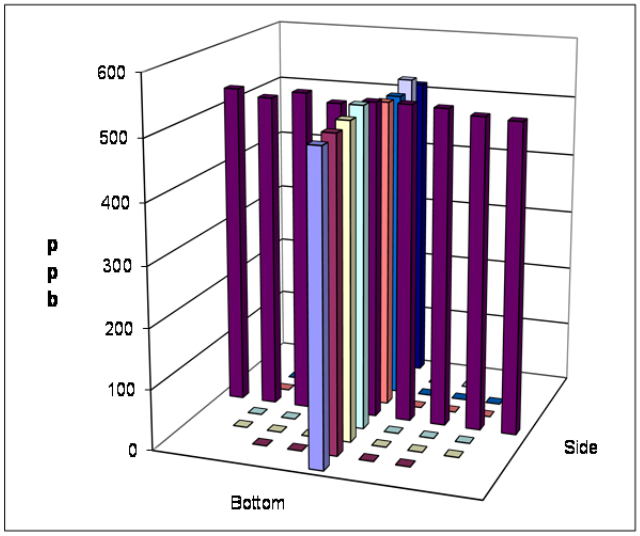
All	ppb	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	514.39		Mean	510.57	521.33	515.95
Min Point	499.33	-2.9%	Std. Dev.	5.52	8.19	8.73
Max Point	532.33	3.5%	COV as %	1.1	1.6	1.7

Avg. Conc. 513.750 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN	1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001		1/17/2013
Fisher Scientific	SN 90936818		12/7/2012

	Start	Finish	
Tracer tank pressure	100	125	psig
Injection flowmeter	30	30	sccm
Stack Temp	65.6	64.8	°F
Mean stack velocity	3121	2808	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	989	989	mbar
Ambient humidity	34%	36%	RH
Ambient Temp	68.9	65.3	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	4,7,6,6,7	9,12,10,6,9	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/9/2012 CA 4/11/12

Notes: The injection flow was increased to 30 sccm to reach about 500 ppb at center of the stack. XY 4/11/12

XY 4/11/12

Entries made by:	CA, XY	Technical Data Review performed by:	Susan Sande
Signature/date	4/11/2012	Signature/date	7/16/2012
	Signature on file with Original		Signature on file with original
			TI-WTPSP-070

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06	Site: HV-S1 Model	Run No.: GT-5	
	Date: 4/11/2012	Fan Configuration: Fan B only	
	Testers: CA, JEF	Fan Setting: 60 Hz	
	Stack Dia.: 11.938 in.	Stack Temp: 65.25 deg F	
	Stack X-Area: 111.9 in.^{2}	Start/End Time: 1220/ 1335	
	Test Port: 2	Center 2/3 from: 1.10 to: 10.84	
	Distance to disturbance: 240 inches	Points in Center 2/3: 2 to: 7	
	Measurement units: ppb SF6	Injection Point: C NEAR WALL	

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	519	513	540	**524.0**	517	532	514	**521.0**
2	1.25	522	516	508	**515.3**	529	542	503	**524.7**
3	2.30	548	521	536	**535.0**	519	537	506	**520.7**
4	3.84	550	515	531	**532.0**	553	517	519	**529.7**
Center	5.94	511	521	531	**521.0**	534	526	561	**540.3**
5	8.04	527	536	541	**534.7**	510	548	512	**523.3**
6	9.57	526	480	527	**511.0**	529	538	517	**528.0**
7	10.63	501	526	526	**517.7**	525	535	555	**538.3**
8	11.38	491	536	487	**504.7**	545	475	518	**512.7**
Averages ---->		521.7	518.2	525.2	521.7	529.0	527.8	522.8	526.5

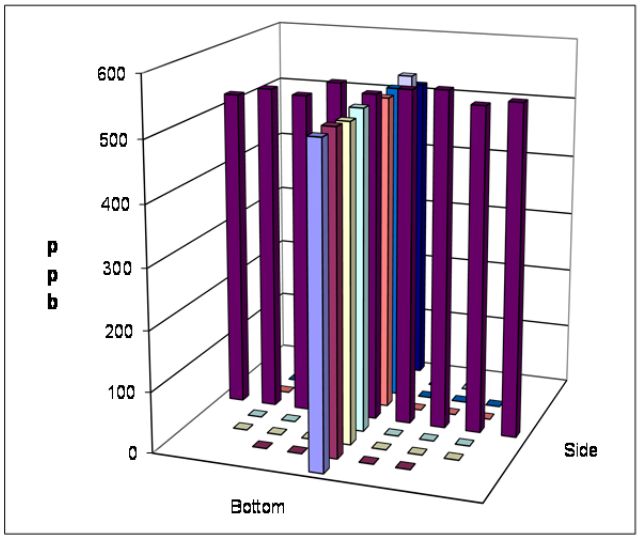
All	ppm	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	524.11		Mean	523.81	529.29	526.55
Min Point	504.67	-3.7%	Std. Dev.	9.93	7.49	8.92
Max Point	540.33	3.1%	COV as %	1.9	1.4	1.7

Avg. Conc. 523.292 ppb

Instuments Used:

B&K 1302 Gas Analyzer	SN	1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001		1/17/2013
Fisher Scientific	SN 90936818		12/7/2012

	Start	Finish	
Tracer tank pressure	125	125	psig
Injection flowmeter	30	30	sccm
Stack Temp	64.8	65.7	°F
Mean stack velocity	2808	2910	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	988	988	mbar
Ambient humidity	38%	37%	RH
Ambient Temp	64.4	67.1	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	13,14,11,9,13	6,8,12,3,7	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/9/2012 XY 4/11/12

Notes:

XY 4/11/2012

Entries made by:	CA, JEF
Signature/date	4/11/2012
	Signature on file with Original

Technical Data Review performed by:	Susan Sande
Signature/date	7/16/2012
	Signature on file with original
	TI-WTPSP-070

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06	Site: HV-S1 Model	Run No.: GT-6	
	Date: 4/11/2012	Fan Configuration: Fan B only	
	Testers: CA, JAG	Fan Setting: 60 Hz	
	Stack Dia.: 11.938 in.	Stack Temp: 66.9 deg F	
	Stack X-Area: 111.9 in.^{2}	Start/End Time: 148/ 315	
	Test Port: 2	Center 2/3 from: 1.10 to: 10.84	
	Distance to disturbance: 240 inches	Points in Center 2/3: 2 to: 7	
	Measurement units: ppb SF6	Injection Point: C Far Wall	

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	577	532	525	544.7	544	535	497	525.3
2	1.25	561	535	533	543.0	509	502	569	526.7
3	2.30	551	577	507	545.0	515	506	561	527.3
4	3.84	550	499	529	526.0	540	521	489	516.7
Center	5.94	547	501	534	527.3	543	545	536	541.3
5	8.04	510	507	504	507.0	514	525	513	517.3
6	9.57	550	520	545	538.3	553	486	528	522.3
7	10.63	566	553	532	550.3	514	500	557	523.7
8	11.38	522	508	529	519.7	553	562	551	555.3
Averages ---->		548.2	525.8	526.4	533.5	531.7	520.2	533.4	528.4

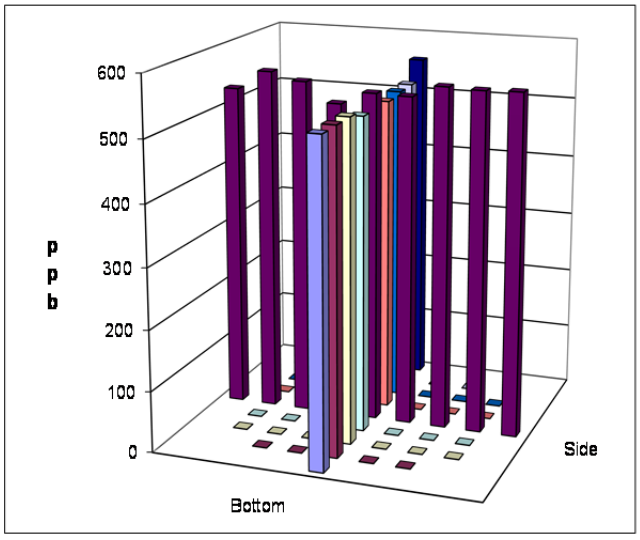
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	530.96		Mean	533.86	525.05	529.45
Min Point	507.00	-4.5%	Std. Dev.	14.86	8.29	12.43
Max Point	555.33	4.6%	COV as %	2.8	1.6	2.3

Avg. Conc. 530.542 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN	1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001		1/17/2013
Fisher Scientific	SN 90936818		12/7/2012

	Start	Finish	
Tracer tank pressure	125	200	psig
Injection flowmeter	30	30	sccm
Stack Temp	65.8	68.0	°F
Mean stack velocity	2910	2889	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	988	988	mbar
Ambient humidity	37%	29%	RH
Ambient Temp	67.1	67	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	1,5,3,5,8	8,8,3,4,4	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/9/2012 XY 4/11/12

Notes:

XY 4/11/2012

Entries made by:	JAG, CA	Technical Data Review performed by:	Susan Sande
Signature/date	4/11/2012	Signature/date	7/16/2012
	Signature on file with Original		Signature on file with original
			TI-WTPSP-070

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S1 Model	Run No.	GT-7
Date	4/12/2012	Fan Configuration	Fan B only
Testers	EA, YFS, JEF	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	66.35 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	0925 / 1055
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C TOP

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	503	495	497	**498.3**	502	511	527	**513.3**
2	1.25	520	487	518	**508.3**	510	506	519	**511.7**
3	2.30	510	527	484	**507.0**	521	532	527	**526.7**
4	3.84	527	493	504	**508.0**	491	487	539	**505.7**
Center	5.94	503	508	499	**503.3**	516	518	538	**524.0**
5	8.04	513	510	512	**511.7**	532	525	515	**524.0**
6	9.57	513	507	527	**515.7**	494	512	506	**504.0**
7	10.63	514	518	504	**512.0**	495	521	496	**504.0**
8	11.38	501	482	498	**493.7**	501	521	531	**517.7**
Averages ---->		**511.6**	**503.0**	**504.8**	**506.4**	**506.9**	**514.8**	**522.0**	**514.6**

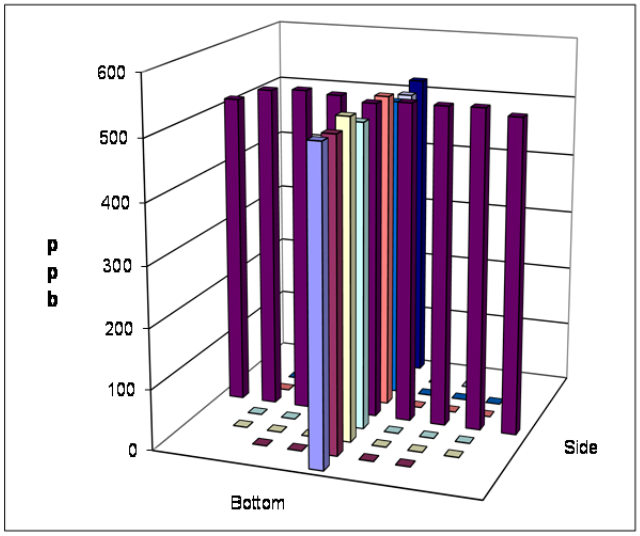
All	ppb	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	510.50		Mean	509.43	514.29	511.86
Min Point	493.67	-3.3%	Std. Dev.	4.02	10.29	7.91
Max Point	526.67	3.2%	COV as %	0.8	2.0	1.5

Avg. Conc. 510.104 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN	1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001		1/17/2013
Fisher Scientific	SN 90936818		12/7/2012

	Start	Finish	
Tracer tank pressure	125	125	psig
Injection flowmeter	30	30	sccm
Stack Temp	63.6	69.1	°F
Mean stack velocity	2930	3106	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	996	996	mbar
Ambient humidity	28%	31%	RH
Ambient Temp	72	69	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	7, 4, 6, 4, 3	13, 16, 13, 9, 20	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/9/2012

JF 4/12/12

Notes: B&K Analyzer reset itself at last run at bottom port. Re-did measurement 1.

JF 4/12/12

Entries made by:	EA	Technical Data Review performed by:	Susan Sande
Signature/date	4/12/2012	Signature/date	7/16/2012
	Signature on file with Original		Signature on file with original TI-WTPSP-070

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06	Site	HV-S1 Model	
	Date	4/12/2012	
	Testers	EA, YFS	
	Stack Dia.	11.938 in.	
	Stack X-Area	111.9 in.^{2}	
	Test Port	2	
	Distance to disturbance	240 inches	
	Measurement units	ppb SF6	
	Run No.	GT-8	
	Fan Configuration	Fan B only	
	Fan Setting	60 Hz	
	Stack Temp	70.8 deg F	
	Start/End Time	1100 / 1225	
	Center 2/3 from	1.10 to: 10.84	
	Points in Center 2/3	2 to: 7	
	Injection Point	C bottom	

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	542	457	521	**506.7**	445	488	492	**475.0**
2	1.25	509	453	605	**522.3**	460	473	487	**473.3**
3	2.30	595	482	508	**528.3**	482	488	497	**489.0**
4	3.84	546	568	512	**542.0**	515	491	537	**514.3**
Center	5.94	470	487	523	**493.3**	546	479	445	**490.0**
5	8.04	452	523	444	**473.0**	574	501	568	**547.7**
6	9.57	579	476	515	**523.3**	554	498	477	**509.7**
7	10.63	567	487	542	**532.0**	516	525	507	**516.0**
8	11.38	488	501	530	**506.3**	490	510	484	**494.7**
Averages ---->		527.6	492.7	522.2	514.1	509.1	494.8	499.3	501.1

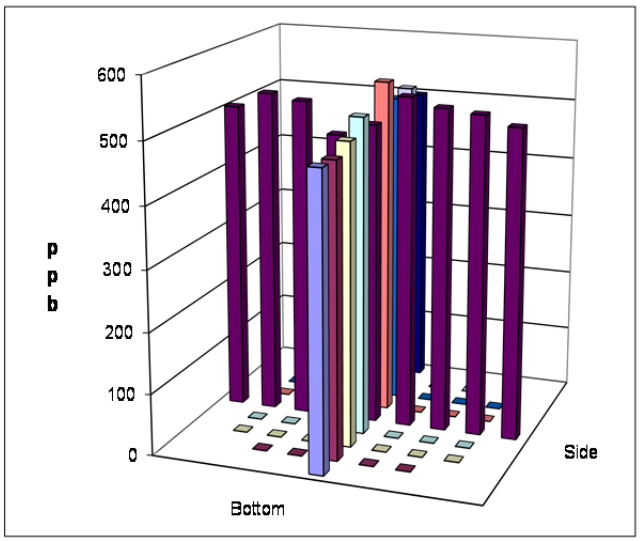
All	ppb	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	507.61		Mean	516.33	505.71	511.02
Min Point	473.00	-6.8%	Std. Dev.	24.29	24.26	23.96
Max Point	547.67	7.9%	COV as %	4.7	4.8	4.7

Avg. Conc. 509.604 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN	1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001		1/17/2013
Fisher Scientific	SN 90936818		12/7/2012

	Start	Finish	
Tracer tank pressure	125	125	psig
Injection flowmeter	30	30	sccm
Stack Temp	68.4	73.2	°F
Mean stack velocity	3006	2910	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	996	996	mbar
Ambient humidity	31%	26%	RH
Ambient Temp	68	71	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	13, 12, 11, 9, 11	13, 12, 16, 10, 8	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/9/2012

Notes: At beginning of first side traverse, B&K Analyzer reset itself. Redid side 1 measurement.

JF 4/12/12

Entries made by:	EA	Technical Data Review performed by:	Susan Sande
Signature/date	4/12/2012	Signature/date	7/16/2012
	Signature on file with Original		Signature on file with original
			TI-WTPSP-070

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S1 Model	Run No.	GT-9
Date	4/12/2012	Fan Configuration	Fan B only
Testers	CA, XY	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	72.4 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	1225 / 1335
Test Port	1	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	300 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C Bottom

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	503	536	466	501.7	510	489	497	498.7
2	1.25	480	491	474	481.7	602	606	555	587.7
3	2.30	551	522	539	537.3	589	477	492	519.3
4	3.84	547	443	484	491.3	530	484	556	523.3
Center	5.94	555	521	525	533.7	530	460	539	509.7
5	8.04	566	496	451	504.3	481	575	428	494.7
6	9.57	572	533	557	554.0	566	506	474	515.3
7	10.63	490	535	515	513.3	610	512	634	585.3
8	11.38	549	509	496	518.0	502	521	498	507.0
Averages ---->		534.8	509.6	500.8	515.0	546.7	514.4	519.2	526.8

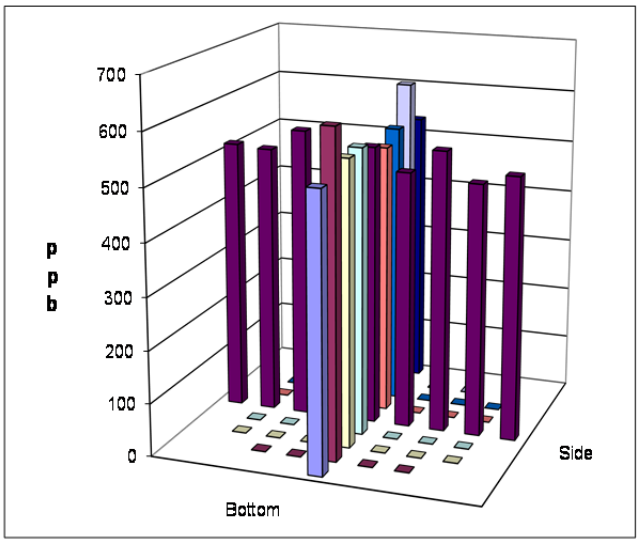
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	520.91		Mean	516.52	533.62	525.07
Min Point	481.67	-7.5%	Std. Dev.	26.27	37.26	32.22
Max Point	587.67	12.8%	COV as %	5.1	7.0	6.1

Avg. Conc. 520.813 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	200	200	psig
Injection flowmeter	30	30	sccm
Stack Temp	72.3	72.5	°F
Mean stack velocity	3324	3283	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	996	995	mbar
Ambient humidity	21%	26%	RH
Ambient Temp	70.4	67.1	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	6, 10, 11, 6, 5	12, 12, 13, 11, 12	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/9/2012 XY 4/12/12

Notes:

XY 4/12/12

Entries made by: CA XY
Signature/date 4/12/2012
Signature on file with Original

Technical Data Review performed by: Susan Sande
Signature/date 7/16/2012
Signature on file with original
TI-WTPSP-070

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S1 Model	Run No.	GT-10
Date	4/12/2012	Fan Configuration	Fan B only
Testers	CA, XY	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	73.4 deg F
Stack X-Area	111.9 $in.^2$	Start/End Time	1345 / 1457
Test Port	1	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	300 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C Top

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	489	496	522	502.3	504	517	509	510.0
2	1.25	513	492	512	505.7	524	514	492	510.0
3	2.30	483	509	473	488.3	514	523	497	511.3
4	3.84	504	509	491	501.3	517	511	513	513.7
Center	5.94	485	492	535	504.0	503	516	493	504.0
5	8.04	501	498	530	509.7	486	509	499	498.0
6	9.57	496	521	561	526.0	505	518	490	504.3
7	10.63	504	494	535	511.0	507	540	514	520.3
8	11.38	496	511	517	508.0	509	493	485	495.7
Averages ---->		496.8	502.4	519.6	506.3	507.7	515.7	499.1	507.5

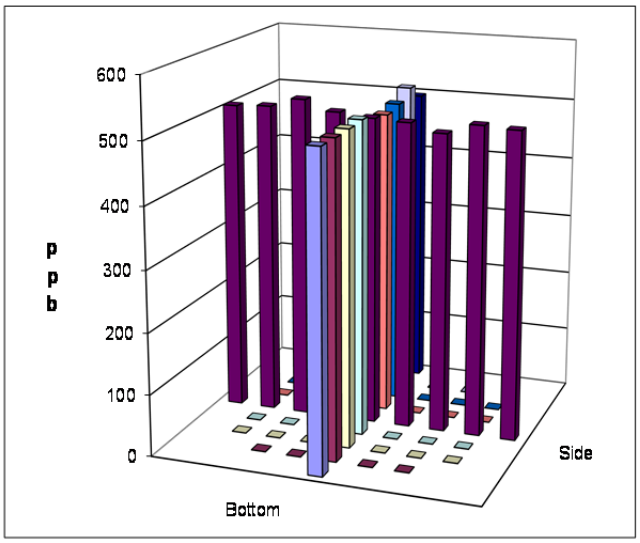
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	506.87		Mean	506.57	508.81	507.69
Min Point	488.33	-3.7%	Std. Dev.	11.36	7.35	9.26
Max Point	526.00	3.8%	COV as %	2.2	1.4	1.8

Avg. Conc. 507.229 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	200	200	psig
Injection flowmeter	30	30	sccm
Stack Temp	71.8	75	°F
Mean stack velocity	3043	3026	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	995	995	mbar
Ambient humidity	25%	20%	RH
Ambient Temp	71.6	64.0	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	12, 12, 13, 11, 12	9, 12, 13, 8, 8	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/9/2012 XY 4/12/12

Notes:

CA 4/12/12

Entries made by:	CA	Technical Data Review performed by:	Susan Sande
Signature/date	4/12/2012	Signature/date	7/16/2012
	Signature on file with Original		Signature on file with original
			TI-WTPSP-070

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S1 Model	Run No.	GT-11
Date	4/12/2012	Fan Configuration	Fan B only
Testers	EA, JEF	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	67.15 deg F
Stack X-Area	111.9 $in.^2$	Start/End Time	1500 / 1625
Test Port	1	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	300 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C NEAR WALL

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	526	530	535	**530.3**	521	543	552	**538.7**
2	1.25	532	494	587	**537.7**	523	508	548	**526.3**
3	2.30	553	514	547	**538.0**	535	523	525	**527.7**
4	3.84	541	527	581	**549.7**	531	528	559	**539.3**
Center	5.94	546	516	556	**539.3**	532	544	518	**531.3**
5	8.04	574	509	531	**538.0**	544	528	505	**525.7**
6	9.57	484	515	536	**511.7**	536	576	531	**547.7**
7	10.63	539	487	531	**519.0**	557	543	548	**549.3**
8	11.38	539	548	569	**552.0**	527	492	526	**515.0**
Averages ---->		**537.1**	**515.6**	**552.6**	**535.1**	**534.0**	**531.7**	**534.7**	**533.4**

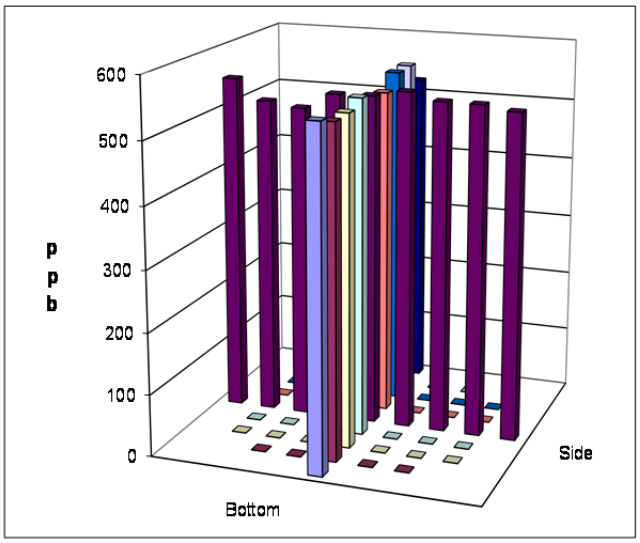
All	ppb	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	534.26		Mean	533.33	535.33	534.33
Min Point	511.67	-4.2%	Std. Dev.	13.17	10.11	11.33
Max Point	552.00	3.3%	COV as %	2.5	1.9	**2.1**

Avg. Conc. 534.125 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	240	125	psig
Injection flowmeter	30	30	sccm
Stack Temp	69.7	64.6	°F
Mean stack velocity	3117	3108	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	995	995	mbar
Ambient humidity	23%	27%	RH
Ambient Temp	75	64	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	9, 12, 5, 10, 11	20, 19, 12, 6, 12	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/9/2012

JEF 4/12/12

Notes: Wind getting pretty gusty during second traverse. Side, Trial 3, Point 4 discovered the SF6 cylinder was closed. Had been running on back pressure. Appears that delivery of SF6 dropped in one sample cycle. Run trial 4 just in case.

JEF 4/12/12

Entries made by:	Julia Flaherty	Technical Data Review performed by:	Susan Sande
Signature/date	Signature on file with original 4/12/2012	Signature/date	7/16/2012 Signature on file with original TI-WTPSP-070

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S1 Model	Run No.	GT-12
Date	4/13/2012	Fan Configuration	Fan B only
Testers	EA, XY	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	62.1 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	9:40/10:46
Test Port	1	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	300 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C FAR WALL

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	554	511	549	538.0	543	565	561	556.3
2	1.25	524	539	519	527.3	522	523	525	523.3
3	2.30	550	544	492	528.7	534	534	529	532.3
4	3.84	517	553	505	525.0	519	542	545	535.3
Center	5.94	529	488	520	512.3	513	527	554	531.3
5	8.04	536	534	521	530.3	531	504	512	515.7
6	9.57	509	511	537	519.0	513	526	508	515.7
7	10.63	545	501	520	522.0	526	539	517	527.3
8	11.38	513	527	518	519.3	524	537	546	535.7
Averages ---->		530.8	523.1	520.1	524.7	525.0	533.0	533.0	530.3

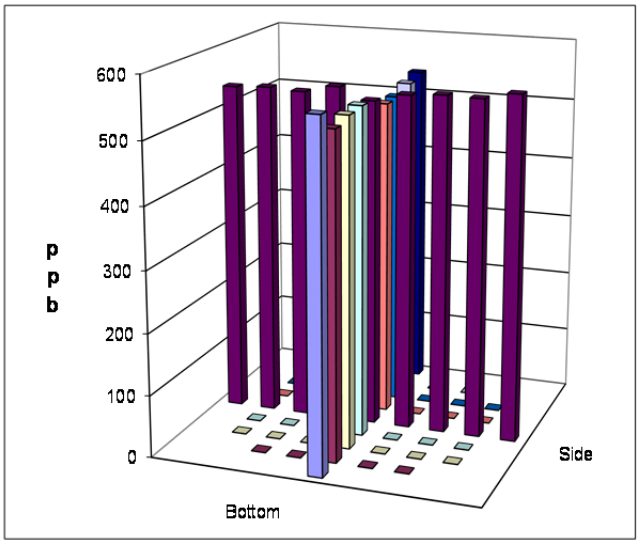
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	527.50		Mean	523.52	525.86	524.69
Min Point	512.33	-2.9%	Std. Dev.	6.29	7.94	6.99
Max Point	556.33	5.5%	COV as %	1.2	1.5	1.3

Avg. Conc. 528.208 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	100	100	psig
Injection flowmeter	30	30	sccm
Stack Temp	61.0	63.2	°F
Mean stack velocity	2799	2822	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	998	998	mbar
Ambient humidity	44%	34%	RH
Ambient Temp	64.4	63.5	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	10,10,13,9,7	7, 9, 5, 5, 10	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/9/2012 XY 4/13/12

Notes: Reduce injection flow meter from 30 to 15 accm to reach ~ 600-700 ooob at center. We foiund this was caused by not completely opening the cover of the fan. Corrected.
Reset the injection flow meter back to 30 sccm, center concentration is about 500 ppb. XY 4/13/12
XY 4/13/12

Entries made by:	Xiao-Ying Yu	Technical Data Review performed by:	Susan Sande
Signature/date	Signature on file with original 4/13/2012	Signature/date	7/16/2012 Signature on file with original TI-WTPSP-070

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S1 Model	Run No.	GT-13
Date	4/13/2012	Fan Configuration	Fan B only
Testers	EA, XY	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	64.7 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	10:46/12:20
Test Port	1	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	300 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C center

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	531	507	554	**530.7**	510	513	488	**503.7**
2	1.25	501	509	495	**501.7**	553	521	517	**530.3**
3	2.30	510	545	556	**537.0**	509	515	510	**511.3**
4	3.84	557	547	517	**540.3**	554	537	562	**551.0**
Center	5.94	529	523	496	**516.0**	534	550	514	**532.7**
5	8.04	553	570	542	**555.0**	518	505	492	**505.0**
6	9.57	513	553	527	**531.0**	519	525	515	**519.7**
7	10.63	528	519	499	**515.3**	565	525	548	**546.0**
8	11.38	499	515	478	**497.3**	514	541	525	**526.7**
Averages ---->		524.6	532.0	518.2	524.9	530.7	525.8	519.0	525.1

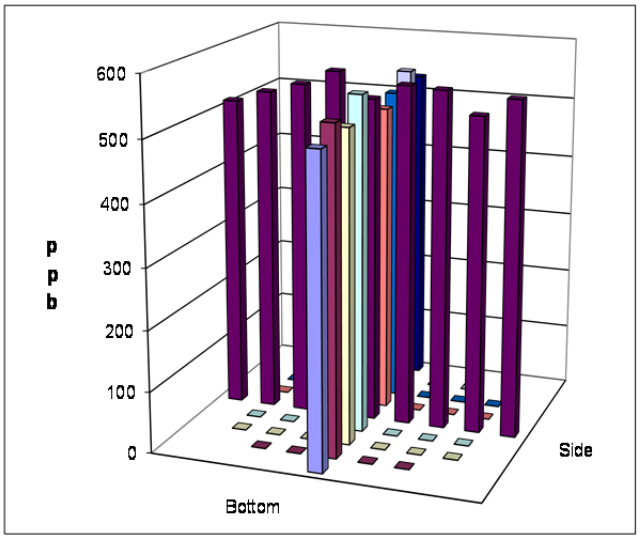
All	ppb	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	525.04		Mean	528.05	528.00	528.02
Min Point	497.33	-5.3%	Std. Dev.	18.12	17.11	16.93
Max Point	555.00	5.7%	COV as %	3.4	3.2	3.2

Avg. Conc. 525.125 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN	1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001		1/17/2013
Fisher Scientific	SN 90936818		12/7/2012

	Start	Finish	
Tracer tank pressure	100	100	psig
Injection flowmeter	30	30	sccm
Stack Temp	62.4	67.0	°F
Mean stack velocity	2938	2788	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	998	998	mbar
Ambient humidity	33%	33%	RH
Ambient Temp	65.3	63.5	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	9,7,6,7,6	9,7,8,7,9	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/9/2012 XY 4/13/12

Notes: Several points were redone, since their values were far off by doing a student T-test, when working on the bottom traverse. XY 4/13/12

XY 4/13/12

Entries made by:	Xiao-Ying Yu	Technical Data Review performed by:	Susan Sande
Signature/date	Signature on file with original 4/13/2012	Signature/date	7/16/2012 Signature on file with original TI-WTPSP-070

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S1 Model	Run No.	GT-14
Date	4/13/2012	Fan Configuration	Fan A only
Testers	EA, YFS	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	73.6 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	1300 / 1415
Test Port	1	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	300 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C center

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	570	561	582	571.0	578	545	553	558.7
2	1.25	562	554	548	554.7	576	550	552	559.3
3	2.30	573	587	575	578.3	546	550	563	553.0
4	3.84	567	535	560	554.0	574	572	555	567.0
Center	5.94	565	569	549	561.0	566	562	555	561.0
5	8.04	552	564	550	555.3	566	556	544	555.3
6	9.57	561	565	552	559.3	543	552	561	552.0
7	10.63	540	547	573	553.3	554	546	568	556.0
8	11.38	565	566	551	560.7	544	557	585	562.0
Averages ---------->		561.7	560.9	560.0	560.9	560.8	554.4	559.6	558.3

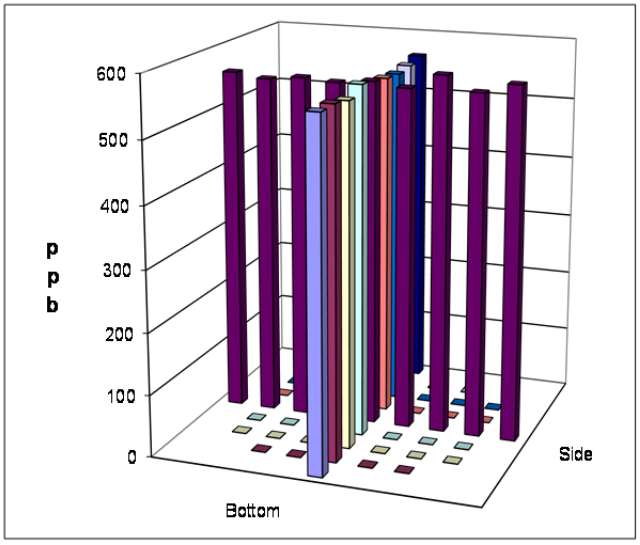
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	559.56		Mean	559.43	557.67	558.55
Min Point	552.00	-1.4%	Std. Dev.	8.81	5.21	7.02
Max Point	578.33	3.4%	COV as %	1.6	0.9	1.3

Avg. Conc. 559.375 ppb

Instuments Used:

B&K 1302 Gas Analyzer SN	1765299	Cat2 M&TE
TSI VelociCalc SN T95351203001		1/17/2013
Fisher Scientific SN 90936818		12/7/2012

	Start	Finish	
Tracer tank pressure	125	200	psig
Injection flowmeter	30	30	sccm
Stack Temp	71.8	75.4	°F
Mean stack velocity	2525	2560	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	996	996	mbar
Ambient humidity	23%	24%	RH
Ambient Temp	75	71	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	4, 8, 6, 4, 3	12, 14, 13, 11, 10	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/9/2012
EA 4/13/12

Notes: B&K Analyzer reset on final traverse side traverse center. Re-did reading 4.

EA 4/13/12

Entries made by:	EA	Technical Data Review performed by:	Susan Sande
Signature/date	Signature on file with original 4/13/2012	Signature/date	7/16/2012 Signature on file with original TI-WTPSP-070

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S1 Model	Run No.	GT-15
Date	4/13/2012	Fan Configuration	Fan B only
Testers	EA, YFS	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	73.55 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	1510 / 1630
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C Bottom

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	537	536	551	541.3	571	571	540	560.7
2	1.25	578	518	498	531.3	530	518	547	531.7
3	2.30	521	555	496	524.0	529	532	555	538.7
4	3.84	543	523	556	540.7	508	544	501	517.7
Center	5.94	540	537	494	523.7	547	543	572	554.0
5	8.04	573	557	543	557.7	508	519	535	520.7
6	9.57	542	552	513	535.7	501	502	553	518.7
7	10.63	479	527	591	532.3	510	504	521	511.7
8	11.38	541	529	585	551.7	533	551	520	534.7
Averages ---->		539.3	537.1	536.3	537.6	526.3	531.6	538.2	532.0

All	ppb	Dev. from mean
Mean	534.81	
Min Point	511.67	-4.3%
Max Point	560.67	4.8%

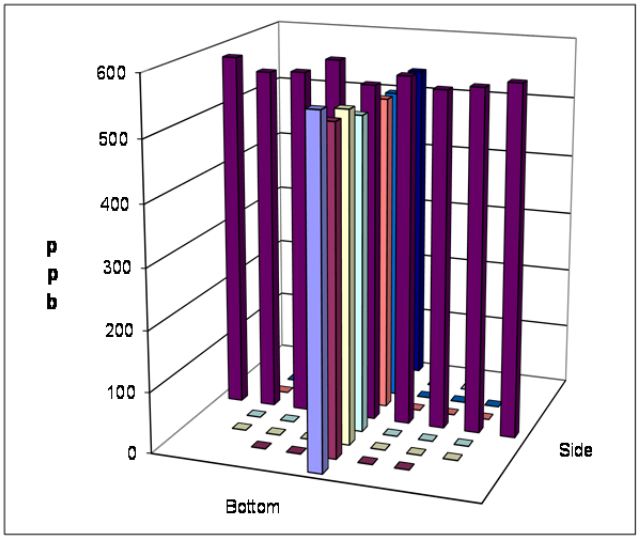
Center 2/3	Side	Bottom	All
Mean	535.05	527.57	531.31
Std. Dev.	11.66	14.81	13.38
COV as %	2.2	2.8	2.5

Avg. Conc. 534.313 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN	1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001		1/17/2013
Fisher Scientific	SN 90936818		12/7/2012

	Start	Finish	
Tracer tank pressure	200	125	psig
Injection flowmeter	30	30	sccm
Stack Temp	76	71.1	°F
Mean stack velocity	3021	2798	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	995	995	mbar
Ambient humidity	25%	24%	RH
Ambient Temp	69.8	70.7	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	10, 6, 6, 10, 6	9, 3, 6, 5, 3	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/9/2012

Notes:

EA 4/13/12

Entries made by:	EA	Technical Data Review performed by:	Susan Sande
Signature/date	Signature on file with original 4/13/2012	Signature/date	7/16/2012 Signature on file with original TI-WTPSP-070

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S1 Model	Run No.	GT-16
Date	4/16/2012	Fan Configuration	Fan B only
Testers	CA, XY	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	57.8 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	11:00/12:30
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C Bottom

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	522	522	512	518.7	525	543	502	523.3
2	1.25	495	507	564	522.0	549	524	556	543.0
3	2.30	511	512	535	519.3	538	576	553	555.7
4	3.84	527	545	552	541.3	557	511	556	541.3
Center	5.94	523	540	550	537.7	574	555	528	552.3
5	8.04	536	555	540	543.7	530	545	552	542.3
6	9.57	533	542	505	526.7	501	547	547	531.7
7	10.63	551	553	540	548.0	530	503	542	525.0
8	11.38	514	611	530	551.7	552	534	541	542.3
Averages ---->		523.6	543.0	536.4	534.3	539.6	537.6	541.9	539.7

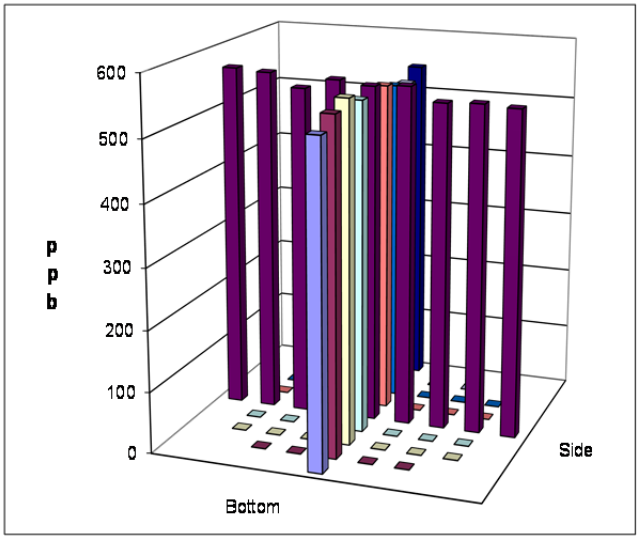
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	537.00		Mean	534.10	541.62	537.86
Min Point	518.67	-3.4%	Std. Dev.	11.32	10.72	11.29
Max Point	555.67	3.5%	COV as %	2.1	2.0	2.1

Avg. Conc. 536.000 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN	1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001		1/17/2013
Fisher Scientific	SN 90936818		12/7/2012

	Start	Finish	
Tracer tank pressure	100	100	psig
Injection flowmeter	30	30	sccm
Stack Temp	57.1	58.5	°F
Mean stack velocity	3175	3004	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1004	1004	mbar
Ambient humidity	79%	68%	RH
Ambient Temp	59	57.2	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	3,4,5,2,4	10,11,9,5,7	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/16/2012 CA XY 4/16/12

Notes: Slight rain, light wind. XY 4/16/12

XY 4/16/12

Entries made by:	CA	Technical Data Review performed by:	Susan Sande
Signature/date	Signature on file with original 4/16/2012	Signature/date	7/16/2012 Signature on file with original TI-WTPSP-070

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S1 Model	Run No.	GT-17
Date	6/28/2012	Fan Configuration	Fan A only
Testers	Ca, EA	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	83 deg F
Stack X-Area	111.9 $in.^2$	Start/End Time	1000/1130
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C-Center

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	481	466	460	**469.0**	475	454	463	**464.0**
2	1.25	465	466	464	**465.0**	463	474	464	**467.0**
3	2.30	448	459	458	**455.0**	443	466	473	**460.7**
4	3.84	475	461	472	**469.3**	479	477	463	**473.0**
Center	5.94	462	472	463	**465.7**	470	477	465	**470.7**
5	8.04	474	472	468	**471.3**	464	472	469	**468.3**
6	9.57	467	462	480	**469.7**	465	467	466	**466.0**
7	10.63	475	473	470	**472.7**	470	475	468	**471.0**
8	11.38	467	474	461	**467.3**	461	445	478	**461.3**
Averages ---->		**468.2**	**467.2**	**466.2**	**467.2**	**465.6**	**467.4**	**467.7**	**466.9**

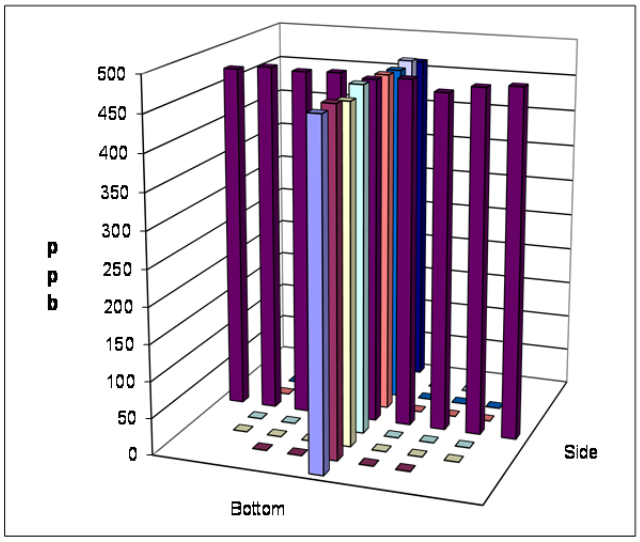
All	ppb	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	467.06		Mean	466.95	468.10	467.52
Min Point	455.00	-2.6%	Std. Dev.	5.96	4.08	4.94
Max Point	473.00	1.3%	COV as %	1.3	0.9	**1.1**

Avg. Conc. 466.917 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	125	125	psig
Injection flowmeter	30	30	sccm
Stack Temp	80	86	°F
Mean stack velocity	3317	3307	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1002	1001	mbar
Ambient humidity	32%	32%	RH
Ambient Temp	75.2	77.0	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	1, 1.27, .3, 4.0,4.1	6.8, 8.3, 8.3, 2.08, 4.28	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 6/27/2012

Notes:

CA 6/28/12

Entries made by:	Carmen Arimescu	Technical Data Review performed by:	Susan Sande
Signature/date	6/28/2012	Signature/date	7/16/2012
	Signature on file with Original		Signature on file with original
			TI-WTPSP-070

A.5 HV-S1 Particle Tracer Uniformity Data Sheets

Rev. 0
3 Aug. 2006

PARTICLE TRACER TRAVERSE DATA FORM

Site	HV-S1 Model	Run No.	PT-1
Date	4/3/2012	Fan configuration	FAN B ONLY
Tester	JAG ,CA	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	72.45 deg F
Stack X-Area	111.9 in.2	Start/End Time	1:48 / 3:48
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	particles/ft3	Injection Point	C Center
Order ---->	2nd		1st

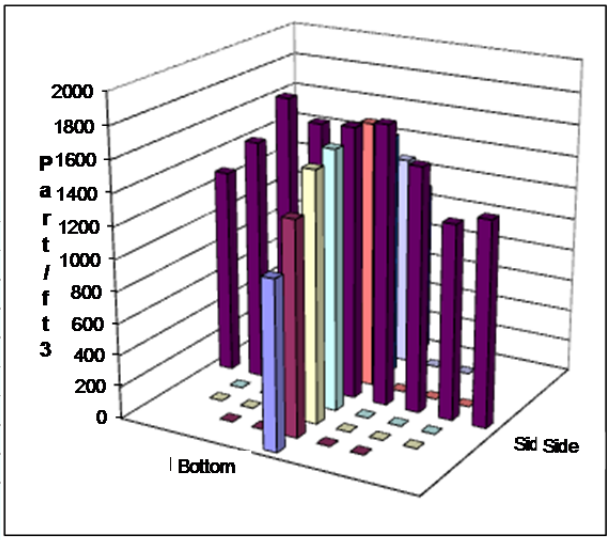
		Side				Bottom			
Traverse-->									
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	particles/ft3				particles/ft3			
1	0.50	983	981	940	968.0	939	1121	1116	1058.7
2	1.24	948	965	844	919.0	1251	1396	1373	1340.0
3	2.29	1084	1294	1077	1151.7	1519	1566	1621	1568.7
4	3.82	1100	1413	1431	1314.7	1582	1636	1674	1630.7
Center	5.91	978	1458	1397	1277.7	1632	1697	1781	1703.3
5	8.00	881	1543	1383	1269.0	1624	1641	1745	1670.0
6	9.52	1249	1481	1359	1363.0	1521	1487	1580	1529.3
7	10.57	1266	1284	853	1134.3	1271	1374	1339	1328.0
8	11.31	994	1041	861	965.3	1013	1124	1110	1082.3
Averages ---------->		1053.7	1273.3	1127.2	1151.4	1372.4	1449.1	1482.1	1434.6

All	pt/ft3	Dev. from mean	*Center 2/3*	Side	Bottom	All	Normlzd
Mean	1293.0		Mean	1204.2	1538.6	1371.4	1571.97
Min Point	919.0	-28.9%	Std. Dev.	150.6	151.5	226.2	174.31
Max Point	1703.3	31.7%	COV as %	12.5	9.8	16.5	11.09

Avg Conc 1268 pt/ft3

	Start	Finish	
Generator Inlet Press	3.5	3.5	psig
Stack Temp	71.5	73.4	F
Mean velocity	2583	2642	sfpm
Ambient pressure	29.44	29.44	inHg
Ambient humidity	26%	25%	RH
Ambient temp	78.8	72.5	F
Back-Gd aerosol	3,2,5,3	3,2,1,4	pt/ft3
No. Bk-Gd samples	4	4	
Compressor output	135	150	psig

Instruments Used:		Cal. Due
TSI VelociCalc	T95351203001	12/17/2012
Fisher Scientific	90936818	12/7/2012
Met One OPC	1011529010 ref	2/1/2013
Met One OPC	1011529009 sample	1/9/2013



Notes: Reference instrument = MetOne WD66891 (S/N 1011529010)

CA 4/3/2012

Oil Used: Edwards

Ref. Probe Location: Port 1, Center bottom

Probe Type / Configuration: L-shaped probe, both sample and reference are identical

Entries made by: JAG, CA
Signature/date 4/3/2011
On File w/ Original

Technical Data Review performed by: Elizabeth Golovich
Signature/date Signature on File with Original
TI-WTPSP-071
6/28/2012

Rev. 0

3 Aug. 2006

PARTICLE TRACER TRAVERSE DATA FORM

Site	HV-S1 Model	Run No.	PT-2
Date	4/3/2012	Fan configuration	FAN B ONLY
Tester	JAG ,CA	Fan Setting	23 Hz
Stack Dia.	11.938 in.	Stack Temp	67.85 deg F
Stack X-Area	111.9 in.2	Start/End Time	3:40 / 5:45
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	particles/ft3	Injection Point	Center
Order ——>	1st		2nd

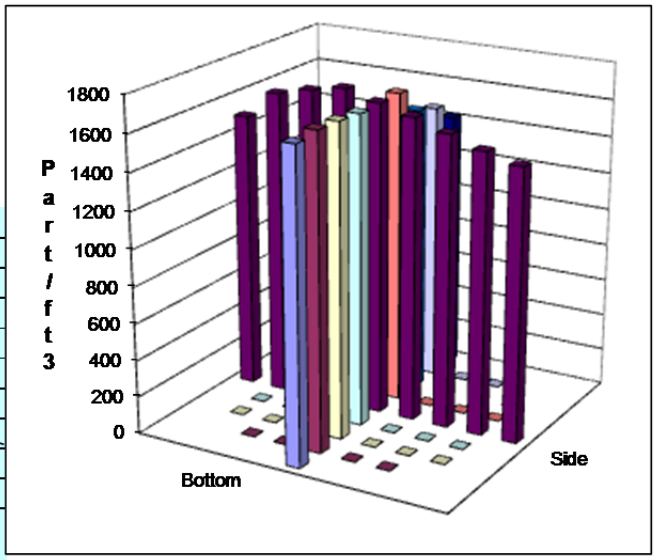
Traverse—>	Side				Bottom			
Trial —>	1	2	3	Mean	1	2	3	Mean
Point / Depth, in.	particles/ft3				particles/ft3			
1 / 0.50	1377	1525	1515	1472.3	1095	1570	1321	1328.7
2 / 1.24	1509	1515	1534	1519.3	1166	1564	1299	1343.0
3 / 2.29	1538	1585	1613	1578.7	1141	1574	1301	1338.7
4 / 3.82	1517	1670	1723	1636.7	1223	1414	1356	1331.0
Center / 5.91	1612	1691	1748	1683.7	1193	1558	1259	1336.7
5 / 8.00	1683	1734	1776	1731.0	1203	1530	1285	1339.3
6 / 9.52	1666	1718	1701	1695.0	1126	1339	1219	1228.0
7 / 10.57	1593	1701	1660	1651.3	1126	1368	1107	1200.3
8 / 11.31	1490	1575	1438	1501.0	1069	1231	1064	1121.3
Averages ——>	1553.9	1634.9	1634.2	1607.7	1149.1	1460.9	1245.7	1285.2

All	pt/ft3	Dev. from mean	*Center 2/3*	Side	Bottom	All	Normlzd
Mean	1446.4		Mean	1642.2	1302.4	1472.3	1641.39
Min Point	1121.3	-22.5%	Std. Dev.	72.6	60.9	187.7	71.78
Max Point	1731.0	19.7%	COV as %	4.4	4.7	12.7	4.37

Avg Conc 1438 pt/ft3

	Start	Finish	
Generator Inlet Press	2	2	psig
Stack Temp	73.4	62.3	F
Mean velocity	908	953	sfpm
Ambient pressure	29.41	29.44	inHg
Ambient humidity	23%	30%	RH
Ambient temp	80.6	65.3	F
Back-Gd aerosol	3,2,1,4	0,3,3,0	pt/ft3
No. Bk-Gd samples	4	4	
Compressor output	15.0	14.5	psig

Instuments Used:		Cal. Due
TSI VelociCalc	T95351203001	12/17/2012
Fisher Scientific	90936818	12/7/2012
Met One OPC	1011529010 ref	2/1/2013
Met One OPC	1011529009 sample	1/9/2013



Notes: Reference instrument = MetOne WD66891 (S/N 1011529010)

CA 4/3/2012

Oil Used: Edwards

Ref. Probe Location: Port 1, Center bottom

Probe Type / Configuration: L-shaped probe, both sample and reference are identical

Entries made by: JAG, CA
Signature/date 4/3/2012
On File w/ Original

Technical Data Review performed by: Elizabeth Golovich
Signature/date Signature on File with Original
TI-WTPSP-071
6/28/2012

Rev. 0

3 Aug. 2006

PARTICLE TRACER TRAVERSE DATA FORM

Site	HV-S1 Model	Run No.	PT-3
Date	4/4/2012	Fan configuration	FAN A ONLY
Tester	CA, XY, JAG	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	58.6 deg F
Stack X-Area	111.9 in.2	Start/End Time	9:45 / 12:45
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	particles/ft3	Injection Point	Center
Order ——>	2nd		1st

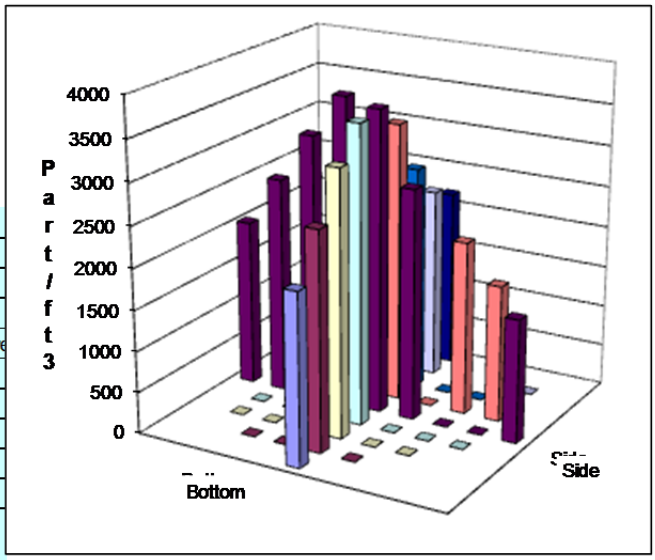
		Side				Bottom			
Traverse—>									
Trial —>		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	particles/ft3				particles/ft3			
1	0.50	750	973	756	826.3	2032	1998	2227	2085.7
2	1.24	895	976	882	917.7	2433	2655	2867	2651.7
3	2.29	1335	935	1221	1163.7	3261	3197	3214	3224.0
4	3.82	1819	913	1906	1546.0	3723	3478	3650	3617.0
Center	5.91	2073	1867	2134	2024.7	3700	3619	3694	3671.0
5	8.00	1991	2275	1955	2073.7	3162	3495	3498	3385.0
6	9.52	1809	1957	1585	1783.7	2673	2652	2863	2729.3
7	10.57	1514	1515	1328	1452.3	2518	2134	2320	2324.0
8	11.31	917	1152	1289	1119.3	2318	2025	2174	2172.3
Averages ——>		1455.9	1395.9	1450.7	1434.1	2868.9	2805.9	2945.2	2873.3

All	pt/ft3	Dev. from mean	*Center 2/3*	Side	Bottom	All	Normlzd
Mean	2153.7		Mean	1566.0	3086.0	2326.0	2962.64
Min Point	826.3	-61.6%	Std. Dev.	430.3	521.1	912.6	650.12
Max Point	3671.0	70.4%	COV as %	27.5	16.9	39.2	21.94

Avg Conc 2067 pt/ft3

	Start	Finish	
Generator Inlet Press	6	5.8	psig
Stack Temp	54.7	62.5	F
Mean velocity	2427	2706	sfpm
Ambient pressure	29.56	29.59	inHg
Ambient humidity	39%	26%	RH
Ambient temp	56.3	67.1	F
Back-Gd aerosol	8,8,10,14	8,4,2,2	pt/ft3
No. Bk-Gd samples	4	4	
Compressor output	7.5	9.0	psig

Instuments Used:		Cal. Due
TSI VelociCalc	T95351203001	12/17/2012
Fisher Scientific	90936818	12/7/2012
Met One OPC	1011529010 sample	2/1/2013
Met One OPC	1011529009 ref	1/9/2013



Notes: Compressor pressure 150 psi

The particle generator seems to be very sensitive to ambient temperaturechange. For example, outdoor temperature changes from 56 F to 72 F, the particle number concentration at center raised from ~ 2700 to 3700. Thus, we redid traverse 1st and 2nd for bottom.

XY 4/4/12

Oil Used: Edwards

Ref. Probe Location: Port 1, Center bottom

Probe Type / Configuration: L-shaped probe, both sample and reference are identical

Entries made by: CA, XY

Signature/date 4/4/2012

On File w/ Original

Technical Data Review performed by: Elizabeth Golovich

Signature/date Signature on File with Original

TI-WTPSP-071

6/28/2012

Rev. 0

3 Aug. 2006

PARTICLE TRACER TRAVERSE DATA FORM

Site	HV-S1 Model	Run No.	PT-4
Date	4/4/2012	Fan configuration	FAN A ONLY
Tester	JAG, CA	Fan Setting	27.1 Hz
Stack Dia.	11.938 in.	Stack Temp	68.95 deg F
Stack X-Area	111.9 in.2	Start/End Time	1:40 / 4:00
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	particles/ft3	Injection Point	Center
Order ——>	1st		2nd

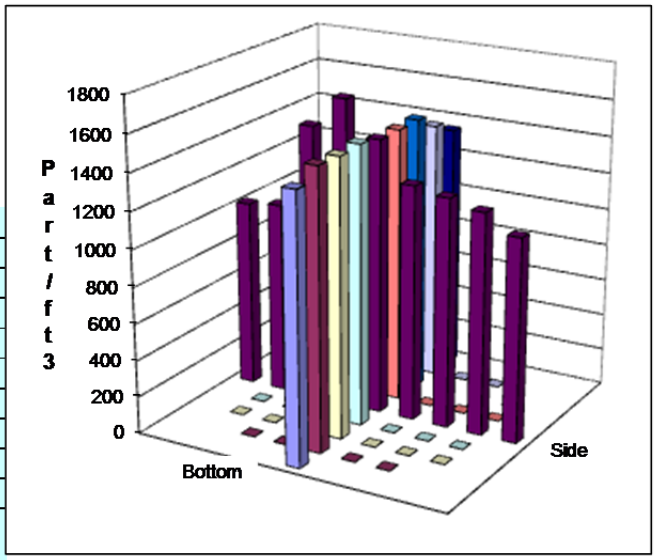
Traverse-->	Side				Bottom			
Trial ——>	1	2	3	Mean	1	2	3	Mean
Point / Depth, in.	particles/ft3				particles/ft3			
1 / 0.50	864	853	848	855.0	1497	1399	1459	1451.7
2 / 1.24	991	973	826	930.0	1530	1550	1467	1515.7
3 / 2.29	982	976	930	962.7	1515	1549	1467	1510.3
4 / 3.82	1012	1016	935	987.7	1491	1596	1476	1521.0
Center / 5.91	1120	1159	1174	1151.0	1422	1587	1469	1492.7
5 / 8.00	1297	1304	1283	1294.7	1514	1552	1418	1494.7
6 / 9.52	1273	1008	1205	1162.0	1479	1521	1496	1498.7
7 / 10.57	929	693	794	805.3	1390	1436	1417	1414.3
8 / 11.31	799	833	731	787.7	1357	1340	1331	1342.7
Averages ——>	1029.7	979.4	969.6	992.9	1466.1	1503.3	1444.4	1471.3

All	pt/ft3	Dev. from mean	*Center 2/3*	Side	Bottom	All	Normlzd
Mean	1232.1		Mean	1041.9	1492.5	1267.2	1421.83
Min Point	787.7	-36.1%	Std. Dev.	167.3	36.1	261.1	166.43
Max Point	1521.0	23.4%	COV as %	16.1	2.4	20.6	11.71

Avg Conc 1221 pt/ft3

	Start	Finish	
Generator Inlet Press	3	3	psig
Stack Temp	69.6	68.3	F
Mean velocity	1034	1097	sfpm
Ambient pressure	29.59	29.59	inHg
Ambient humidity	22%	20%	RH
Ambient temp	77	84.2	F
Back-Gd aerosol	0,1,1,1	1,0,0,4	pt/ft3
No. Bk-Gd samples	4	4	
Compressor output	20	20	psig

Instuments Used:			Cal. Due
TSI VelociCalc	T95351203001		12/17/2012
Fisher Scientific	90936818		12/7/2012
Met One OPC	1011529010	Measure	2/1/2013
Met One OPC	1011529009	Ref	1/9/2013



Notes:

CA 4/4/2012

Oil Used: Edwards

Ref. Probe Location: Port 1, Center bottom

Probe Type / Configuration: L-shaped probe, both sample and reference are identical

Entries made by:	CA, JAG	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	4/4/2012 On File w/ Original	Signature/date	Signature on File with Original TI-WTPSP-071 6/28/2012

Rev. 0
3 Aug. 2006

PARTICLE TRACER TRAVERSE DATA FORM

Site	HV-S1 Model	Run No.	PT-5
Date	4/5/2012	Fan configuration	FAN A ONLY
Tester	JEF, XY, CA	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	60.8 deg F
Stack X-Area	111.9 in.2	Start/End Time	1218/230
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	particles/ft3	Injection Point	Center

		Side				Bottom			
Order →		2nd				1st			
Traverse→		Side				Bottom			
Trial →		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	particles/ft3				particles/ft3			
1	0.50	1069	1220	1140	1143.0	1320	1564	1516	1466.7
2	1.24	1371	1314	1259	1314.7	1843	1804	1832	1826.3
3	2.29	1231	1106	1351	1229.3	2082	2095	2179	2118.7
4	3.82	1395	1145	1325	1288.3	2164	2206	2196	2188.7
Center	5.91	1403	1483	1425	1437.0	2169	2159	2276	2201.3
5	8.00	1290	1732	1485	1502.3	2073	2193	2133	2133.0
6	9.52	1348	1556	1312	1405.3	1861	2091	2025	1992.3
7	10.57	1130	1227	1094	1150.3	1807	1732	1890	1809.7
8	11.31	1023	1111	1194	1109.3	1403	1624	1639	1555.3
Averages →		1251.1	1321.6	1287.2	1286.6	1858.0	1940.9	1965.1	1921.3

All	pt/ft3	Dev. from mean
Mean	1604.0	
Min Point	1109.3	-30.8%
Max Point	2201.3	37.2%

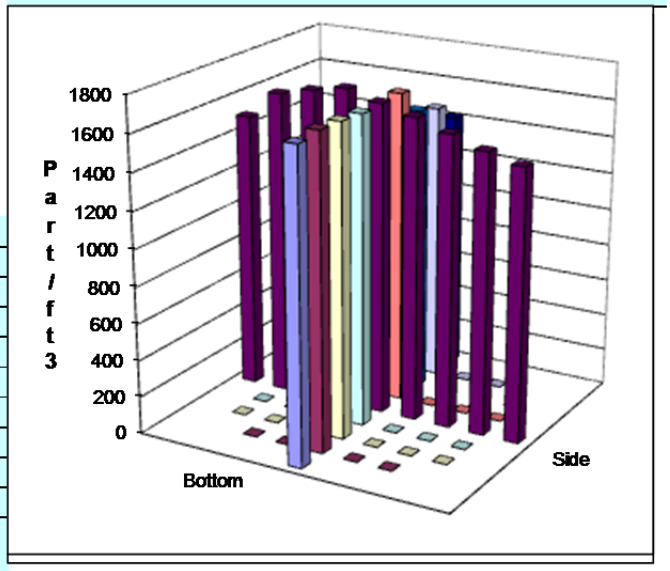
Center 2/3	Side	Bottom	All	Normlzd
Mean	1332.5	2038.6	1685.5	2039.89
Std. Dev.	123.3	165.3	392.2	170.50
COV as %	9.3	8.1	23.3	8.36

Avg Conc 1577 pt/ft3

	Start	Finish	
Generator Inlet Press	4.5	4.5	psig
Stack Temp	61.2	60.4	F
Mean velocity	2592	2500	sfpm
Ambient pressure	29.74	29.71	inHg
Ambient humidity	24%	29%	RH
Ambient temp	67.1	64.4	F
Back-Gd aerosol	6,3,9,4	1,2,1,3	pt/ft3
No. Bk-Gd samples	4	4	
Compressor output	22	24	psig

Instuments Used:

		Cal. Due
TSI VelociCalc	T95351203001	12/17/2012
Fisher Scientific	90936818	12/7/2012
Met One OPC	1011529010	2/1/2013
Met One OPC	1011529009	1/9/2013



Notes: WD66891 (S/N 1011529010) used as Reference instrument

RE-do PT-3

XY 4/5/12

Oil Used: Edwards

Ref. Probe Location: Port1, Bottom C

Probe Type / Configuration: L-shaped probe

Entries made by: CA, XY
Signature/date 4/5/2012
On File w/ Original

Technical Data Review performed by: Elizabeth Golovich
Signature/date Signature on File with Original
TI-WTPSP-071
6/28/2012

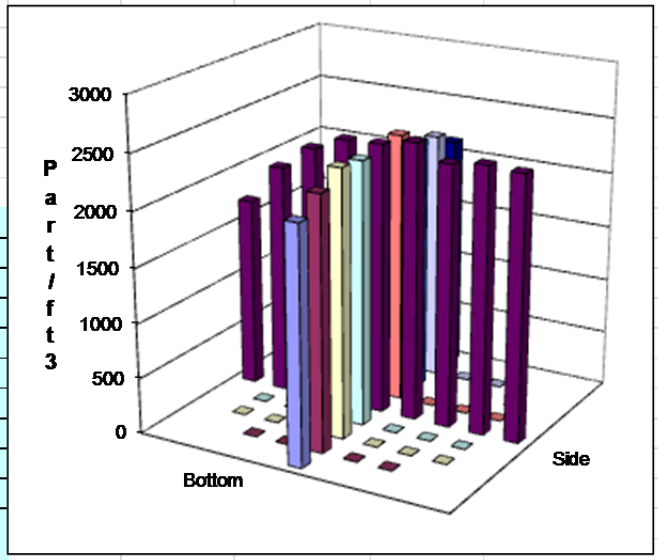
Rev. 0		PARTICLE TRACER TRAVERSE DATA FORM							
3 Aug. 2006	Site	HV-S1 Model			Run No.	PT-6			
	Date	4/6/2012			Fan configuration	FAN B ONLY			
	Tester	JEF,XY			Fan Setting	28		Hz	
	Stack Dia.	11.938	in.		Stack Temp	59.35	deg F		
	Stack X-Area	111.9	in.2		Start/End Time	1055/ 1225			
	Test Port	2			Center 2/3 from	1.10	to:	10.84	
Distance to disturbance		240	inches		Points in Center 2/3	2	to:	7	
	Measurement units	particles/ft3			Injection Point	C, CENTER			
	Order —>	1st				2nd			
	Traverse—>	Side				Bottom			
	Trial —>	1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	particles/ft3				particles/ft3			
1	0.50	1722	1977	1907	1868.7	2251	2060	2113	2141.3
2	1.24	1844	1887	1918	1883.0	2295	2245	2331	2290.3
3	2.29	1810	1965	1777	1850.7	2481	2329	2441	2417.0
4	3.82	1951	2079	1840	1956.7	2444	2283	2449	2392.0
Center	5.91	1899	2034	1789	1907.3	2418	2392	2528	2446.0
5	8.00	1872	1948	1875	1898.3	2445	2349	2528	2440.7
6	9.52	1843	1823	1736	1800.7	2237	2246	2413	2298.7
7	10.57	1713	1530	1636	1626.3	2248	2185	2344	2259.0
8	11.31	1426	1469	1136	1343.7	2049	2195	2141	2128.3
Averages —>		1786.7	1856.9	1734.9	1792.8	2318.7	2253.8	2365.3	2312.6

All	pt/ft3	Dev. from mean	*Center 2/3*	Side	Bottom	All	Normlzd
Mean	2052.7		Mean	1846.1	2363.4	2104.8	2365.45
Min Point	1343.7	-34.5%	Std. Dev.	108.4	78.4	283.3	108.43
Max Point	2446.0	19.2%	COV as %	5.9	3.3	13.5	4.58

Avg Conc 2037 pt/ft3

	Start	Finish	
Generator Inlet Press	3.8	3.8	psig
Stack Temp	61.1	57.6	F
Mean velocity	1281	1314	sfpm
Ambient pressure	29.88	29.88	inHg
Ambient humidity	28%	26%	RH
Ambient temp	59	68.9	F
Back-Gd aerosol	1,0,2,0	1,1,0,1	pt/ft3
No. Bk-Gd samples	4	4	
Compressor output	23	23	psig

Instuments Used:			Cal. Due
TSI VelociCalc	T95351203001		12/17/2012
Fisher Scientific	90936818		12/7/2013
Met One OPC	1011529010	Ref.	2/1/2013
Met One OPC	1011529009	Sample	1/9/2013



Notes: Cloudy day

Rain drops during the last measurements points.

JF 4/6/12

Oil Used: Edwards

Ref. Probe Location: Port 1, Center Bottom

Probe Type / Configuration: L-shaped probe

Entries made by:	JEF	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	4/6/2012	Signature/date	Signature on File with Original
	On File w/ Original		TI-WTPSP-071
			6/28/2012

Rev. 0

3 Aug. 2006

PARTICLE TRACER TRAVERSE DATA FORM

Site	HV-S1 Model	Run No.	PT-7
Date	4/6/2012	Fan configuration	Fan B only
Tester	JEF, XY, CA	Fan Setting	55 Hz
Stack Dia.	11.938 in.	Stack Temp	62.75 deg F
Stack X-Area	111.9 in.2	Start/End Time	1230/ 217
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	particles/ft3	Injection Point	CENTER PORT C

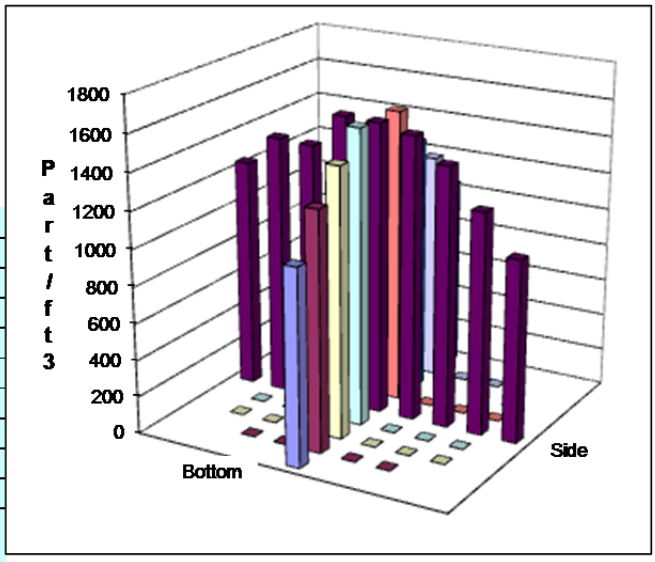
Order —>		2nd				1st			
Traverse—>		Side				Bottom			
Trial —>		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	particles/ft3				particles/ft3			
1	0.50	840	770	660	756.7	1150	991	1044	1061.7
2	1.24	963	1010	788	920.3	1319	1265	1302	1295.3
3	2.29	1122	1172	943	1079.0	1420	1456	1507	1461.0
4	3.82	1148	1247	1136	1177.0	1628	1568	1615	1603.7
Center	5.91	1120	1376	1122	1206.0	1563	1559	1618	1580.0
5	8.00	1109	1304	1219	1210.7	1596	1538	1640	1591.3
6	9.52	810	1204	1196	1070.0	1393	1357	1378	1376.0
7	10.57	1042	1056	1133	1077.0	1209	1216	1285	1236.7
8	11.31	1052	904	901	952.3	1039	1020	1046	1035.0
Averages —>		1022.9	1115.9	1010.9	1049.9	1368.6	1330.0	1381.7	1360.1

All	pt/ft3	Dev. from mean	*Center 2/3*	Side	Bottom	All	Normlzd
Mean	1205.0		Mean	1105.7	1449.1	1277.4	1448.88
Min Point	756.7	-37.2%	Std. Dev.	102.7	150.3	216.9	137.06
Max Point	1603.7	33.1%	COV as %	9.3	10.4	17.0	9.46

Avg Conc 1181 pt/ft3

	Start	Finish	
Generator Inlet Press	5.3	5.3	psig
Stack Temp	58.9	66.6	F
Mean velocity	2242	2550	sfpm
Ambient pressure	29.85	29.85	inHg
Ambient humidity	29%	23%	RH
Ambient temp	60.8	70.7	F
Back-Gd aerosol	4,1,0,3	0,1,3,2	pt/ft3
No. Bk-Gd samples	4	4	
Compressor output	21	24	psig

Instuments Used:		Cal. Due
TSI VelociCalc	T95351203001	12/17/2012
Fisher Scientific	90936818	12/7/2012
Met One OPC	1011529010 Ref	2/1/2013
Met One OPC	1011529009 Sample	1/9/2013



Notes:

CA 4/6/12

Oil Used: Edwards

Ref. Probe Location: Port 1, Center Bottom

Probe Type / Configuration: L-shaped probe, both sample & reference are identical. XY 4/6/12

Entries made by:	CA, JEF, XY
Signature/date	4/6/2012
	On File w/ Original

Technical Data Review performed by:	Elizabeth Golovich
Signature/date	Signature on File with Original
	TI-WTPSP-071
	6/28/2012

Rev. 0

3 Aug. 2006

PARTICLE TRACER TRAVERSE DATA FORM

Site	HV-S1 Model	Run No.	PT-8
Date	4/6/2012	Fan configuration	Fan B only
Tester	CA, JEF	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	60.7 deg F
Stack X-Area	111.9 in.2	Start/End Time	225/ 500
Test Port	1	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	300 inches	Points in Center 2/3	2 to: 7
Measurement units	particles/ft3	Injection Point	Center
Order ---->	2nd		1st

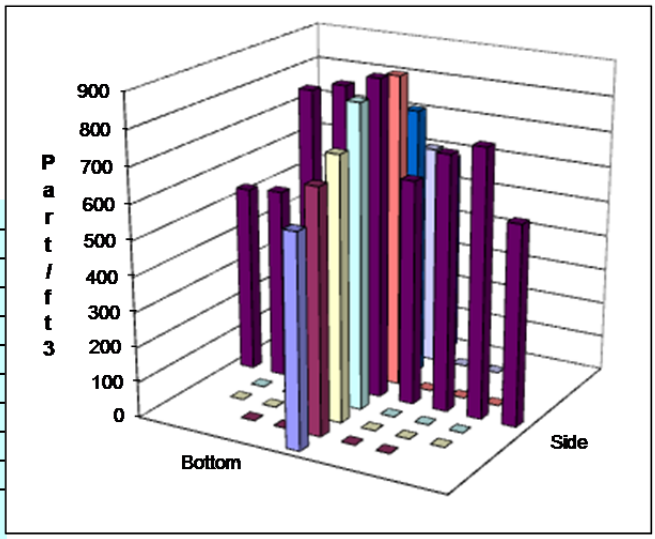
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	particles/ft3				particles/ft3			
1	0.50	325	485	373	394.3	653	518	627	599.3
2	1.24	507	589	482	526.0	769	678	618	688.3
3	2.29	534	561	412	502.3	812	707	718	745.7
4	3.82	400	473	451	441.3	870	858	845	857.7
Center	5.91	664	588	620	624.0	1041	835	820	898.7
5	8.00	623	594	587	601.3	934	879	836	883.0
6	9.52	584	595	572	583.7	871	701	717	763.0
7	10.57	395	396	334	375.0	746	565	575	628.7
8	11.31	352	319	435	368.7	598	546	582	575.3
Averages --------->		487.1	511.1	474.0	490.7	810.4	698.6	704.2	737.7

All	pt/ft3	Dev. from mean	*Center 2/3*	Side	Bottom	All	Normlzd
Mean	614.2		Mean	522.0	780.7	651.3	766.21
Min Point	368.7	-40.0%	Std. Dev.	90.4	102.9	163.3	113.72
Max Point	898.7	46.3%	COV as %	17.3	13.2	25.1	14.84

Avg Conc 596 pt/ft3

	Start	Finish	
Generator Inlet Press	6.9	6.9	psig
Stack Temp	61.1	60.3	F
Mean velocity	3055	2810	sfpm
Ambient pressure	29.85	29.85	inHg
Ambient humidity	22%	26%	RH
Ambient temp	75.2	63.5	F
Back-Gd aerosol	2,8,4,14	4,0,0,0	pt/ft3
No. Bk-Gd samples	4	4	
Compressor output	23	24	psig

Instuments Used:			Cal. Due
TSI VelociCalc	T95351203001		12/17/2012
Fisher Scientific	90936818		12/7/2012
Met One OPC	1011529010	Ref	2/1/2013
Met One OPC	1011529009	Sample	1/9/2013



Notes: Cloudy, varied temperatures sometimes light gusts. ..
Aerosol counts appear to have temperature dependence.
Run 4 trials on bottom.

JF 4/6/12

Oil Used: Edwards

Ref. Probe Location: Port 2, Bottom Center

Probe Type / Configuration: L-shaped probe

Entries made by:	CA, JEF	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	4/6/2012	Signature/date	Signature on File with Original
	On File w/ Original		TI-WTPSP-071
			6/28/2012

Appendix B

HV-S2 Data Sheets

B.1 HV-S2 Calibration of Ventilation Flow Controller

VELOCITY TRAVERSE DATA FORM

Site	HV-S2 Model	Run No.	FC-1
Date	4/25/12	Fan Configuration	Fan A
Testers	EA, YFS	Fan Setting	32 Hz
Stack Dia.	11.938 in.	Stack Temp	79.5 deg F
Stack X-Area	111.9 in.2	Start/End Time	1530 / 1555
Test Port	2	Center 2/3 from	1.10 to: 10.84
istance to disturbance	96.44 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

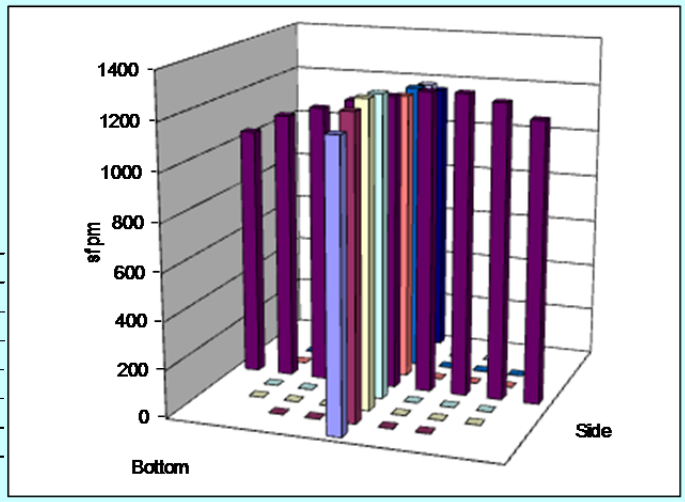
Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	1174	1165	1183	1174.0	1202	1180	1171	1184.3
2	1.25	1247	1219	1236	1234.0	1249	1232	1252	1244.3
3	2.32	1262	1258	1264	1261.3	1263	1273	1267	1267.7
4	3.86	1261	1260	1257	1259.3	1258	1258	1264	1260.0
Center	6.00	1239	1231	1223	1231.0	1231	1211	1229	1223.7
5	8.08	1209	1203	1199	1203.7	1198	1203	1194	1198.3
6	9.62	1171	1158	1158	1162.3	1203	1211	1202	1205.3
7	10.68	1135	1113	1113	1120.3	1183	1200	1199	1194.0
8	11.44	1041	1045	1041	1042.3	1135	1158	1149	1147.3
Averages ---->		1193.2	1183.6	1186.0	1187.6	1213.6	1214.0	1214.1	1213.9

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	1200.7		Mean	1210.3	1227.6	1219.0
Min Point	1042.3	-13.2%	Std. Dev.	52.3	30.1	42.0
Max Point	1267.7	5.6%	COV as %	4.3	2.5	3.4

Flow w/o C-Pt	931	scfm
Vel Avg w/o C-Pt	1197	sfpm

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	1/17/2013

	Start	Finish	
Stack temp	81.4	77.5	F
Equipment temp	NA	NA	F
Ambient temp	79.7	80.6	F
Stack static	NA	NA	mbars
Ambient pressure	29.32	29.32	in Hg
Total Stack pressure	NA	NA	mbars
Ambient humidity	30%	29%	RH



Notes: EA
4/25/2012

Entries made by:	EA	Technical Data Review performed by:	Rosanne Aaberg
Signature/date	4/25/2012	Signature/date	6/15/2012
	Signature on file with original	Signaure on file with original	TI-WTPSP-073

VELOCITY TRAVERSE DATA FORM

Site	HV-S2 Model	Run No.	FC-2
Date	4/25/12	Fan Configuration	Fan B
Testers	YFS, EA	Fan Setting	32 Hz
Stack Dia.	11.938 in.	Stack Temp	78.4 deg F
Stack X-Area	111.9 in.2	Start/End Time	1600 / 1615
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

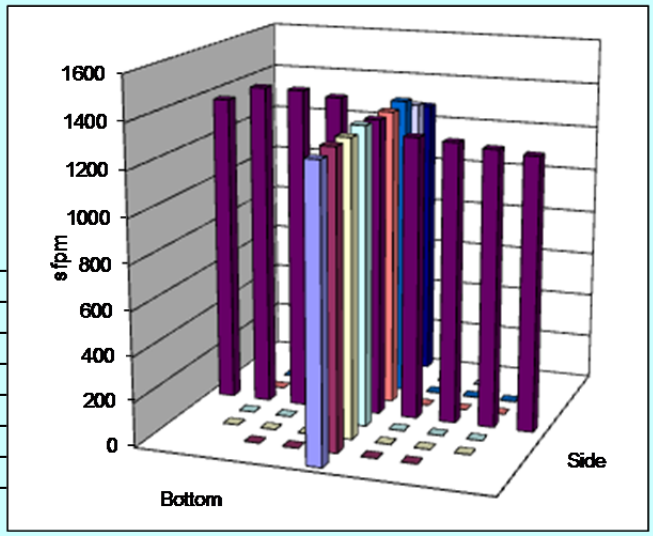
Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	1212	1214	1229	1218.3	1316	1295	1283	1298.0
2	1.25	1233	1231	1237	1233.7	1321	1317	1311	1316.3
3	2.32	1229	1258	1268	1251.7	1322	1316	1322	1320.0
4	3.86	1258	1243	1284	1261.7	1339	1344	1331	1338.0
Center	6.00	1347	1310	1321	1326.0	1326	1324	1341	1330.3
5	8.08	1423	1403	1407	1411.0	1325	1349	1329	1334.3
6	9.62	1433	1419	1444	1432.0	1357	1343	1355	1351.7
7	10.68	1444	1439	1418	1433.7	1315	1298	1299	1304.0
8	11.44	1409	1357	1345	1370.3	1272	1274	1262	1269.3
Averages ---------->		1332.0	1319.3	1328.1	1326.5	1321.4	1317.8	1314.8	1318.0

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	1322.2		Mean	1335.7	1327.8	1331.7
Min Point	1218.3	-7.9%	Std. Dev.	89.1	15.7	61.6
Max Point	1433.7	8.4%	COV as %	6.7	1.2	4.6

Flow w/o C-Pt	1027	scfm
Vel Avg w/o C-Pt	1322	sfpm

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	1/17/2013

	Start	Finish	
Stack temp	78.9	77.9	F
Equipment temp	NA	NA	F
Ambient temp	80.6	81.5	F
Stack static	NA	NA	mbars
Ambient pressure	29.32	29.32	in Hg
Total Stack pressure	NA	NA	mbars
Ambient humidity	29%	29%	RH



Notes: EA
4/25/2012

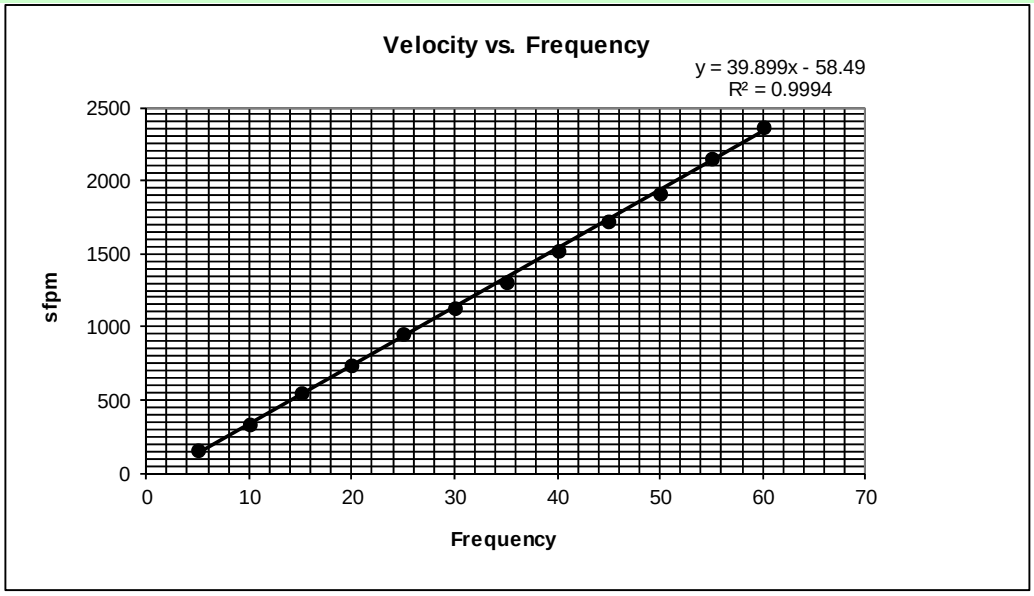
Entries made by:	EA	Technical Data Review performed by:	Rosanne Aaberg
Signature/date	4/25/2012	Signature/date	6/15/2012
	Signature on file with original	Signaure on file with original	TI-WTPSP-073

VELOCITY vs. FREQUENCY DATA FORM

Site	**HV-S2 model**	Run No.	**VF-1**
Date	4/27/2012	Stack Temp	61.6 deg F
Tester	YFS, EA	Stack RH%	37%
Stack Dia.	11.938 in.	Baro Press	29.85 in Hg
Stack X-Area	111.9 in2	Fan Configuration	Fan A Only
Test Port	2	Start/End Time	0855 / 0930
Dist. from disturbance	96.4 inches	Reference point from velocity test VC :	Bottom 5
Velocity Readings, units =	sfpm		

					Target scfm	Target sfpm	Estmtd Hz
					53,631	2,558	65
	sfpm				26,040	1,242	33
Hz	1	2	3	Mean	StDev	2 StDev	cfm
5	159	146	155	153.3	6.7	13.3	119.2
10	319	351	345	338.3	17.0	34.0	263.0
15	573	527	561	553.7	23.9	47.7	430.4
20	746	709	748	734.3	22.0	43.9	570.8
25	960	939	972	957.0	16.7	33.4	743.9
30	1123	1123	1134	1126.7	6.4	12.7	875.8
35	1313	1300	1315	1309.3	8.1	16.3	1017.7
40	1527	1514	1527	1522.7	7.5	15.0	1183.6
45	1736	1716	1725	1725.7	10.0	20.0	1341.4
50	1928	1914	1914	1918.7	8.1	16.2	1491.4
55	2147	2119	2204	2156.7	43.3	86.6	1676.4
60	2335	2413	2339	2362.3	43.9	87.8	1836.2

Instuments Used:	**Cal Exp. Date:**
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	1/17/2013



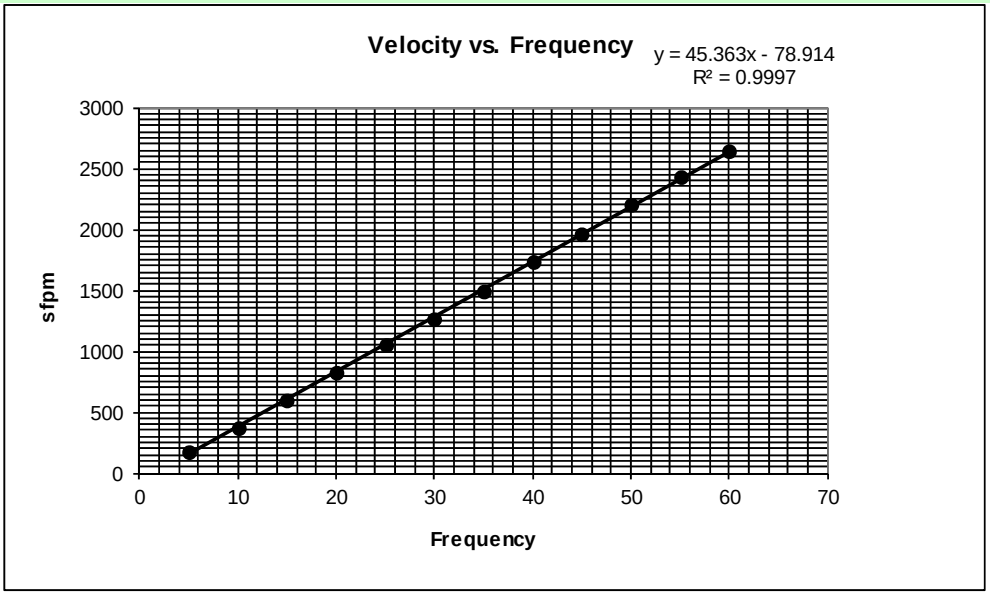
Entries made by: YFS	Technical Data Review performed by: RLA
Signature/date 4/27/2012	Signature/date 6/15/2012
Signature on file with original	Signature on file with original TI-WTPSP-073

VELOCITY vs. FREQUENCY DATA FORM

Site	**HV-S2 model**	Run No.	**VF-2**
Date	4/27/2012	Stack Temp	61 deg F
Tester	YFS, EA	Stack RH%	31%
Stack Dia.	11.938 in.	Baro Press	29.85 inHg
Stack X-Area	111.9 in2	Fan Configuration	Fan B only
Test Port	2	Start/End Time	0935 / 1000
Dist. from disturbance	96.4 inches	Reference point from velocity test VC :	Bottom 3
Velocity Readings, units =	sfpm		

					Target	Target	Estmtd
					scfm	sfpm	Hz
					53,631	2,558	58
	sfpm				26,040	1,242	29
Hz	1	2	3	Mean	StDev	2 StDev	cfm
5	204	165	170	179.7	21.2	42.4	139.7
10	359	384	355	366.0	15.7	31.4	284.5
15	626	589	575	596.7	26.4	52.7	463.8
20	836	819	821	825.3	9.3	18.6	641.5
25	1045	1037	1059	1047.0	11.1	22.3	813.8
30	1271	1253	1275	1266.3	11.7	23.4	984.3
35	1507	1484	1482	1491.0	13.9	27.8	1159.0
40	1762	1732	1712	1735.3	25.2	50.3	1348.9
45	1990	1938	1971	1966.3	26.3	52.6	1528.4
50	2199	2199	2208	2202.0	5.2	10.4	1711.6
55	2397	2436	2444	2425.7	25.1	50.3	1885.5
60	2641	2632	2657	2643.3	12.7	25.3	2054.7

Instuments Used:	**Cal Exp. Date:**
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	1/17/2013



Entries made by: YFS	Technical Data Review performed by: RLA
Signature/date 4/27/2012	Signature/date 6/15/2012
Signature on file with original	Signature on file with original TI-WTPSP-073

B.2 HV-S2 Velocity Uniformity Data Sheets

VELOCITY TRAVERSE DATA FORM

Site	HV-S2 Model	Run No.	VT-1		
Date	4/27/12	Fan Configuration	Fan A only		
Testers	EA, YFS	Fan Setting	60	Hz	
Stack Dia.	11.938 in.	Stack Temp	66	deg F	
Stack X-Area	111.9 in.2	Start/End Time	1050 / 1110		
Test Port	2	Center 2/3 from	1.10	to:	10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2	to:	7
Velocity units	s ft/min	Data Files:	NA		

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	2294	2221	2271	2262.0	2203	2256	2264	2241.0
2	1.25	2373	2379	2380	2377.3	2391	2403	2395	2396.3
3	2.32	2443	2430	2417	2430.0	2473	2488	2451	2470.7
4	3.86	2420	2464	2438	2440.7	2445	2455	2415	2438.3
Center	5.97	2455	2431	2379	2421.7	2378	2360	2346	2361.3
5	8.08	2353	2359	2329	2347.0	2293	2314	2321	2309.3
6	9.62	2345	2311	2328	2328.0	2286	2291	2286	2287.7
7	10.68	2346	2317	2307	2323.3	2250	2262	2260	2257.3
8	11.44	2201	2194	2175	2190.0	2203	2120	2152	2158.3
Averages ---->		2358.9	2345.1	2336.0	2346.7	2324.7	2327.7	2321.1	2324.5

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	2335.6		Mean	2381.1	2360.1	2370.6
Min Point	2158.3	-7.6%	Std. Dev.	49.9	79.6	64.8
Max Point	2470.7	5.8%	COV as %	2.1	3.4	2.7

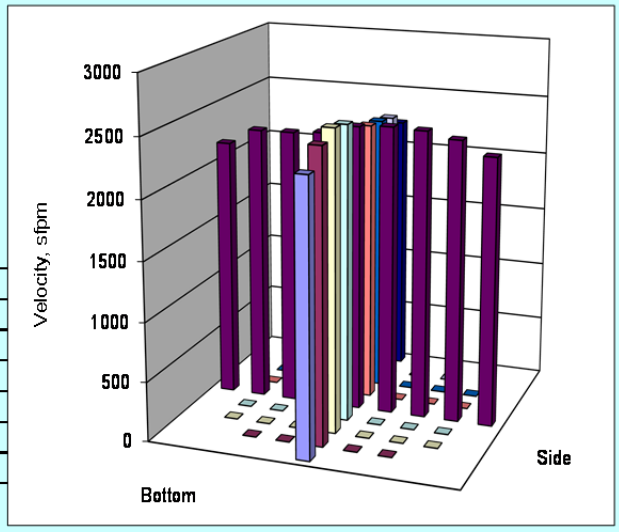
Flow w/o C-Pt 1810 scfm
Vel Avg w/o C-Pt 2329 sfpm

Instuments Used:

	Cal Due
Fisher Scientific Barometer SN 90936818	12/7/2012
TSI VelociCalc SN T95351203001	12/17/2012

	Start	Finish	
Stack temp	67.4	64.8	F
Equipment temp	NA	NA	F
Ambient temp	71.6	57.2	F
Stack static	NA	NA	mbars
Ambient pressure	29.85	29.85	in Hg
Total Stack pressure	NA	NA	mbars
Ambient humidity	27%	36%	RH

Notes: Fisher Scientific Barometer was in direct sunlight at start of testing.



Entries made by:	EA
Signature/date	4/27/2012
	Signature on file with original

Technical Data Review performed by:	Susan Sande
Signature/date	7/10/2012
	Signature on file with original TI-WTPSP-074

VELOCITY TRAVERSE DATA FORM

Site	HV-S2 Model	Run No.	VT-2
Date	4/27/12	Fan Configuration	Fan B only
Testers	YFS, EA	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	67 deg F
Stack X-Area	111.9 in.2	Start/End Time	1115 / 1136
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

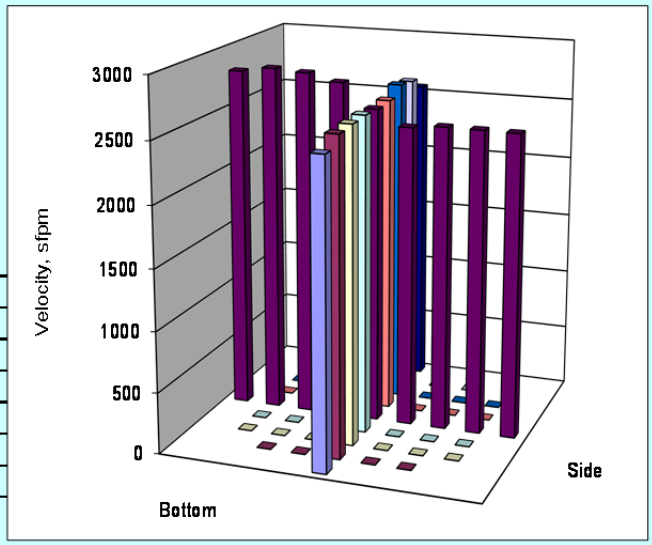
Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	2472	2456	2438	2455.3	2502	2498	2464	2488.0
2	1.25	2447	2446	2484	2459.0	2566	2601	2560	2575.7
3	2.32	2467	2464	2452	2461.0	2567	2620	2589	2592.0
4	3.86	2415	2436	2457	2436.0	2608	2598	2600	2602.0
Center	5.97	2544	2567	2571	2560.7	2565	2608	2599	2590.7
5	8.08	2778	2731	2750	2753.0	2585	2601	2629	2605.0
6	9.62	2781	2860	2793	2811.3	2707	2669	2662	2679.3
7	10.68	2806	2837	2844	2829.0	2666	2624	2680	2656.7
8	11.44	2773	2803	2793	2789.7	2533	2553	2585	2557.0
Averages ------>		2609.2	2622.2	2620.2	2617.2	2588.8	2596.9	2596.4	2594.0

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	2605.6		Mean	2615.7	2614.5	2615.1
Min Point	2436.0	-6.5%	Std. Dev.	176.3	38.3	122.6
Max Point	2829.0	8.6%	COV as %	6.7	1.5	4.7

Flow w/o C-Pt	2028	scfm
Vel Avg w/o C-Pt	2609	sfpm

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/7/2012
TSI VelociCalc SN T95351203001	12/17/2012

	Start	Finish	
Stack temp	67.7	66	F
Equipment temp	NA	NA	F
Ambient temp	58.1	72.5	F
Stack static	NA	NA	mbars
Ambient pressure	29.85	29.88	in Hg
Total Stack pressure	NA	NA	mbars
Ambient humidity	34%	30%	RH



Notes: Fisher Scientific Barometer was in direct sunlight at end of the testing.

Entries made by:	EA
Signature/date	4/27/2012
	Signature on file with original

Technical Data Review performed by:	Susan Sande
Signature/date	7/10/2012
	Signature on file with original TI-WTPSP-074

VELOCITY TRAVERSE DATA FORM

Site	HV-S2 Model	Run No.	VT-3
Date	4/27/12	Fan Configuration	Fan A
Testers	JAG, XYY	Fan Setting	28.9 Hz
Stack Dia.	11.938 in.	Stack Temp	68 deg F
Stack X-Area	111.9 in.2	Start/End Time	1315 / 1348
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	1057	1070	1081	1069.3	1038	1045	1025	1036.0
2	1.25	1118	1135	1121	1124.7	1098	1140	1115	1117.7
3	2.32	1126	1151	1124	1133.7	1144	1149	1133	1142.0
4	3.86	1142	1124	1143	1136.3	1134	1167	1147	1149.3
Center	5.97	1129	1124	1117	1123.3	1117	1129	1097	1114.3
5	8.08	1101	1092	1098	1097.0	1096	1073	1067	1078.7
6	9.62	1088	1069	1084	1080.3	1072	1086	1088	1082.0
7	10.68	1022	997	1016	1011.7	1060	1062	1028	1050.0
8	11.44	936	958	939	944.3	979	1020	967	988.7
Averages ---->		1079.9	1080.0	1080.3	1080.1	1082.0	1096.8	1074.1	1084.3

All	s ft/min	Dev. from mean	Center 2/3	Side	Bottom	All
Mean	1082.2		Mean	1101.0	1104.9	1102.9
Min Point	944.3	-12.7%	Std. Dev.	44.3	36.1	38.9
Max Point	1149.3	6.2%	COV as %	4.0	3.3	3.5

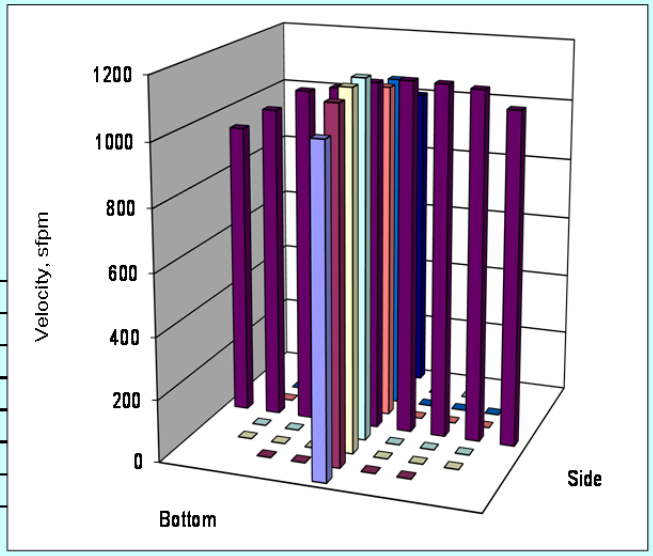
Flow w/o C-Pt 838 scfm

Vel Avg w/o C-Pt 1078 sfpm

Instuments Used:

	Cal Due
Fisher Scientific Barometer SN 90936818	12/7/2012
TSI VelociCalc SN T95351203001	12/17/2012

	Start	Finish	
Stack temp	67.9	67.9	F
Equipment temp	NA	NA	F
Ambient temp	84.2	72.5	F
Stack static	NA	NA	mbars
Ambient pressure	1011	1011	in Hg
Total Stack pressure	NA	NA	mbars
Ambient humidity	20%	23%	RH



Notes: Bottom 5 for Fan A; Bottom 3 for Fan B

Target flow is 1047 - 1216 fpm.

XY 4/27/12

Entries made by:	John Glyssmeyer	Technical Data Review performed by:	Susan Sande
Signature/date	4/27/2012	Signature/date	7/10/2012
	signature on file with original	Signature on file with original TI-WTPSP-074	

VELOCITY TRAVERSE DATA FORM

Site	HV-S2 Model	Run No.	VT-4
Date	4/27/12	Fan Configuration	Fan A Only
Testers	JAG / XYY	Fan Setting	32.5 Hz
Stack Dia.	11.938 in.	Stack Temp	72 deg F
Stack X-Area	111.9 in.2	Start/End Time	1350 / 1407
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	1164	1155	1153	1157.3	1152	1149	1165	1155.3
2	1.25	1207	1198	1213	1206.0	1237	1264	1271	1257.3
3	2.32	1242	1254	1250	1248.7	1307	1302	1299	1302.7
4	3.86	1281	1263	1246	1263.3	1283	1283	1303	1289.7
Center	5.97	1247	1263	1260	1256.7	1246	1243	1282	1257.0
5	8.08	1216	1226	1224	1222.0	1233	1238	1243	1238.0
6	9.62	1181	1204	1184	1189.7	1237	1242	1240	1239.7
7	10.68	1117	1131	1146	1131.3	1213	1229	1243	1228.3
8	11.44	1028	1088	1052	1056.0	1172	1171	1172	1171.7
Averages ---->		1187.0	1198.0	1192.0	1192.3	1231.1	1235.7	1246.4	1237.7

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	1215.0		Mean	1216.8	1259.0	1237.9
Min Point	1056.0	-13.1%	Std. Dev.	46.5	27.7	42.8
Max Point	1302.7	7.2%	COV as %	3.8	2.2	3.5

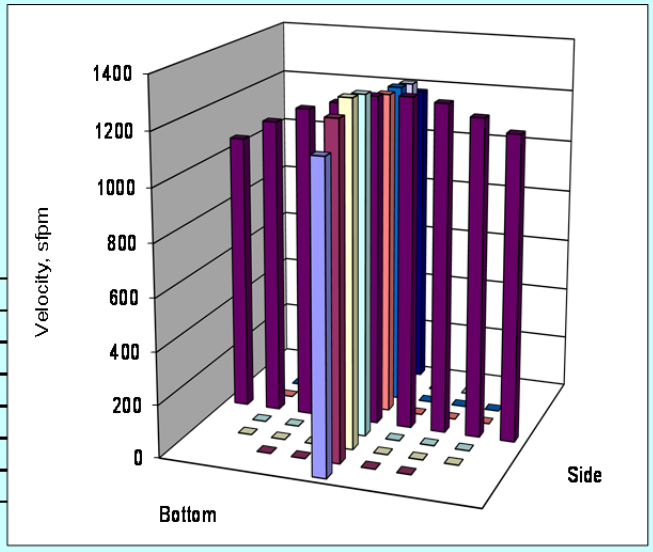
Flow w/o C-Pt 940 scfm

Vel Avg w/o C-Pt 1210 sfpm

Instuments Used:

	Cal Due
Fisher Scientific Barometer SN 90936818	12/7/2012
TSI VelociCalc SN T95351203001	12/17/2012

	Start	Finish	
Stack temp	72.0	72.8	F
Equipment temp	N.A.	N.A.	F
Ambient temp	75.2	70.7	F
Stack static	N.A.	N.A.	mbars
Ambient pressure	1011	1011	in Hg
Total Stack pressure	N.A.	N.A.	mbars
Ambient humidity	22%	24%	RH



Notes: Light wind.

Target fkiw us 1216 fpm. XY 4/27/12

XY 4/27/12

Entries made by:	XY
Signature/date	4/27/2012
	signature on file with original

Technical Data Review performed by:	Susan Sande
Signature/date	7/10/2012
Signature on file with original TI-WTPSP-074	

VELOCITY TRAVERSE DATA FORM

Site	HV-S2 Model	Run No.	VT-5		
Date	4/27/12	Fan Configuration	B		
Testers	JAG/XYY	Fan Setting	26.0	Hz	
Stack Dia.	11.938 in.	Stack Temp	70	deg F	
Stack X-Area	111.9 in.2	Start/End Time	1410 / 1434		
Test Port	2	Center 2/3 from	1.10	to:	10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2	to:	7
Velocity units	s ft/min	Data Files:	NA		

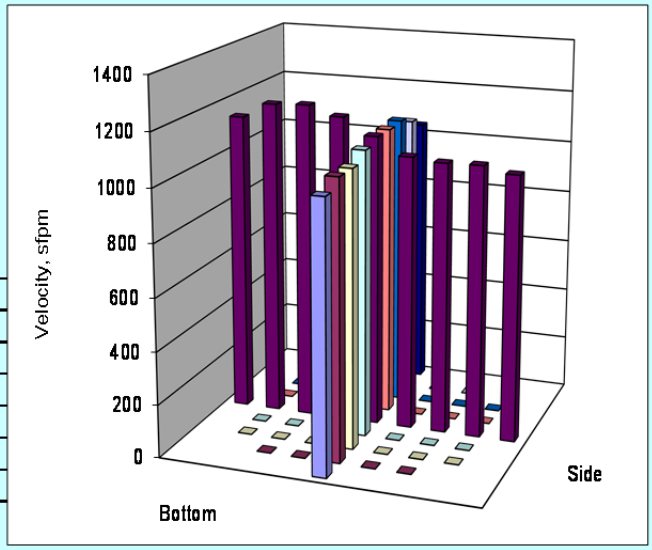
Order -->		2nd				ast			
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	997	990	990	992.3	996	1016	1041	1017.7
2	1.25	1005	1005	1036	1015.3	1027	1062	1073	1054.0
3	2.32	1042	993	1003	1012.7	1040	1061	1057	1052.7
4	3.86	1025	1041	1007	1024.3	1068	1087	1109	1088.0
Center	5.97	1082	1091	1094	1089.0	1098	1104	1125	1109.0
5	8.08	1155	1139	1158	1150.7	1095	1130	1095	1106.7
6	9.62	1172	1183	1200	1185.0	1117	1118	1102	1112.3
7	10.68	1168	1172	1196	1178.7	1077	1079	1090	1082.0
8	11.44	1110	1123	1131	1121.3	1039	1041	1042	1040.7
Averages ---->		1084.0	1081.9	1090.6	1085.5	1061.9	1077.6	1081.6	1073.7

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	1079.6		Mean	1093.7	1086.4	1090.0
Min Point	992.3	-8.1%	Std. Dev.	77.8	25.2	55.7
Max Point	1185.0	9.8%	COV as %	7.1	2.3	5.1

Flow w/o C-Pt	837	scfm
Vel Avg w/o C-Pt	1077	sfpm

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/7/2012
TSI VelociCalc SN T95351203001	12/17/2012

	Start	Finish	
Stack temp	68.5	71.3	F
Equipment temp	N.A.	N.A.	F
Ambient temp	79.7	70.7	F
Stack static	N.A.	N.A.	mbars
Ambient pressure	1011	1011	in Hg
Total Stack pressure	N.A.	N.A.	mbars
Ambient humidity	22%	24%	RH



Notes: Light wind. XY 4/27/12
Target flow is 1047 fpm.

XY 4/27/12

Entries made by:	XY
Signature/date	4/27/2012
	signature on file with original
Technical Data Review performed by:	Susan Sande
Signature/date	7/10/2012
Signature on file with original TI-WTPSP-074	

VELOCITY TRAVERSE DATA FORM

Site	HV-S2 Model	Run No.	VT-6
Date	4/27/12	Fan Configuration	Fan B Only
Testers	JAG, XY	Fan Setting	56.0 Hz
Stack Dia.	11.938 in.	Stack Temp	70 deg F
Stack X-Area	111.9 in.2	Start/End Time	1437 / 1500
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

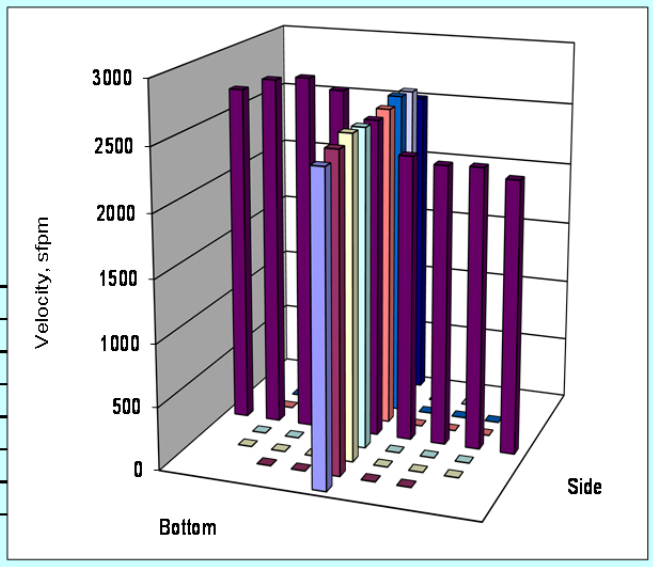
Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	2193	2166	2163	2174.0	2305	2356	2280	2313.7
2	1.25	2258	2261	2218	2245.7	2381	2374	2362	2372.3
3	2.32	2241	2207	2264	2237.3	2435	2427	2415	2425.7
4	3.86	2308	2281	2271	2286.7	2430	2422	2382	2411.3
Center	5.97	2571	2507	2551	2543.0	2405	2387	2425	2405.7
5	8.08	2785	2741	2736	2754.0	2436	2451	2415	2434.0
6	9.62	2869	2812	2816	2832.3	2475	2430	2531	2478.7
7	10.68	2775	2805	2820	2800.0	2507	2420	2467	2464.7
8	11.44	2734	2668	2710	2704.0	2354	2370	2356	2360.0
Averages ---->		2526.0	2494.2	2505.4	2508.6	2414.2	2404.1	2403.7	2407.3

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	2457.9		Mean	2528.4	2427.5	2478.0
Min Point	2174.0	-11.6%	Std. Dev.	270.9	36.1	192.9
Max Point	2832.3	15.2%	COV as %	10.7	1.5	7.8

Flow w/o C-Pt	1909	scfm
Vel Avg w/o C-Pt	2456	sfpm

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/7/2012
TSI VelociCalc SN T95351203001	12/17/2012

	Start	Finish	
Stack temp	68.6	71.3	F
Equipment temp	N.A.	N.A.	F
Ambient temp	69.8	72.5	F
Stack static	N.A.	N.A.	mbars
Ambient pressure	1011	1011	in Hg
Total Stack pressure	N.A.	N.A.	mbars
Ambient humidity	24%	24%	RH



Notes: Target flow is 2443 fpm.

XY 4/27/12

Entries made by:	XY	Technical Data Review performed by:	Susan Sande
Signature/date	4/27/2012	Signature/date	7/10/2012
	signature on file with original	Signature on file with original TI-WTPSP-074	

VELOCITY TRAVERSE DATA FORM

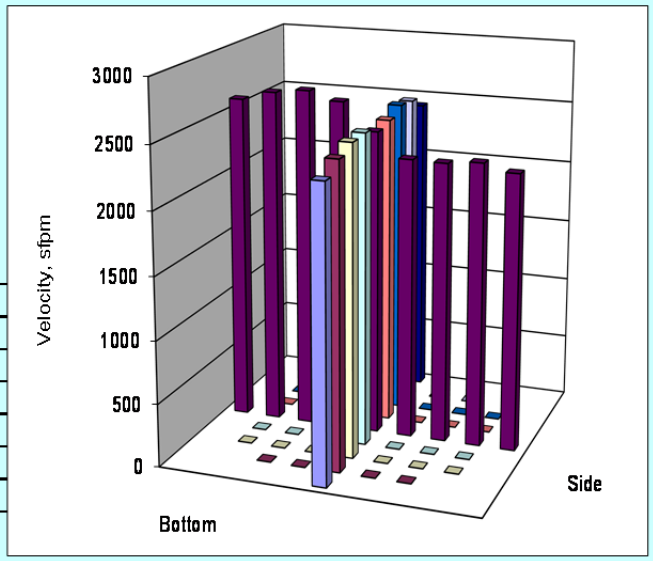
Site	HV-S2 Model	Run No.	VT-7
Date	4/27/12	Fan Configuration	B
Testers	JAG/XYY	Fan Setting	56.0 Hz
Stack Dia.	11.938 in.	Stack Temp	70 deg F
Stack X-Area	111.9 in.2	Start/End Time	1504 / 1522
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	2201	2192	2226	2206.3	2275	2332	2271	2292.7
2	1.25	2224	2281	2286	2263.7	2407	2360	2389	2385.3
3	2.32	2192	2268	2251	2237.0	2451	2420	2467	2446.0
4	3.86	2249	2236	2244	2243.0	2425	2478	2466	2456.3
Center	5.97	2472	2411	2429	2437.3	2437	2380	2395	2404.0
5	8.08	2688	2620	2650	2652.7	2458	2465	2384	2435.7
6	9.62	2721	2738	2700	2719.7	2538	2507	2451	2498.7
7	10.68	2713	2667	2679	2686.3	2522	2489	2422	2477.7
8	11.44	2610	2631	2596	2612.3	2418	2402	2336	2385.3
Averages ---->		2452.2	2449.3	2451.2	2450.9	2436.8	2425.9	2397.9	2420.2

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	2435.6		Mean	2462.8	2443.4	2453.1
Min Point	2206.3	-9.4%	Std. Dev.	220.5	39.6	152.5
Max Point	2719.7	11.7%	COV as %	9.0	1.6	6.2

Flow w/o C-Pt	1895 scfm	Instuments Used:	Cal Due
Vel Avg w/o C-Pt	2437 sfpm	Fisher Scientific Barometer SN 90936818	12/7/2012
		TSI VelociCalc SN T95351203001	12/17/2012

	Start	Finish	
Stack temp	68.5	72.3	F
Equipment temp	N.A.	N.A.	F
Ambient temp	73.4	71.6	F
Stack static	N.A.	N.A.	mbars
Ambient pressure	1011	1011	in Hg
Total Stack pressure	N.A.	N.A.	mbars
Ambient humidity	24%	24%	RH



Notes:

XY 4/27/12

Entries made by:	XY	Technical Data Review performed by:	Susan Sande
Signature/date	4/27/2012	Signature/date	7/10/2012
	signature on file with original	Signature on file with original TI-WTPSP-074	

VELOCITY TRAVERSE DATA FORM

Site	HV-S2 Model	Run No.	VT-8
Date	4/27/12	Fan Configuration	Fan B only
Testers	JAG, XYY	Fan Setting	56.0 Hz
Stack Dia.	11.938 in.	Stack Temp	70 deg F
Stack X-Area	111.9 in.2	Start/End Time	1523 / 1547
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

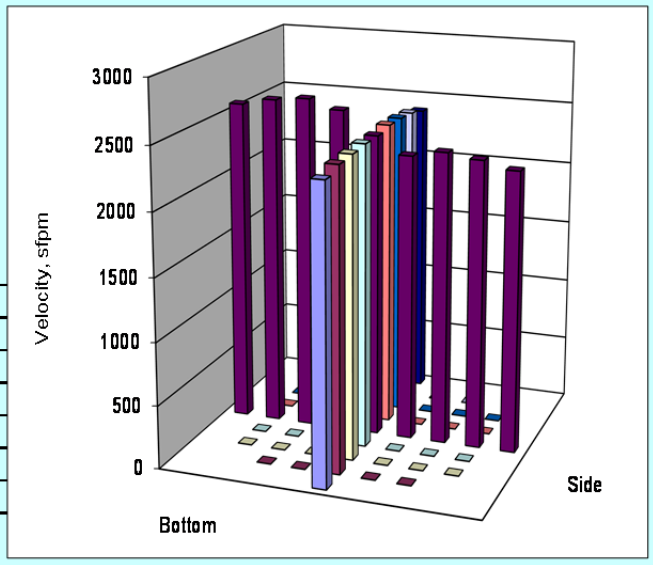
Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	2189	2202	2220	2203.7	2333	2356	2332	2340.3
2	1.25	2261	2251	2273	2261.7	2355	2386	2416	2385.7
3	2.32	2311	2299	2282	2297.3	2386	2413	2396	2398.3
4	3.86	2262	2240	2242	2248.0	2445	2409	2385	2413.0
Center	5.97	2416	2346	2381	2381.0	2399	2396	2444	2413.0
5	8.08	2525	2597	2548	2556.7	2426	2440	2449	2438.3
6	9.62	2651	2625	2602	2626.0	2434	2411	2458	2434.3
7	10.68	2613	2612	2569	2598.0	2460	2422	2377	2419.7
8	11.44	2532	2586	2517	2545.0	2382	2368	2389	2379.7
Averages ---->		2417.8	2417.6	2403.8	2413.0	2402.2	2400.1	2405.1	2402.5

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	2407.8		Mean	2424.1	2414.6	2419.4
Min Point	2203.7	-8.5%	Std. Dev.	165.3	18.6	113.1
Max Point	2626.0	9.1%	COV as %	6.8	0.8	4.7

Flow w/o C-Pt	1873 scfm	
Vel Avg w/o C-Pt	2409 sfpm	

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/7/2012
TSI VelociCalc SN T95351203001	12/17/2012

	Start	Finish	
Stack temp	68.2	71	F
Equipment temp	N.A.	N.A.	F
Ambient temp	71.6	76.1	F
Stack static	N.A.	N.A.	mbars
Ambient pressure	1011	1011	in Hg
Total Stack pressure	N.A.	N.A.	mbars
Ambient humidity	24%	22%	RH



Notes:

XY 4/27/12

Entries made by:	XYY
Signature/date	4/27/2012
	signature on file with original

Technical Data Review performed by:	Susan Sande
Signature/date	7/10/2012
Signature on file with original TI-WTPSP-074	

VELOCITY TRAVERSE DATA FORM

Site	HV-S2 Model	Run No.	VT-9
Date	6/19/12	Fan Configuration	Fan B only
Testers	JEF, CA	Fan Setting	59.1 Hz
Stack Dia.	11.938 in.	Stack Temp	67 deg F
Stack X-Area	111.9 in.2	Start/End Time	925/948
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

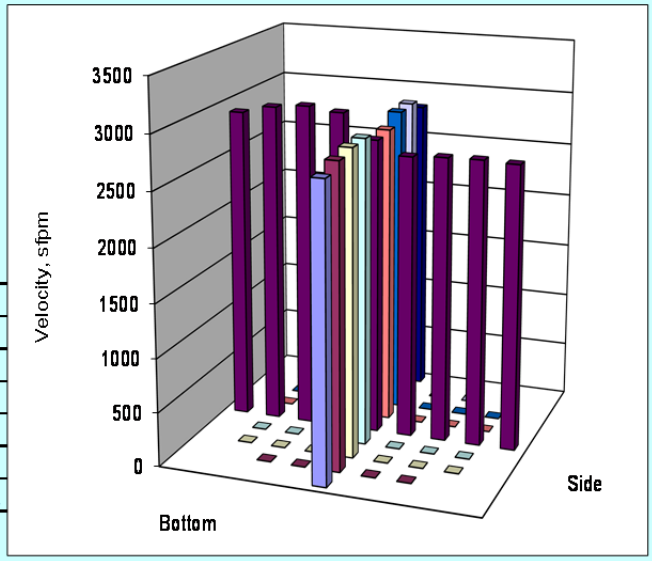
Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	2606	2598	2616	2606.7	2717	2726	2739	2727.3
2	1.25	2593	2639	2625	2619.0	2786	2797	2821	2801.3
3	2.32	2605	2585	2647	2612.3	2834	2853	2836	2841.0
4	3.86	2595	2553	2633	2593.7	2826	2860	2863	2849.7
Center	5.97	2745	2721	2686	2717.3	2757	2774	2752	2761.0
5	8.08	2982	2902	2934	2939.3	2813	2725	2815	2784.3
6	9.62	2974	3015	2937	2975.3	2928	2807	2916	2883.7
7	10.68	3044	2922	2864	2943.3	2924	2871	2897	2897.3
8	11.44	2929	2810	2875	2871.3	2860	2768	2763	2797.0
Averages ---->		2785.9	2749.4	2757.4	2764.3	2827.2	2797.9	2822.4	2815.9

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	2790.1		Mean	2771.5	2831.2	2801.3
Min Point	2593.7	-7.0%	Std. Dev.	174.4	51.0	127.2
Max Point	2975.3	6.6%	COV as %	6.3	1.8	4.5

Flow w/o C-Pt	2174	scfm
Vel Avg w/o C-Pt	2796	sfpm

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/7/2012
TSI VelociCalc SN T95351203001	12/17/2012

	Start	Finish	
Stack temp	65.0	68	F
Equipment temp	N.A.	N.A.	F
Ambient temp	66	65	F
Stack static	N.A.	N.A.	mbars
Ambient pressure	29.68	29.68	in Hg
Total Stack pressure	N.A.	N.A.	mbars
Ambient humidity	29%	23%	RH



Notes: Fan B max flow target is 2619 to 3041 fpm at Bottom 3

JF 6/19/12

Entries made by:	Carmen Arimescu 6/19/2012
Signature/date	signature on file with original
Technical Data Review performed by:	Susan Sande
Signature/date	7/10/2012
	Signature on file with original TI-WTPSP-074

VELOCITY TRAVERSE DATA FORM

Site	HV-S2 Model	Run No.	VT-10
Date	6/19/12	Fan Configuration	Fan A only
Testers	JEF, CA	Fan Setting	60.0 Hz
Stack Dia.	11.938 in.	Stack Temp	71 deg F
Stack X-Area	111.9 in.2	Start/End Time	950/1018
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

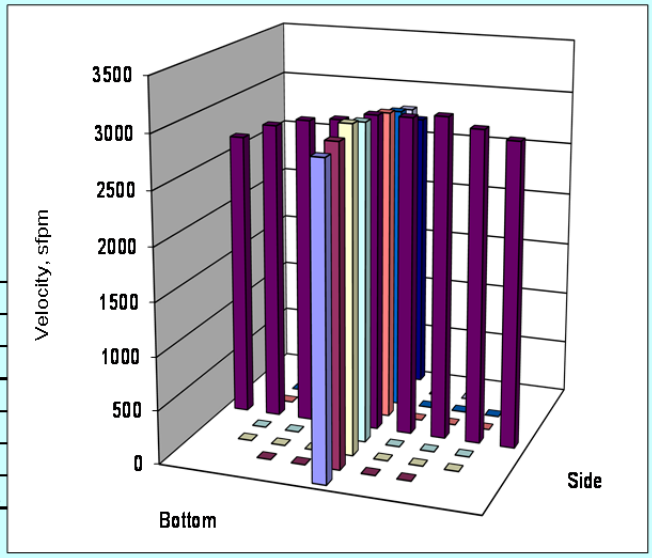
Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	2861	2813	2773	2815.7	2877	2923	2897	2899.0
2	1.25	2907	2885	2890	2894.0	2961	2946	2980	2962.3
3	2.32	3003	2984	2961	2982.7	3062	3022	3056	3046.7
4	3.86	2944	2952	2955	2950.3	2989	3004	2983	2992.0
Center	5.97	3018	2920	2907	2948.3	3003	3040	2916	2986.3
5	8.08	2884	2883	2876	2881.0	2964	2832	3021	2939.0
6	9.62	2877	2830	2842	2849.7	2951	2824	2881	2885.3
7	10.68	2764	2775	2795	2778.0	2783	2756	2974	2837.7
8	11.44	2661	2601	2670	2644.0	2660	2601	2754	2671.7
Averages ------>		2879.9	2849.2	2852.1	2860.4	2916.7	2883.1	2940.2	2913.3

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	2886.9		Mean	2897.7	2949.9	2923.8
Min Point	2644.0	-8.4%	Std. Dev.	70.1	70.1	72.6
Max Point	3046.7	5.5%	COV as %	2.4	2.4	2.5

Flow w/o C-Pt	2236	scfm
Vel Avg w/o C-Pt	2877	sfpm

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/7/2012
TSI VelociCalc SN T95351203001	12/17/2012

	Start	Finish	
Stack temp	69.0	72	F
Equipment temp	N.A.	N.A.	F
Ambient temp	70	73	F
Stack static	N.A.	N.A.	mbars
Ambient pressure	29.68	29.68	in Hg
Total Stack pressure	N.A.	N.A.	mbars
Ambient humidity	23%	27%	RH



Notes: Fan A max flow target is 2619 to 3041 fpm at Bottom 5

JF 6/19/12

Entries made by:	Carmen Arimescu 6/19/2012	Technical Data Review performed by:	Susan Sande
Signature/date	signature on file with original	Signature/date	7/10/2012
		Signature on file with original TI-WTPSP-074	

B.3 HV-S2 Flow Angle Data Sheets

FLOW ANGLE DATA FORM HV-S2_FlowAngle.xls

Site	HV-S2 scale model	Run No.	FA-1
Date	5/2/2012	Fan Setting	28.5 Hz
Tester	JAG EA	Fan configuration	Fan A Only
Stack Dia.	11.938 in	Approx. air vel.	1063 sfpm at point >> Bottom 5
Stack X-Area	111.9 in2	Units	degrees (clockwise > pos. nos.)
Elevation	N.A. ft	Port	2
Distance to disturbance	96.4 in	Stack Temp	70.9 °F
Start/End Time	1340 / 1455		

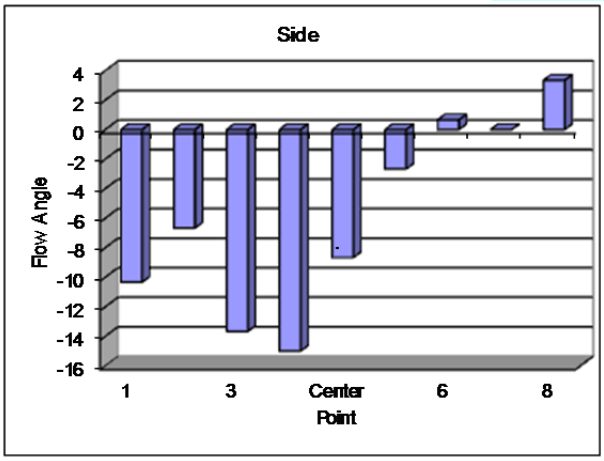
Order -->		1				2			
Traverse-->		Side				Bottom			
Trial -->		1	2	3		1	2	3	
Point	Depth, in.	deg. cw	deg. cw	deg. cw	Avg.	deg. cw	deg. cw	deg. cw	Avg.
1	0.50	3	-5	-29	**-10.3**	2	-1	6	**2.3**
2	1.25	5	0	-25	**-6.7**	13	-2	10	**7.0**
3	2.32	3	-21	-23	**-13.7**	-6	-8	12	**-0.7**
4	3.86	-13	-15	-17	**-15.0**	2	5	8	**5.0**
Center	5.97	-7	-8	-11	**-8.7**	-1	4	0	**1.0**
5	8.08	0	-1	-7	**-2.7**	5	5	6	**5.3**
6	9.62	0	2	0	**0.7**	9	7	7	**7.7**
7	10.68	3	0	-3	**0.0**	10	6	10	**8.7**
8	11.44	4	4	2	**3.3**	13	11	12	**12.0**
Mean of absolute values:					**6.8**				**5.5**
" "w/o points by wall:					**6.8**				**5.0**
								Grand mean ABS	**6.1**
								" "w/o wall pts	**5.9**

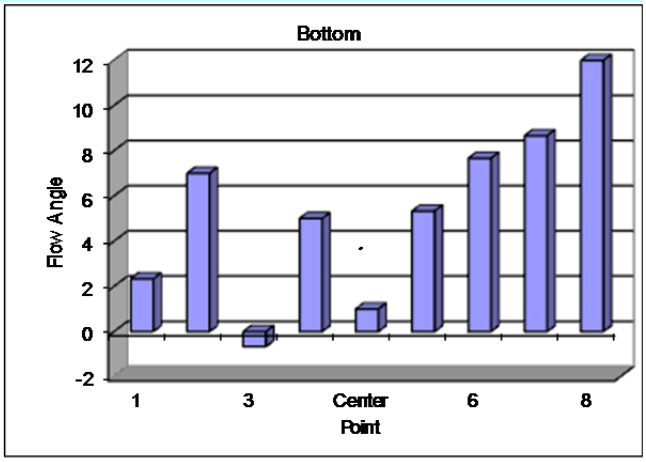
Instuments Used:		**Cal. Due**
S-type pitot	Dwyer 24-inch S-type Pitot#10	Cert. of conformance
Velocity sensor	TSI Velocicalc SN#T95351203001	17-Dec-12
Angle indicator	Shop built	Cat. 3
Manometer	Dwyer 400-5, S36N	Cat. 3

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:

EA
5/2/2012





Entries made by:	JAG	5/2/2012
Signature/date	*Signature on file with Original*	

Technical Data Review performed by Susan Sande
Signature/date 7/19/2012
Signature on original
TI-WTPSP-075

FLOW ANGLE DATA FORM

HV-S2_FlowAngle.xls

Site	HV-S2 scale model		Run No.	FA-2	
Date	5/2/2012		Fan Setting	60	Hz
Tester	JAG EA		Fan configuration	Fan A	
Stack Dia.	11.938	in	Approx. air vel.	2443	sfpm at point >> Bottom 5
Stack X-Area	111.9	in2	Units	degrees (clockwise > pos. nos.)	
Elevation	N.A.	ft	Port	2	
Distance to disturbance	96.4	in	Stack Temp	71.1	°F
Start/End Time	1500 / 1521				

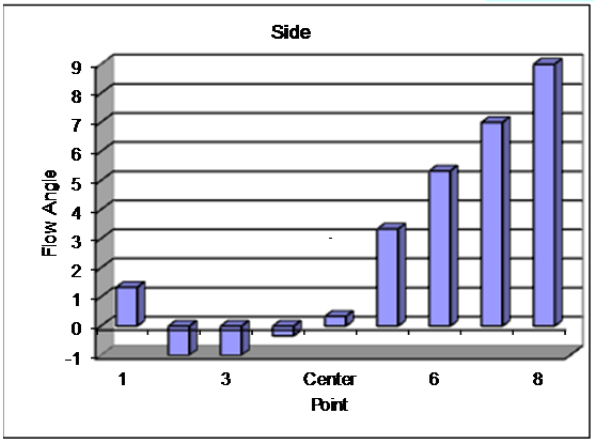
		Side				Bottom			
Order -->		2				1			
Traverse-->		1	2	3		1	2	3	
Trial —>									
Point	Depth, in.	deg. cw	deg. cw	deg. cw	Avg.	deg. cw	deg. cw	deg. cw	Avg.
1	0.50	1	3	0	1.3	0	-1	1	0.0
2	1.25	-6	-5	8	-1.0	-2	-3	-1	-2.0
3	2.32	-6	-5	8	-1.0	-2	-2	-1	-1.7
4	3.86	-1	0	0	-0.3	5	2	0	2.3
Center	5.97	0	0	1	0.3	4	0	2	2.0
5	8.08	2	4	4	3.3	5	4	4	4.3
6	9.62	5	6	5	5.3	8	7	7	7.3
7	10.68	6	7	8	7.0	11	11	10	10.7
8	11.44	9	9	9	9.0	13	11	12	12.0
Mean of absolute values:					3.2				4.7
" " w/o points by wall:					2.6				4.3
								Grand mean ABS	3.9
								" " w/o wall pts	3.5

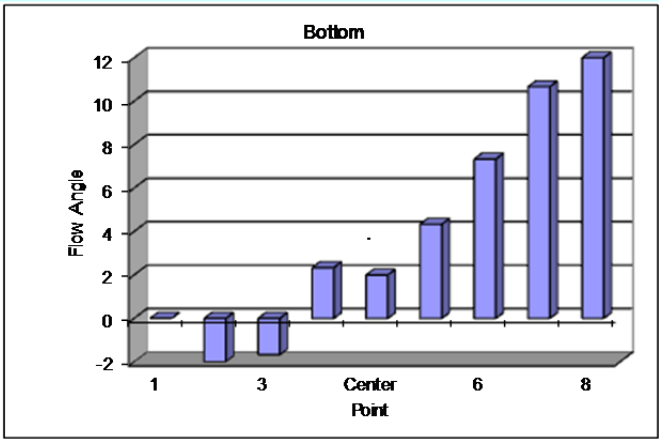
Instruments Used:			Cal. Due
S-type pitot	Dwyer 24-inch S-type Pitot#10		Cert. of conformance
Velocity sensor	TSI Velocicalc SN#T95351203001		17-Dec-12
Angle indicator	Shop built		Cat. 3
Manometer	Dwyer 400-5, S36N	MAN 5	Cat. 3

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:

EA 5/2/12





Entries made by:	JAG	5/2/2012	Technical Data Review performed by:	Susan Sande
Signature/date	*Signature on file with Original*		Signature/date	7/19/2012 Signature on original TI-WTPSP-075

FLOW ANGLE DATA FORM

HV-S2_FlowAngle.xls

Site	HV-S2 scale model	Run No.	FA-3
Date	5/2/2012	Fan Setting	55.9 Hz
Tester	JAG , EA	Fan configuration	Fan B
Stack Dia.	11.938 in	Approx. air vel.	2471 sfpm at point >> Bottom 3
Stack X-Area	111.9 in2	Units	degrees (clockwise > pos. nos.)
Elevation	N.A. ft	Port	2
Distance to disturbance	96.4 in	Stack Temp	74 °F
Start/End Time	1530 / 1555		

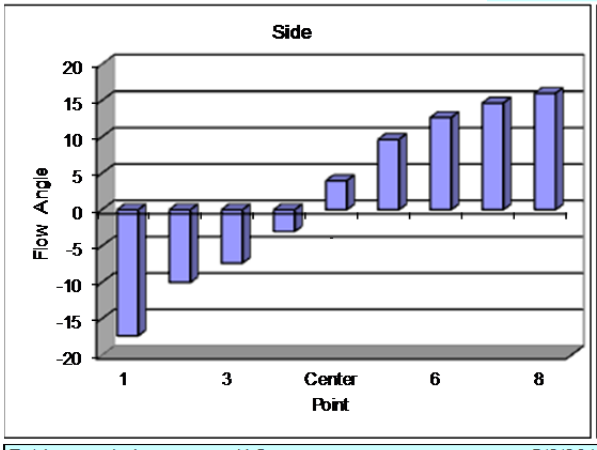
Order -->	1				2			
Traverse-->	Side				Bottom			
Trial -->	1	2	3		1	2	3	
Point	Depth, in.	deg. cw	deg. cw	deg. cw	Avg.	deg. cw	deg. cw	deg. cw	Avg.
1	0.50	-17	-18	-17	**-17.3**	-12	-16	-5	**-11.0**
2	1.25	-10	-10	-10	**-10.0**	0	-3	-1	**-1.3**
3	2.32	-8	-7	-7	**-7.3**	-15	2	0	**-4.3**
4	3.86	-2	-3	-4	**-3.0**	-5	-3	-1	**-3.0**
Center	5.97	4	4	4	**4.0**	2	3	1	**2.0**
5	8.08	10	11	8	**9.7**	10	11	12	**11.0**
6	9.62	13	13	12	**12.7**	17	15	18	**16.7**
7	10.68	15	14	15	**14.7**	20	20	20	**20.0**
8	11.44	16	16	16	**16.0**	21	22	23	**22.0**
Mean of absolute values:					**10.5**				**10.1**
" " w/o points by wall:					**8.8**				**8.3**
							Grand mean ABS		**10.3**
							" " w/o wall pts		**8.5**

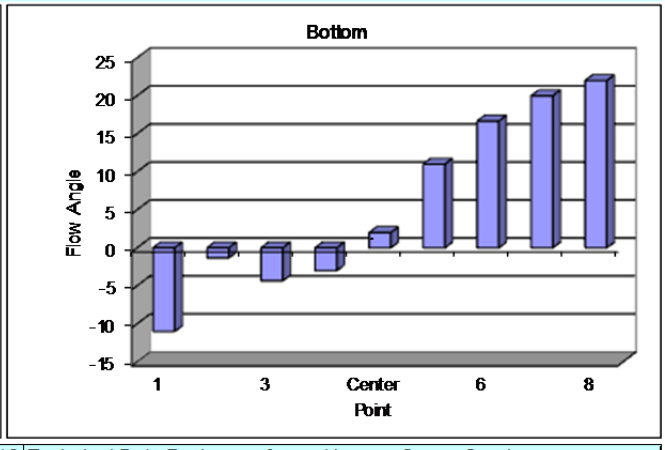
Instruments Used:			Cal. Due
S-type pitot	Dwyer 24-inch S-type Pitot#10		Cert. of conformance
Velocity sensor	TSI Velocicalc SN#T95351203001		17-Dec-12
Angle indicator	Shop built		Cat. 3
Manometer	Dwyer 400-5, S36N	MAN 5	Cat. 3

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:

EA 5/2/12





Entries made by:	JAG	5/2/2012	Technical Data Review performed by:	Susan Sande	
Signature/date	*Signature on file with Original*		Signature/date	7/20/2012	
				Signature on original	
				TI-WTPSP-075	

FLOW ANGLE DATA FORM

HV-S2_FlowAngle.xls

Site	HV-S2 scale model		Run No.	FA-4	
Date	5/4/2012		Fan Setting	53	Hz
Tester	EA, CA		Fan configuration	Fan B only	
Stack Dia.	11.938	in	Approx. air vel.	2627	sfpm at point >> Bottom 3
Stack X-Area	111.9	in2	Units	degrees (clockwise > pos. nos.)	
Elevation	N.A.	ft	Port	2	
Distance to disturbance	96.4	in	Stack Temp	66.8	°F
Start/End Time	1135 / 1155				

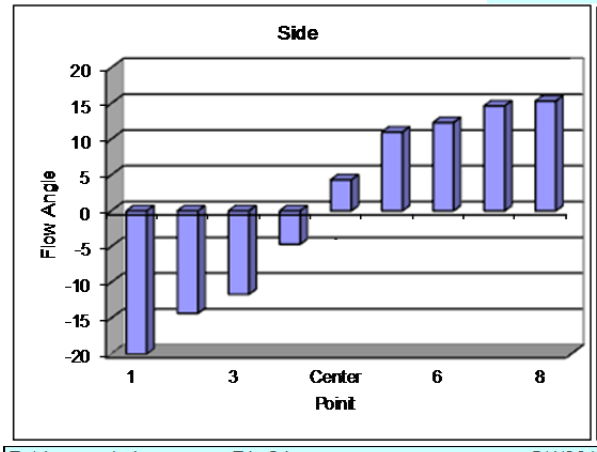
Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial --->		1	2	3		1	2	3	
Point	Depth, in.	deg. cw	deg. cw	deg. cw	Avg.	deg. cw	deg. cw	deg. cw	Avg.
1	0.50	-18	-21	-21	-20.0	-16	-12	-16	-14.7
2	1.25	-13	-14	-16	-14.3	-4	-4	-4	-4.0
3	2.32	-9	-14	-12	-11.7	-2	-4	-5	-3.7
4	3.86	-3	-5	-6	-4.7	-8	-7	-5	-6.7
Center	5.97	4	5	4	4.3	1	0	-1	0.0
5	8.08	11	11	11	11.0	11	8	8	9.0
6	9.62	12	12	13	12.3	14	15	13	14.0
7	10.68	15	14	15	14.7	18	18	17	17.7
8	11.44	15	15	16	15.3	20	20	20	20.0
Mean of absolute values:					12.0				10.0
" " w/o points by wall:					10.4				7.9
								Grand mean ABS	11.0
								" " w/o wall pts	9.1

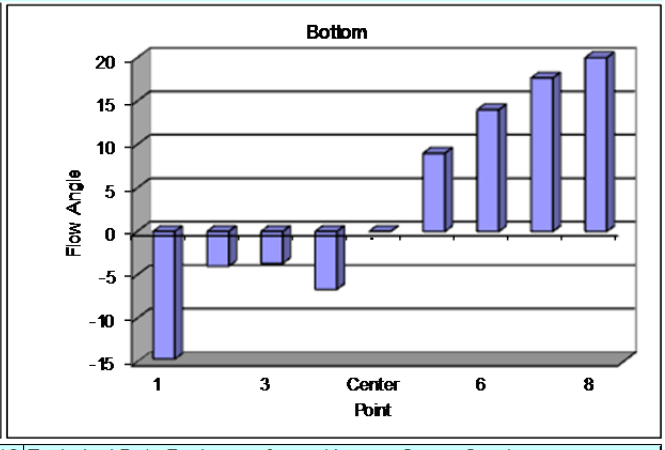
Instruments Used:			Cal. Due
S-type pitot	Dwyer 24-inch S-type Pitot#10		Cert. of conformance
Velocity sensor	TSI Velocicalc SN#T95351203001		17-Dec-12
Angle indicator	Shop built		Cat. 3
Manometer	Dwyer 400-5, S36N	MAN 5	Cat. 3

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:

CA
5/4/2012





Entries made by:	EA, CA	5/4/2012	Technical Data Review performed by:	Susan Sande	
Signature/date	*Signature on file with original*		Signature/date	7/20/2012	
				Signature on original	
				TI-WTPSP-075	

FLOW ANGLE DATA FORM

HV-S2_FlowAngle.xls

Site	HV-S2 scale model		Run No.	FA-5	
Date	5/4/2012		Fan Setting	60	Hz
Tester	EA, CA		Fan configuration	Fan A Only	
Stack Dia.	11.938	in	Approx. air vel.	3065	sfpm at point >> Bottom 5
Stack X-Area	111.9	in2	Units	degrees (clockwise > pos. nos.)	
Elevation	N.A.	ft	Port	2	
Distance to disturbance	96.4	in	Stack Temp	63.5	°F
Start/End Time	1030 1130				

Order -->	1st				2nd			
Traverse-->	Side				Bottom			
Trial -->	1	2	3		1	2	3	
Point	Depth, in.	deg. cw	deg. cw	deg. cw	Avg.	deg. cw	deg. cw	deg. cw	Avg.
1	0.50	-4	8	7	3.7	-9	-12	-12	-11.0
2	1.25	0	13	10	7.7	7	3	1	3.7
3	2.32	8	13	11	10.7	9	-2	1	2.7
4	3.86	9	10	7	8.7	-6	-1	-4	-3.7
Center	5.97	9	10	5	8.0	0	0	0	0.0
5	8.08	8	5	5	6.0	4	4	4	4.0
6	9.62	8	9	9	8.7	5	6	7	6.0
7	10.68	11	11	9	10.3	8	11	9	9.3
8	11.44	13	13	12	12.7	11	10	12	11.0
Mean of absolute values:					8.5				5.7
" " w/o points by wall:					8.6				4.2
								Grand mean ABS	7.1
								" " w/o wall pts	6.4

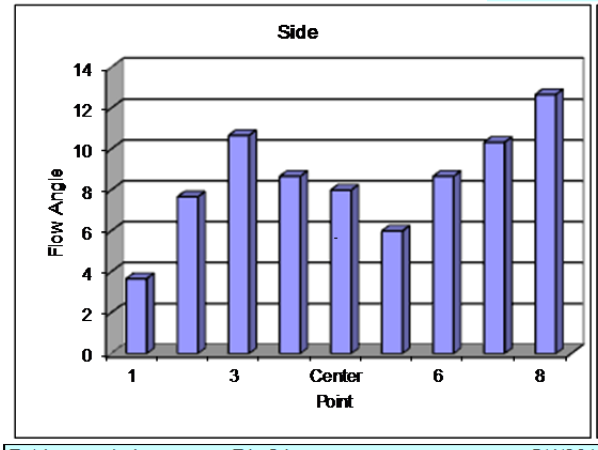
Instruments Used:			Cal. Due
S-type pitot	Dwyer 24-inch S-type Pitot#10		Cert. of conformance
Velocity sensor	TSI Velocicalc SN#T95351203001		17-Dec-12
Angle indicator	Shop built		Cat. 3
Manometer	Dwyer 400-5, S36N	MAN 5	Cat. 3

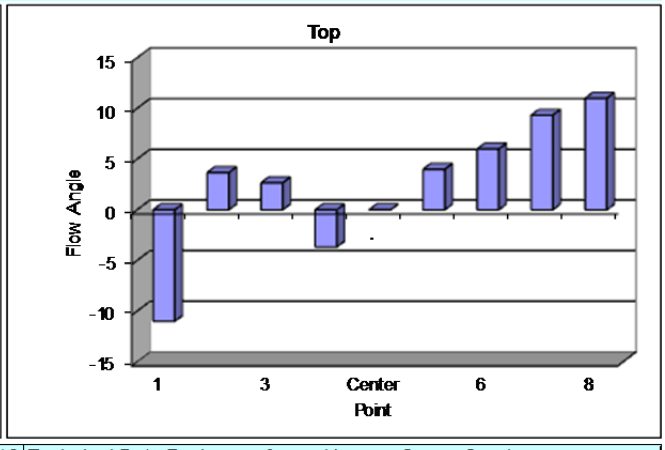
Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes:

CA

5/4/2012





Entries made by:	EA, CA	5/4/2012	Technical Data Review performed by:	Susan Sande
Signature/date	*Signature on file with original*		Signature/date	7/20/2012 Signature on original TI-WTPSP-075

FLOW ANGLE DATA FORM

HV-S2_FlowAngle.xls

Site	HV-S2 scale model		Run No.	FA-6	
Date	5/4/2012		Fan Setting	23.5	Hz
Tester	YFS, XYY		Fan configuration	B Only	
Stack Dia.	11.938	in	Approx. air vel.	1084	sfpm at point >> 3 bottom
Stack X-Area	111.9	in2	Units	degrees (clockwise > pos. nos.)	
Elevation	N.A.	ft	Port	2	
Distance to disturbance	96.4	in	Stack Temp	69.2	°F
Start/End Time	13:15/14:33				

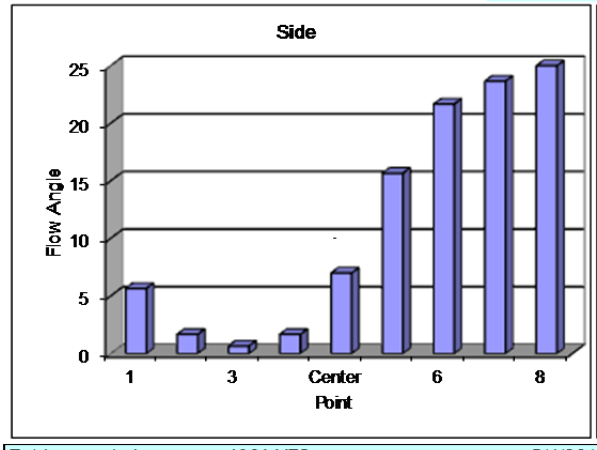
Order -->	1st				2nd			
Traverse-->	Side				Bottom			
Trial --->	1	2	3		1	2	3	
Point	Depth, in.	deg. cw	deg. cw	deg. cw	Avg.	deg. cw	deg. cw	deg. cw	Avg.
1	0.50	3	10	4	5.7	-20	-14	-22	-18.7
2	1.25	-4	1	8	1.7	-15	-11	-16	-14.0
3	2.32	-1	0	3	0.7	-8	-5	-16	-9.7
4	3.86	-5	8	2	1.7	-5	-7	-11	-7.7
Center	5.97	7	6	8	7.0	-15	6	8	-0.3
5	8.08	16	14	17	15.7	10	12	11	11.0
6	9.62	19	23	23	21.7	15	12	12	13.0
7	10.68	22	20	29	23.7	17	15	13	15.0
8	11.44	24	22	29	25.0	15	15	15	15.0
Mean of absolute values:					11.4				11.6
" " w/o points by wall:					10.3				10.1
								Grand mean ABS	11.5
								" " w/o wall pts	10.2

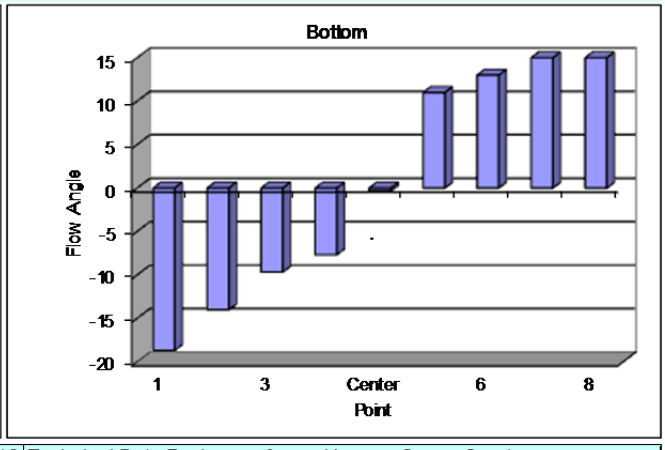
Instruments Used:			Cal. Due
S-type pitot	Dwyer 24-inch S-type Pitot#10		Cert. of conformance
Velocity sensor	TSI Velocicalc SN#T95351203001		17-Dec-12
Angle indicator	Shop built		Cat. 3
Manometer	Dwyer 400-5, S36N	MAN 5	Cat. 3

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: Mild wind, overcast.
Ambient pressure 1006 mb, RH 29%, ambient temperature: 67F.
Vel: initial 1088 fpm; ini. stack temp: 67.4F.
Vel: end 1079 fpm; end stack temp: 71.0 F.

XYY 5/4/12





Entries made by:	XYY, YFS	5/4/2012	Technical Data Review performed by:	Susan Sande
Signature/date	*Signature on file with original*		Signature/date	7/20/2012 Signature on original TI-WTPSP-075

FLOW ANGLE DATA FORM

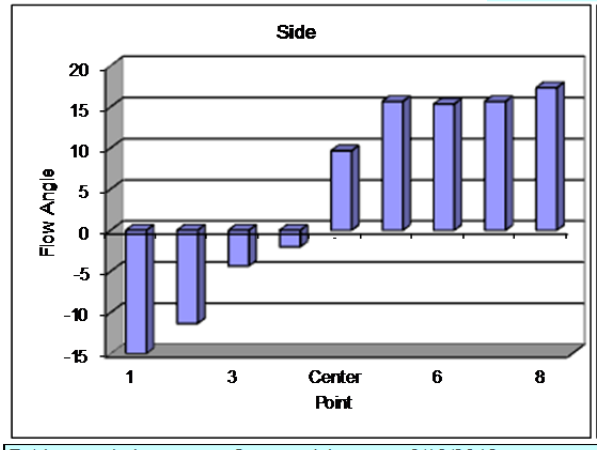
Site	HV-S2 scale model	Run No.	FA-7
Date	6/19/2012	Fan Setting	24.4 Hz
Tester	JEF,CA	Fan configuration	B Only
Stack Dia.	11.938 in	Approx. air vel.	1195 sfpm at point >> 3 bottom
Stack X-Area	111.9 in2	Units	degrees (clockwise > pos. nos.)
Elevation	N.A. ft	Port	2
Distance to disturbance	96.4 in	Stack Temp	66 °F
Start/End Time	8:30 / 8:57		

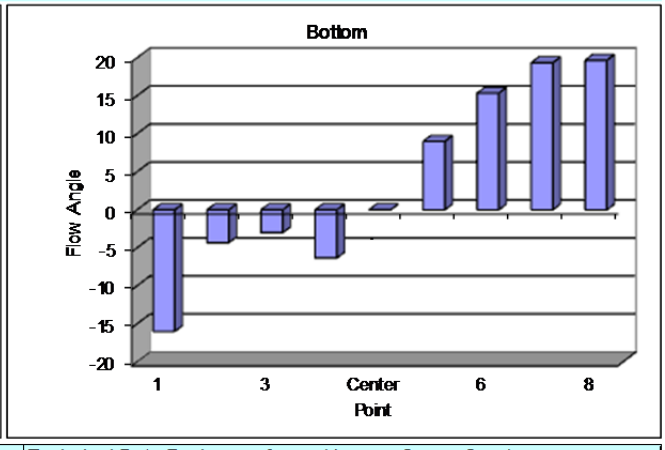
		Side				Bottom			
Order -->		2nd				1st			
Traverse-->									
Trial -->		1	2	3		1	2	3	
Point	Depth, in.	deg. cw	deg. cw	deg. cw	Avg.	deg. cw	deg. cw	deg. cw	Avg.
1	0.50	-14	-15	-16	**-15.0**	-2	-24	-22	**-16.0**
2	1.25	-5	-14	-15	**-11.3**	3	-6	-10	**-4.3**
3	2.32	-2	-5	-6	**-4.3**	4	-8	-5	**-3.0**
4	3.86	4	-4	-6	**-2.0**	6	-8	-17	**-6.3**
Center	5.97	12	8	9	**9.7**	9	-3	-6	**0.0**
5	8.08	20	15	12	**15.7**	15	5	7	**9.0**
6	9.62	16	15	15	**15.3**	20	12	14	**15.3**
7	10.68	16	15	16	**15.7**	22	17	19	**19.3**
8	11.44	18	16	18	**17.3**	22	18	19	**19.7**
Mean of absolute values:					**11.8**				**10.3**
" " w/o points by wall:					**10.6**				**8.2**
								Grand mean ABS	**11.1**
								" " w/o wall pts	**9.4**

Instruments Used:			**Cal. Due**
S-type pitot	Dwyer 24-inch S-type Pitot#10		Cert. of conformance
Velocity sensor	TSI Velocicalc SN#T95351203001		17-Dec-12
Angle indicator	Shop built		Cat. 3
Manometer	Dwyer 400-5, S36N	MAN 5	Cat. 3

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: Fan B min flow target is 1047 to 1216 fpm at Bottom 3.
Repeat of FA-6.
Light winds, overcast skies.
JF 6/19/12





Entries made by:	Carmen Arimescu 6/19/2012	Technical Data Review performed by:	Susan Sande
Signature/date	*Signature on file w/ original*	Signature/date	7/20/2012 Signature on original TI-WTPSP-075

FLOW ANGLE DATA FORM

Site	HV-S2 scale model	Run No.	FA-8
Date	6/19/2012	Fan Setting	59.1 Hz
Tester	JEF,CA	Fan configuration	B Only
Stack Dia.	11.938 in	Approx. air vel.	3008 sfpm at point >> 3 bottom
Stack X-Area	111.9 in2	Units	degrees (clockwise > pos. nos.)
Elevation	N.A. ft	Port	2
Distance to disturbance	96.4 in	Stack Temp	67 °F
Start/End Time	9:00 / 9:21		

Order -->	1st				2nd			
Traverse-->	Side				Bottom			
Trial -->	1	2	3		1	2	3	
Point	Depth, in.	deg. cw	deg. cw	deg. cw	Avg.	deg. cw	deg. cw	deg. cw	Avg.
1	0.50	-20	-21	-19	-20.0	-14	12	-11	-4.3
2	1.25	-11	-14	-13	-12.7	-17	-4	-16	-12.3
3	2.32	-9	-10	-9	-9.3	-21	-4	-17	-14.0
4	3.86	-3	-4	-4	-3.7	-11	-7	-12	-10.0
Center	5.97	6	7	6	6.3	0	1	3	1.3
5	8.08	12	12	12	12.0	9	10	9	9.3
6	9.62	15	14	14	14.3	16	12	17	15.0
7	10.68	16	17	16	16.3	24	22	23	23.0
8	11.44	16	17	18	17.0	24	24	25	24.3
Mean of absolute values:					12.4				12.6
" " w/o points by wall:					10.7				12.1
								Grand mean ABS	12.5
								" " w/o wall pts	11.4

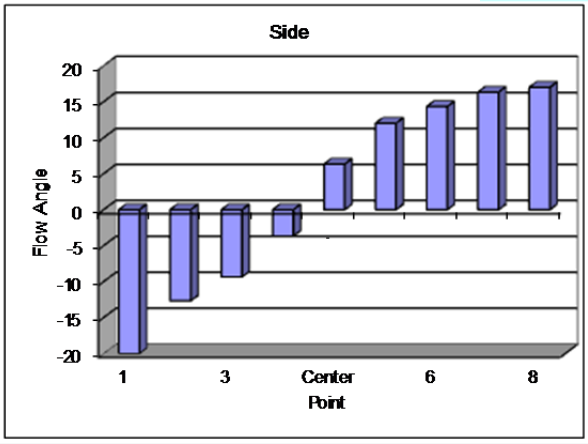
Instruments Used:			Cal. Due
S-type pitot	Dwyer 24-inch S-type Pitot#10		Cert. of conformance
Velocity sensor	TSI Velocicalc SN#T95351203001		17-Dec-12
Angle indicator	Shop built		Cat. 3
Manometer	Dwyer 400-5, S36N	MAN 5	Cat. 3

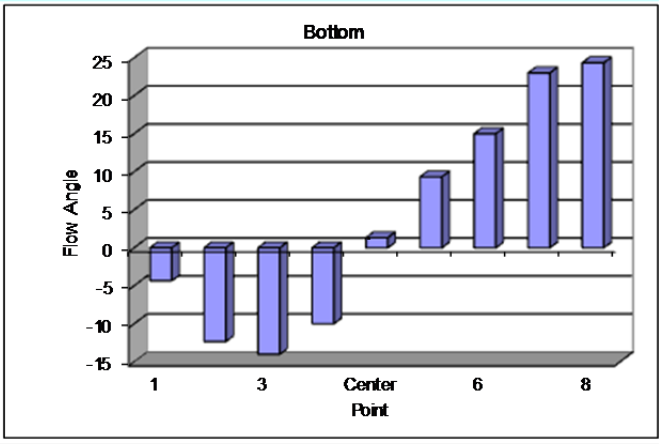
Note:
To assure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).

Notes: Fan B max flow target is 2619 to 3041 fpm at Bottom 3.

Mostly light winds, occassional gusts, overcast skies.

JF 6/19/12





Entries made by:	Carmen Arimescu 6/19/2012	Technical Data Review performed by:	Susan Sande
Signature/date	*Signature on file w/ original*	Signature/date	7/20/2012 Signature on original TI-WTPSP-075

B.4 HV-S2 Gas Tracer Calibration and Uniformity Data Sheets

SULFUR HEXAFLUORIDE GAS INSTRUMENT CALIBRATION

Site	HV-S2 Model	Instrument	Model 1302
Date/Time	4/30/12 8:15	Serial No.	1765299
Testers	CA, JEF	Property No.	WD17210

Setup:	7.7	ft B&K sample inlet tube length
	992	mbar station pressure
	65	deg F ambient temp analyzer corrects to 20 deg C
	45	percent RH ambient humidity

Pre-Test background, ppb
Not compensating for water vapor, monitoring task 2
37.0, 35.3, 32.0, 34.2, 35.4
Compensating for water vapor, monitoring task 1
7.4, 4.2, 3.2, 7.8, 5.4

	100	ppb		4.97	ppm
Cylinder	CAL11936		Cylinder	FF34346	
start P =	1600	psi	start P =	1490	psi
end P =	1500	psi	end P =	1450	psi

B&K Calibration readings: (ppb)	B&K Calibration readings:
Compensating for water vapor	**Compensating for water vapor**
107	5.10
106	5.09
107	5.08
104	5.09
107	5.08
Not compensating for water vapor	**Not compensating for water vapor**
107	5.08
108	5.07
105	5.06
109	5.06
107	5.06
106.70 = avg	**5.08** = avg
1.067 = avg/standard	**1.022** = avg/standard

Standards Used:	Expiration date:
Air Liquide 0.1 ppm SF6 in air, CAL11936	3/19/2013
Air Liquide 4.97 ppm SF6 in air, FF34346	3/19/2014
Weather Station Used:	
Fisher Scientific S/N 90936818	12/7/2012

Entries made by:	Julia Flaherty		Technical Data Review performed by:	Susan Sande	
Signature/date	*On File w/ Original*	5/10/2012	Signature/date	7/10/2012	
			Signature on file with Original TI-WTPSP-078		

SULFUR HEXAFLUORIDE GAS INSTRUMENT CALIBRATION

Site	HV-S2 Model	Instrument	B&K Model 1302
Date/Time	5/7/12 8:00	Serial No.	1765299
Testers	CA, JEF	Property No.	WD17210

Setup:
- 7.7 ft B&K sample inlet tube length
- 1016 mbar station pressure
- 58 deg F ambient temp analyzer corrects to 20 deg C
- 34 percent RH ambient humidity

Pre-Test background, ppb

Not compensating for water vapor, monitoring task 2

24.3, 28.7, 22.3, 27.7, 22.4

Compensating for water vapor, monitoring task 1

5.23, 3.36, 5.69, 6.09, 9.12

	100 ppb		4.97 ppm
Cylinder	CAL11936	Cylinder	FF34346
start P =	1400 psi	start P =	1400 psi
end P =	1400 psi	end P =	1400 psi

B&K Calibration readings: (ppb)	B&K Calibration readings: (ppm)
Compensating for water vapor	**Compensating for water vapor**
108	5.12
109	5.13
107	5.20
107	5.21
111	5.21
Not compensating for water vapor	**Not compensating for water vapor**
107	5.19
105	5.18
108	5.19
105	5.18
107	5.15
107.40 = avg	**5.18** = avg
1.074 = avg/standard	**1.041** = avg/standard

Standards Used:	Expiration date:
Air Liquide 0.1 ppm SF6 in air, CAL11936	3/19/2013
Air Liquide 4.97 ppm SF6 in air, FF34346	3/19/2014
Weather Station Used:	
Fisher Scientific S/N 90936818	12/7/2012

Entries made by: Julia Flaherty	Technical Data Review performed by: Susan Sande
Signature/date *On File w/ Original* 5/10/2012	Signature/date 7/10/2012
	Signature on file with Original TI-WTPSP-078

SULFUR HEXAFLUORIDE GAS INSTRUMENT CALIBRATION

Site	HV-S2 Model	Instrument	B&K Model 1302
Date/Time	5/10/12 13:45	Serial No.	1765299
Testers	JEF	Property No.	WD17210

Setup:
- 7.7 ft B&K sample inlet tube length
- 1015 mbar station pressure
- 65 deg F ambient temp analyzer corrects to 20 deg C
- 25 percent RH ambient humidity

Pre-Test background, ppb

Not compensating for water vapor, monitoring task 2

19.3, 21.9, 17.2, 17.3, 21.0

Compensating for water vapor, monitoring task 1

8.27, 8.30, 5.97, 7.58, 8.58

	100 ppb		4.97 ppm
Cylinder	CAL11936	Cylinder	FF34346
start P =	1350 psi	start P =	1400 psi
end P =	1310 psi	end P =	1390 psi

B&K Calibration readings: (ppm)		B&K Calibration readings: (ppm)	
Compensating for water vapor		**Compensating for water vapor**	
103		4.98	
103		4.90	
105		5.03	
105		5.03	
104		5.02	
Not compensating for water vapor		**Not compensating for water vapor**	
108		5.02	
103		4.95	
106		5.03	
105		4.96	
103		4.96	
104.50	= avg	**4.99**	= avg
1.045	= avg/standard	**1.004**	= avg/standard

Standards Used:	Expiration date:
Air Liquide 0.1 ppm SF6 in air, CAL11936	3/19/2013
Air Liquide 4.97 ppm SF6 in air, FF34346	3/19/2014
Weather Station Used:	
Fisher Scientific S/N 90936818	12/7/2012

Entries made by: Julia Flaherty	Technical Data Review performed by: Susan Sande
Signature/date *On File w/ Original* 5/10/2012	Signature/date 7/10/2012
	Signature on file with Original TI-WTPSP-078

SULFUR HEXAFLUORIDE GAS INSTRUMENT CALIBRATION

Site	HV-S2 Model	Instrument	B&K Model 1302
Date/Time	6/19/12 1025	Serial No.	1765299
Testers	CA,JEF	Property No.	WD17210

Setup:
- 7.7 ft B&K sample inlet tube length
- 996 mbar station pressure
- 65 deg F ambient temp analyzer corrects to 20 deg C
- 28 percent RH ambient humidity

Pre-Test background, ppb

Not compensating for water vapor, monitoring task 2

30, 27, 28, 29, 29

Compensating for water vapor, monitoring task 1

8.3, 6.6, 4.3, 5.3, 6.1

	100 ppb		4.97 ppm
Cylinder	CAL11936	Cylinder	FF34346
start P =	1300 psi	start P =	1275 psi
end P =	1250 psi	end P =	1200 psi

B&K Calibration readings: (ppm)	B&K Calibration readings: (ppm)
Compensating for water vapor	**Compensating for water vapor**
102	4.90
103	4.89
104	4.89
102	4.89
102	4.89
Not compensating for water vapor	**Not compensating for water vapor**
103	4.90
107	4.90
100	4.90
103	4.89
103	4.90
102.90 = avg	**4.90** = avg
1.029 = avg/standard	**0.985** = avg/standard

Standards Used:	Expiration date:
Air Liquide 0.1 ppm SF6 in air, CAL11936	3/19/2013
Air Liquide 4.97 ppm SF6 in air, FF34346	3/19/2014
Weather Station Used:	
Fisher Scientific S/N 90936818	12/7/2012

Entries made by: Julia Flaherty	Technical Data Review performed by: Susan Sande
Signature/date 6/19/2012	Signature/date 7/10/2012
Signature on file with Original	Signature on file with Original TI-WTPSP-078

SULFUR HEXAFLUORIDE GAS INSTRUMENT CALIBRATION

Site	HV-S2 Model	Instrument	B&K Model 1302
Date/Time	6/27/12 1145	Serial No.	1765299
Testers	CA,JEF	Property No.	WD17210

Setup:
- 7.7 ft B&K sample inlet tube length
- 1005 mbar station pressure
- 72 deg F ambient temp analyzer corrects to 20 deg C
- 35 percent RH ambient humidity

Pre-Test background, ppb

Not compensating for water vapor, monitoring task 2

38.4, 36.1, 34.3, 35.5, 33.8

Compensating for water vapor, monitoring task 1

2.6, 1.6, 2.8, 1.83, 4.05

	100 ppb		4.97 ppm
Cylinder	CAL11936	Cylinder	FF34346
start P =	1100 psi	start P =	1100 psi
end P =	1100 psi	end P =	1100 psi

B&K Calibration readings: (ppm)

Compensating for water vapor	**Compensating for water vapor**
100	4.86
95	4.86
99	4.86
99	4.87
101	4.87
Not compensating for water vapor	**Not compensating for water vapor**
101	4.81
103	4.86
99	4.86
103	4.84
102	4.85
100.20 = avg	**4.85** = avg
1.002 = avg/standard	**0.977** = avg/standard

Standards Used:	Expiration date:
Air Liquide 0.1 ppm SF6 in air, CAL11936	3/19/2013
Air Liquide 4.97 ppm SF6 in air, FF34346	3/19/2014
Weather Station Used:	
Fisher Scientific S/N 90936818	12/7/2012

Entries made by: Julia Flaherty	Technical Data Review performed by: Susan Sande
Signature/date 6/27/2012	Signature/date 7/10/2012
Signature on file with Original	Signature on file with Original TI-WTPSP-078

SULFUR HEXAFLUORIDE GAS INSTRUMENT CALIBRATION

Site	HV-S2 Model	Instrument	B&K Model 1302
Date/Time	6/27/12 1145	Serial No.	1765299
Testers	CA,JEF	Property No.	WD17210

Setup:
- 7.7 ft B&K sample inlet tube length
- 1005 mbar station pressure
- 72 deg F ambient temp analyzer corrects to 20 deg C
- 35 percent RH ambient humidity

Pre-Test background, ppb

Not compensating for water vapor, monitoring task 2

38.4, 36.1, 34.3, 35.5, 33.8

Compensating for water vapor, monitoring task 1

2.6, 1.6, 2.8, 1.83, 4.05

	100 ppb		4.97 ppm
Cylinder	CAL11936	Cylinder	FF34346
start P =	1100 psi	start P =	1100 psi
end P =	1100 psi	end P =	1100 psi

B&K Calibration readings: (ppm)

Compensating for water vapor

100	4.86
95	4.86
99	4.86
99	4.87
101	4.87

Not compensating for water vapor

101	4.81
103	4.86
99	4.86
103	4.84
102	4.85
100.20 = avg	**4.85** = avg
1.002 = avg/standard	**0.977** = avg/standard

Standards Used:	Expiration date:
Air Liquide 0.1 ppm SF6 in air, CAL11936	3/19/2013
Air Liquide 4.97 ppm SF6 in air, FF34346	3/19/2014
Weather Station Used:	
Fisher Scientific S/N 90936818	12/7/2012

Entries made by: Julia Flaherty	Technical Data Review performed by: Susan Sande
Signature/date 6/27/2012	Signature/date 7/10/2012
Signature on file with Original	Signature on file with Original TI-WTPSP-078

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S2 Model	Run No.	GT-1
Date	5/1/2012	Fan Configuration	Fan A
Testers	JEF, CA, XY	Fan Setting	29 Hz
Stack Dia.	11.938 in.	Stack Temp	60.8 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	827 / 1000
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	E -Center

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial —>		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	716	780	714	**736.7**	628	710	711	**683.0**
2	1.25	707	722	642	**690.3**	666	709	691	**688.7**
3	2.32	674	643	738	**685.0**	665	669	676	**670.0**
4	3.86	654	662	604	**640.0**	661	644	599	**634.7**
Center	5.97	655	657	634	**648.7**	650	629	591	**623.3**
5	8.08	609	653	602	**621.3**	655	584	605	**614.7**
6	9.62	632	580	690	**634.0**	631	624	672	**642.3**
7	10.68	617	629	634	**626.7**	675	631	651	**652.3**
8	11.44	568	609	655	**610.7**	727	618	704	**683.0**
Averages ——>		**648.0**	**659.4**	**657.0**	**654.8**	**662.0**	**646.4**	**655.6**	**654.7**

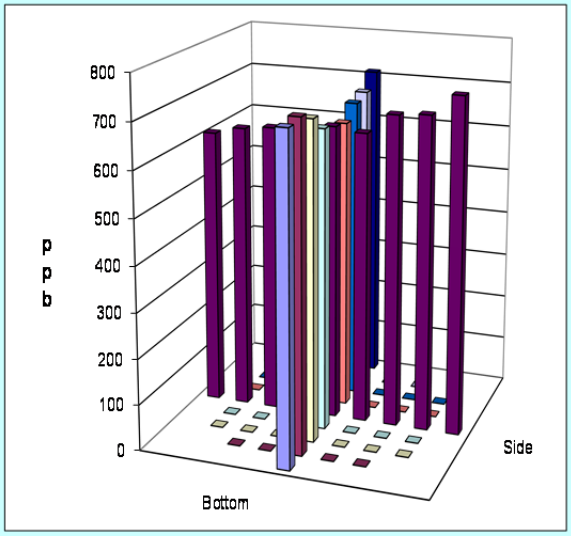
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	654.7		Mean	649.4	646.6	648.0
Min Point	610.7	-6.7%	Std. Dev.	27.6	26.1	25.8
Max Point	736.7	12.5%	COV as %	4.3	4.0	4.0

Avg. Conc. 657.08 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN	1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001		1/17/2013
Fisher Scientific	SN 90936818		12/7/2012

	Start	Finish	
Tracer tank pressure	10	10	psig
Injection flowmeter	15	15	sccm
Stack Temp	58.8	62.8	°F
Mean stack velocity	1072	1095	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1002	1002	mbar
Ambient humidity	35%	28%	RH
Ambient Temp	57.2	72.5	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	6,5,7,6,13	11,6,13,10,11	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/30/2012 CA 5/1/12

Notes:

CA 5/1/12

Entries made by: XY, CA
Signature/date 5/1/2012
Signature on file with original

Technical Data Review performed by: Susan Sande
Signature/date 7/10/2012
Signature on file with original TI-WTPSP-078

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S2 Model	Run No.	GT-2
Date	5/1/2012	Fan Configuration	Fan B only
Testers	XY, CA	Fan Setting	26 Hz
Stack Dia.	11.938 in.	Stack Temp	67.2 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	1013 / 1130
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	E -Center

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	700	740	732	**724.0**	736	735	751	**740.7**
2	1.25	743	716	731	**730.0**	727	729	706	**720.7**
3	2.32	697	730	737	**721.3**	747	713	737	**732.3**
4	3.86	741	768	770	**759.7**	727	744	754	**741.7**
Center	5.97	720	711	729	**720.0**	729	762	727	**739.3**
5	8.08	777	722	710	**736.3**	677	715	739	**710.3**
6	9.62	700	727	718	**715.0**	725	750	706	**727.0**
7	10.68	729	718	712	**719.7**	737	753	733	**741.0**
8	11.44	692	719	725	**712.0**	703	738	726	**722.3**
Averages ---->		722.1	727.9	729.3	726.4	723.1	737.7	731.0	730.6

All	ppb	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	728.5		Mean	728.9	730.3	729.6
Min Point	710.3	-2.5%	Std. Dev.	15.4	11.8	13.2
Max Point	759.7	4.3%	COV as %	2.1	1.6	1.8

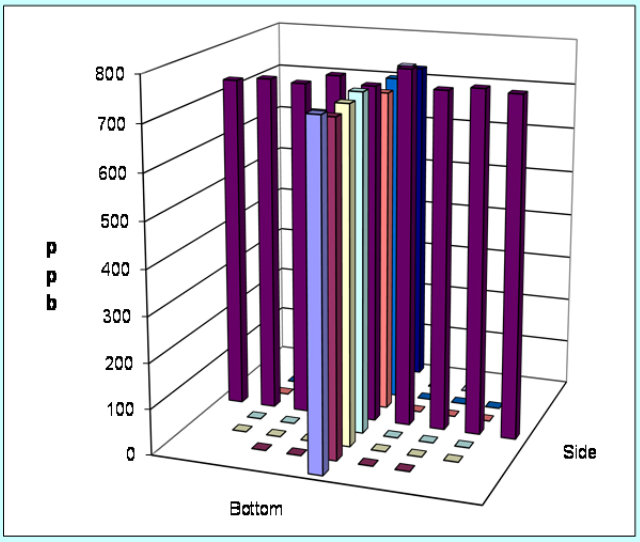
Avg. Conc. 728.38 ppb

Instuments Used:

B&K 1302 Gas Analyzer	SN	1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001		1/17/2013
Fisher Scientific	SN 90936818		12/7/2012

	Start	Finish	
Tracer tank pressure	125	125	psig
Injection flowmeter	15	15	sccm
Stack Temp	65.8	68.6	°F
Mean stack velocity	1042	1087	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1002	1002	mbar
Ambient humidity	28%	24%	RH
Ambient Temp	72.5	76.1	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	9,11,11,10,10	3,7,8,10,8	ppb
No. Bk-Gd samples	5	5	n

Gas analyzer checked: 4/30/2012 CA 5/1/12



Notes:

CA 5/1/12

Entries made by: XY, CA
Signature/date 5/1/2012
Signature on file with original

Technical Data Review performed by: Susan Sande
Signature/date 7/10/2012
Signature on file with original TI-WTPSP-078

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S2 Model	Run No.	GT-3
Date	5/1/2012	Fan Configuration	Fan B only
Testers	XY, CA	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	65.5 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	11:43/1300
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	E -Center

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	634	642	667	647.7	633	647	641	640.3
2	1.25	617	655	678	650.0	629	615	624	622.7
3	2.32	659	633	659	650.3	632	644	642	639.3
4	3.86	635	664	680	659.7	646	624	650	640.0
Center	5.97	668	667	658	664.3	666	631	630	642.3
5	8.08	650	641	638	643.0	633	620	632	628.3
6	9.62	617	645	635	632.3	633	632	654	639.7
7	10.68	613	605	613	610.3	622	643	637	634.0
8	11.44	650	635	659	648.0	623	638	616	625.7
Averages ---->		638.1	643.0	654.1	645.1	635.2	632.7	636.2	634.7

All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	639.9		Mean	644.3	635.2	639.7
Min Point	610.3	-4.6%	Std. Dev.	18.3	7.3	14.2
Max Point	664.3	3.8%	COV as %	2.8	1.1	2.2

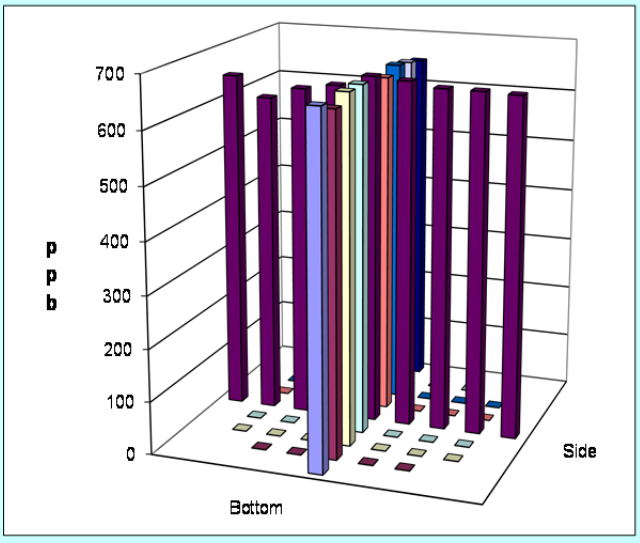
Avg. Conc. 638.21 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN	1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001		1/17/2013
Fisher Scientific	SN 90936818		12/7/2012

	Start	Finish	
Tracer tank pressure	125	125	psig
Injection flowmeter	30	30	sccm
Stack Temp	66.5	64.5	°F
Mean stack velocity	2615	2686	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1002	1001	mbar
Ambient humidity	26%	27%	RH
Ambient Temp	69.8	67.1	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	9,6,6,7,10	10,10,6,9,7	ppb
No. Bk-Gd samples	5	5	n

Gas analyzer checked: 4/30/2012 CA 5/1/12



Notes:

CA 5/1/12

Entries made by:	XY, CA	Technical Data Review performed by:	Susan Sande
Signature/date	5/1/2012	Signature/date	7/10/2012
	Signature on file with original		Signature on file with original TI-WTPSP-078

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S2 Model	Run No.	GT-4
Date	5/1/2012	Fan Configuration	Fan B only
Testers	EA, JAG	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	66.95 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	1300 / 1418
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	Port E, Bottom

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	670	579	632	627.0	651	640	606	632.3
2	1.25	631	579	651	620.3	602	563	603	589.3
3	2.32	584	632	562	592.7	619	659	609	629.0
4	3.86	603	642	663	636.0	604	659	664	642.3
Center	5.97	631	587	644	620.7	662	677	598	645.7
5	8.08	583	647	524	584.7	653	581	624	619.3
6	9.62	656	641	664	653.7	615	627	608	616.7
7	10.68	601	625	605	610.3	634	598	577	603.0
8	11.44	636	584	585	601.7	634	629	711	658.0
Averages ---->		621.7	612.9	614.4	616.3	630.4	625.9	622.2	626.2

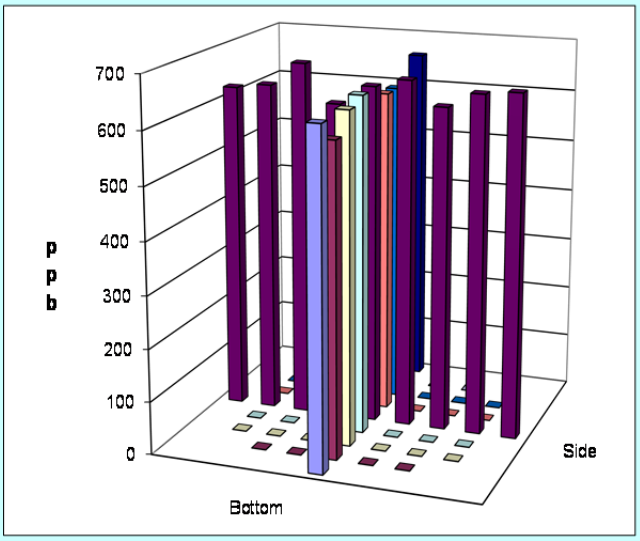
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	621.3		Mean	616.9	620.8	618.8
Min Point	584.7	-5.9%	Std. Dev.	23.8	20.3	21.4
Max Point	658.0	5.9%	COV as %	3.9	3.3	3.5

Avg. Conc. 619.77 ppb

Instuments Used:

B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	125	125	psig
Injection flowmeter	30	30	sccm
Stack Temp	64.9	69	°F
Mean stack velocity	2546	2599	sfpm
Sampling flowmeter	5	4	lpm
Ambient pressure	1001	1000	mbar
Ambient humidity	27%	26%	RH
Ambient Temp	65.3	67.1	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	9, 10, 5, 8, 7	8, 7, 1, 6, 2	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/30/2012

Notes:

EA
5/1/2012

Entries made by: John Glissmeyer
Signature/date 5/1/2012
Signature on file with original

Technical Data Review performed by: Susan Sande
Signature/date 7/10/2012
Signature on file with original TI-WTPSP-078

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S2 Model	Run No.	GT-5
Date	5/1/2012	Fan Configuration	Fan B only
Testers	EA, JAG	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	70.05 deg F
Stack X-Area	111.9 $in.^2$	Start/End Time	1419 / 1526
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	Port E, Top

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	635	643	665	**647.7**	624	625	625	**624.7**
2	1.25	672	663	665	**666.7**	642	642	622	**635.3**
3	2.32	670	681	672	**674.3**	637	648	650	**645.0**
4	3.86	626	698	652	**658.7**	620	624	598	**614.0**
Center	5.97	649	641	647	**645.7**	619	620	646	**628.3**
5	8.08	612	582	615	**603.0**	634	637	607	**626.0**
6	9.62	631	618	603	**617.3**	621	618	600	**613.0**
7	10.68	600	622	617	**613.0**	605	635	658	**632.7**
8	11.44	589	596	584	**589.7**	649	654	621	**641.3**
Averages ---->		631.6	638.2	635.6	635.1	627.9	633.7	625.2	628.9

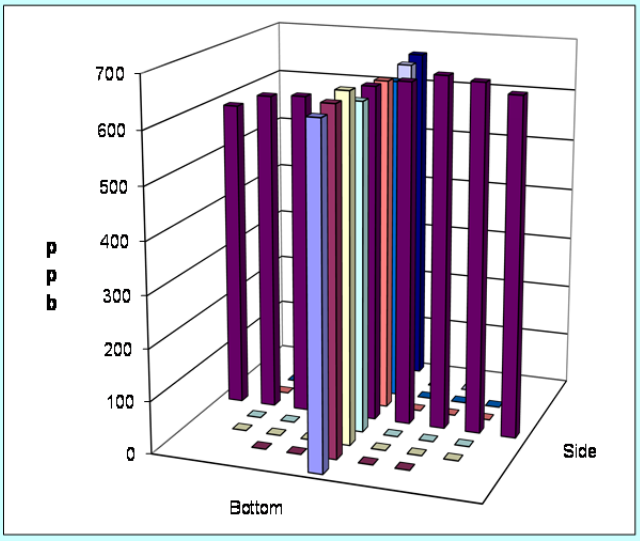
All	ppb	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	632.0		Mean	639.8	627.8	633.8
Min Point	589.7	-6.7%	Std. Dev.	28.5	11.5	21.8
Max Point	674.3	6.7%	COV as %	4.5	1.8	3.4

Avg. Conc. 631.40 ppb

Instuments Used:

B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	125	125	psig
Injection flowmeter	30	30	sccm
Stack Temp	69	71.1	°F
Mean stack velocity	2594	2609	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1000	999	mbar
Ambient humidity	26%	26%	RH
Ambient Temp	67.1	67	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	8, 7, 1, 6, 2	2, 5, 3, 8, 3	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/30/2012

Notes:

EA

5/1/2012

Entries made by: John Glissmeyer
Signature/date 5/1/2012
Signature on file with original

Technical Data Review performed by: Susan Sande
Signature/date 7/10/2012
Signature on file with original TI-WTPSP-078

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S2 Model	Run No.	GT-6
Date	5/2/2012	Fan Configuration	Fan B only
Testers	CA, JEF, XY	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	58 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	830 / 955
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	Port E, Near

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	593	604	590	595.7	637	617	615	623.0
2	1.25	596	609	572	592.3	603	606	631	613.3
3	2.32	574	597	590	587.0	614	610	612	612.0
4	3.86	575	590	598	587.7	616	603	634	617.7
Center	5.97	568	586	594	582.7	611	608	588	602.3
5	8.08	616	635	623	624.7	599	593	606	599.3
6	9.62	645	615	623	627.7	609	618	609	612.0
7	10.68	654	646	627	642.3	617	603	610	610.0
8	11.44	641	648	653	647.3	617	589	608	604.7
Averages ---->		606.9	614.4	607.8	609.7	613.7	605.2	612.6	610.5

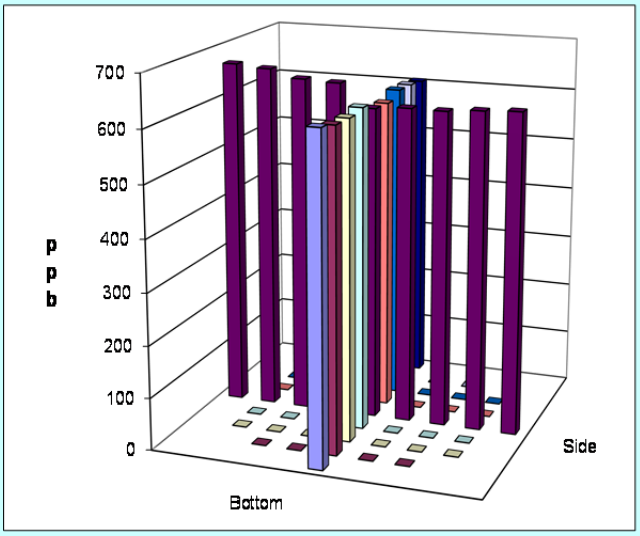
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	610.1		Mean	606.3	609.5	607.9
Min Point	582.7	-4.5%	Std. Dev.	24.4	6.4	17.2
Max Point	647.3	6.1%	COV as %	4.0	1.1	2.8

Avg. Conc. 612.29 ppb

Instuments Used:

B&K 1302 Gas Analyzer	SN	1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001		1/17/2013
Fisher Scientific	SN 90936818		12/7/2012

	Start	Finish	
Tracer tank pressure	50	50	psig
Injection flowmeter	30	30	sccm
Stack Temp	55.5	60.5	°F
Mean stack velocity	2641	2679	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1003	1003	mbar
Ambient humidity	37%	37%	RH
Ambient Temp	55.4	55.4	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	3,1,3,3,2	9,9,12,9,11	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/30/2012 CA 5/2/12

Notes:

CA 5/2/12

Entries made by: XY, CA, JEF
Signature/date 5/2/2012
Signature on file with original

Technical Data Review performed by: Susan Sande
Signature/date 7/10/2012
Signature on file with original TI-WTPSP-078

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S2 Model	Run No.	GT-7
Date	5/2/2012	Fan Configuration	Fan B only
Testers	CA, XY	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	62.25 deg F
Stack X-Area	111.9 $in.^2$	Start/End Time	10:00 / 10:55
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	Port E, Far

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	564	693	625	627.3	644	619	639	634.0
2	1.25	604	608	605	605.7	603	616	606	608.3
3	2.32	591	620	636	615.7	658	658	669	661.7
4	3.86	617	651	636	634.7	639	592	623	618.0
Center	5.97	596	653	604	617.7	651	623	659	644.3
5	8.08	595	587	578	586.7	645	602	633	626.7
6	9.62	607	613	619	613.0	602	633	599	611.3
7	10.68	574	616	620	603.3	599	647	583	609.7
8	11.44	581	605	591	592.3	617	611	584	604.0
Averages ---->		592.1	627.3	612.7	610.7	628.7	622.3	621.7	624.2

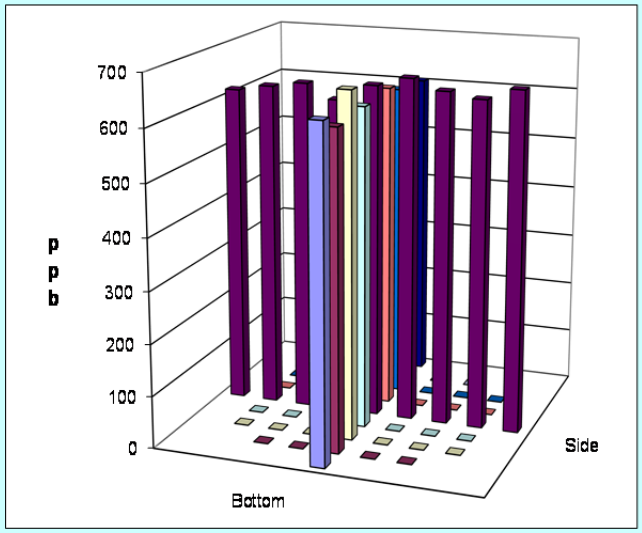
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	617.5		Mean	611.0	625.7	618.3
Min Point	586.7	-5.0%	Std. Dev.	14.8	20.3	18.7
Max Point	661.7	7.2%	COV as %	2.4	3.2	3.0

Avg. Conc. 615.77 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN	1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001		1/17/2013
Fisher Scientific	SN 90936818		12/7/2012

	Start	Finish	
Tracer tank pressure	100	100	psig
Injection flowmeter	30	30	sccm
Stack Temp	60.7	63.8	°F
Mean stack velocity	2654	2668	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1003	1003	mbar
Ambient humidity	35%	34%	RH
Ambient Temp	58.1	61.7	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	9,9,12,9,11	8,8,10,10,9	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/30/2012 CA 5/2/12

Notes:

CA 5/2/12

Entries made by: XY, CA
Signature/date 5/2/2012
Signature on file with original

Technical Data Review performed by: Susan Sande
Signature/date 7/10/2012
Signature on file with original TI-WTPSP-078

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S2 Model	Run No.	GT-8
Date	5/2/2012	Fan Configuration	Fan B only
Testers	XY, CA	Fan Setting	56 Hz
Stack Dia.	11.938 in.	Stack Temp	65.15 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	11:11/12:45
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	Port E, Center

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	637	698	648	661.0	681	649	679	669.7
2	1.25	669	681	699	683.0	669	689	653	670.3
3	2.32	660	664	690	671.3	705	645	692	680.7
4	3.86	705	670	670	681.7	689	653	686	676.0
Center	5.97	652	685	717	684.7	656	662	673	663.7
5	8.08	636	666	662	654.7	667	670	719	685.3
6	9.62	619	655	645	639.7	645	664	677	662.0
7	10.68	652	687	630	656.3	699	674	669	680.7
8	11.44	729	655	640	674.667	673	654	661	662.7
Averages ---->		662.1	673.4	666.8	667.4	676.0	662.2	678.8	672.3

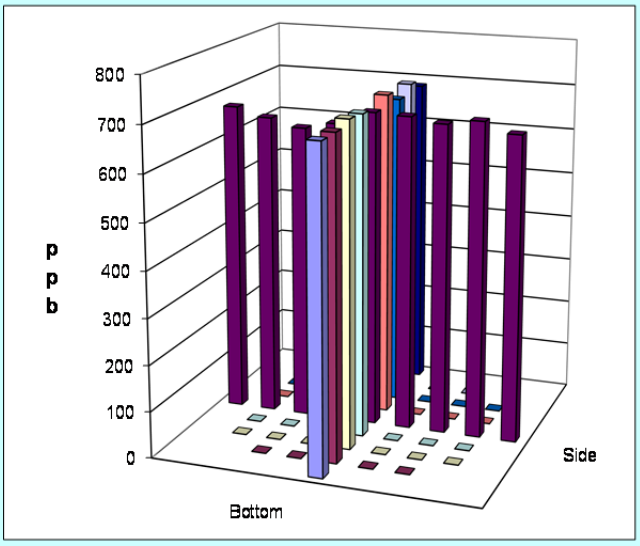
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	669.9		Mean	667.3	674.1	670.7
Min Point	639.7	-4.5%	Std. Dev.	17.4	9.0	13.8
Max Point	685.3	2.3%	COV as %	2.6	1.3	2.1

Avg. Conc. 669.35 ppb

Instuments Used:

B&K 1302 Gas Analyzer	SN	1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001		1/17/2013
Fisher Scientific	SN 90936818		12/7/2012

	Start	Finish	
Tracer tank pressure	125	125	psig
Injection flowmeter	30	30	sccm
Stack Temp	64.0	66.3	°F
Mean stack velocity	2434	2499	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1003	1003	mbar
Ambient humidity	32%	29%	RH
Ambient Temp	60.7	63.5	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	8,6,8,8,10	5,7,10,8,9	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/30/2012 CA 5/2/12

Notes:

CA 5/2/12

Entries made by: XY, CA
Signature/date 5/2/2012
Signature on file with original

Technical Data Review performed by: Susan Sande
Signature/date 7/10/2012
Signature on file with original TI-WTPSP-078

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S2 Model	Run No.	GT-9
Date	5/4/2012	Fan Configuration	Fan A Only
Testers	CA, EA	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	60.55 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	840 / 950
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	Port E Center

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	582	558	599	**579.7**	530	511	462	**501.0**
2	1.25	564	583	549	**565.3**	491	501	532	**508.0**
3	2.32	557	551	562	**556.7**	469	476	492	**479.0**
4	3.86	567	539	511	**539.0**	483	473	469	**475.0**
Center	5.97	485	505	506	**498.7**	492	481	509	**494.0**
5	8.08	465	460	478	**467.7**	494	512	513	**506.3**
6	9.62	482	466	450	**466.0**	564	541	566	**557.0**
7	10.68	475	490	511	**492.0**	560	571	563	**564.7**
8	11.44	475	473	432	**460.0**	580	587	603	**590.0**
Averages ---->		**516.9**	**513.9**	**510.9**	**513.9**	**518.1**	**517.0**	**523.2**	**519.4**

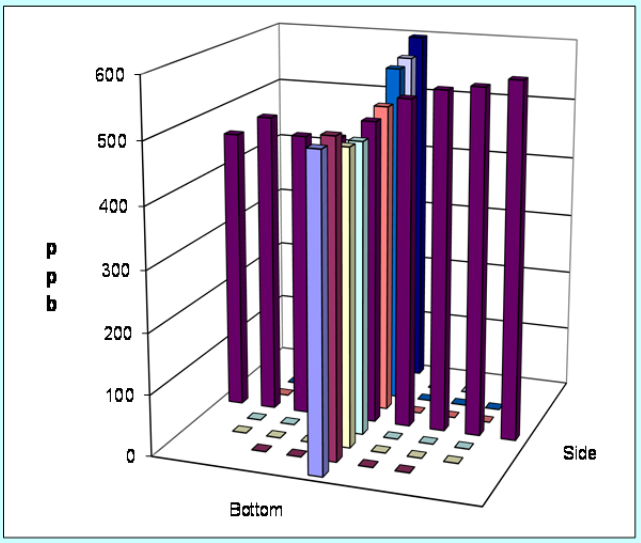
All	ppb	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	516.7		Mean	512.2	512.0	512.1
Min Point	460.0	-11.0%	Std. Dev.	41.3	35.7	37.1
Max Point	590.0	14.2%	COV as %	8.1	7.0	7.2

Avg. Conc. 519.21 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012
		EA
		5/4/2012

	Start	Finish	
Tracer tank pressure	100	75	psig
Injection flowmeter	30	30	sccm
Stack Temp	57.9	63.2	°F
Mean stack velocity	3076	3130	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1005.00	1006.00	mbar
Ambient humidity	44%	30%	RH
Ambient Temp	59.0	59	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	6, 4, 4, 5, 8	6, 3, 2, 4, 0.3	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/30/152 CA 5/4/12

Notes:

CA\
5/4/2012

Entries made by:	EA, CA	Technical Data Review performed by:	Susan Sande
Signature/date	5/4/2012	Signature/date	7/10/2012
	Signature on fiel with original		Signature on file with original TI-WTPSP-078

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S2 Model	Run No.	GT-10
Date	5/4/2012	Fan Configuration	A Only
Testers	YFS, XYY	Fan Setting	57.9 Hz
Stack Dia.	11.938 in.	Stack Temp	67.9 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	14:36 / 16:30
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	E -Center

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	560	588	601	583.0	540	577	541	552.7
2	1.25	589	602	598	596.3	539	556	543	546.0
3	2.32	517	546	513	525.3	517	504	528	516.3
4	3.86	476	513	540	509.7	549	566	514	543.0
Center	5.97	543	482	494	506.3	514	537	552	534.3
5	8.08	497	561	495	517.7	526	566	521	537.7
6	9.62	538	465	493	498.7	512	569	546	542.3
7	10.68	484	528	484	498.7	542	584	546	557.3
8	11.44	481	517	516	504.7	594	619	591	601.3
Averages ---->		520.6	533.6	526.0	526.7	537.0	564.2	542.4	547.9

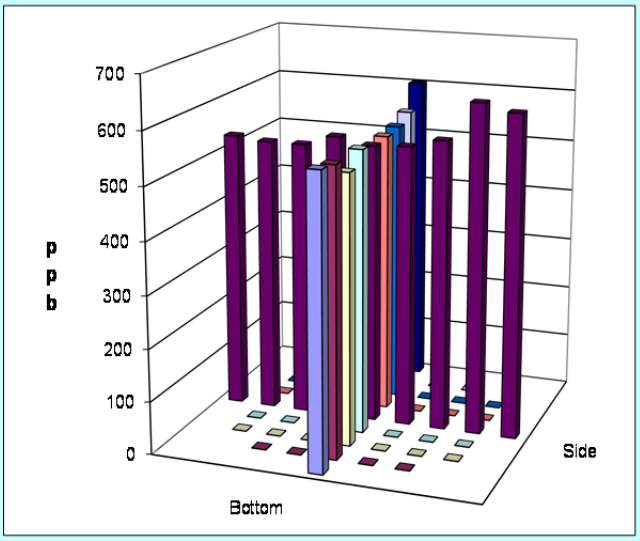
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	537.3		Mean	521.8	539.6	530.7
Min Point	498.7	-7.2%	Std. Dev.	34.3	12.6	26.4
Max Point	601.3	11.9%	COV as %	6.6	2.3	5.0

Avg. Conc. 539.42 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012
		EA
		5/4/2012

	Start	Finish	
Tracer tank pressure	150	150	psig
Injection flowmeter	30	30	sccm
Stack Temp	67.1	68.7	°F
Mean stack velocity	3073	3030	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1008	1007	mbar
Ambient humidity	25%	33%	RH
Ambient Temp	71.6	62.6	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	5,7,5,7,5	6,10,6,4,4	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/30/152 XY 5/4/12

Notes: Light rain and wind.

Repeat of GT-9, A max flow. Reduce frequency to be close to rtarget velocity of 3040 fpm.

XYY 5/4/12

5/7/12 JEF found injection probe pointed upsteam, suspect injection probe oriented incorrectly during this test.

Entries made by: XYY
Signature/date 5/4/2012
Signature on file with original

Technical Data Review performed by: Susan Sande
Signature/date 7/10/2012
Signature on file with original TI-WTPSP-078

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S2 Model	Run No.	GT-11
Date	5/7/2012	Fan Configuration	Fan A
Testers	CA, EA	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	66 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	0846 / 1015
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	Center, Port E

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	541	550	552	**547.7**	568	570	552	**563.3**
2	1.25	522	510	507	**513.0**	531	550	543	**541.3**
3	2.32	486	534	535	**518.3**	556	564	521	**547.0**
4	3.86	507	482	515	**501.3**	477	524	518	**506.3**
Center	5.97	478	489	490	**485.7**	458	513	504	**491.7**
5	8.08	519	484	499	**500.7**	478	490	484	**484.0**
6	9.62	506	497	497	**500.0**	494	448	464	**468.7**
7	10.68	530	498	497	**508.3**	491	506	492	**496.3**
8	11.44	495	523	515	**511.0**	527	463	488	**492.7**
Averages ---->		**509.3**	**507.4**	**511.9**	**509.6**	**508.9**	**514.2**	**507.3**	**510.1**

All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	509.9		Mean	503.9	505.0	504.5
Min Point	468.7	-8.1%	Std. Dev.	10.6	29.2	21.1
Max Point	563.3	10.5%	COV as %	2.1	5.8	4.2

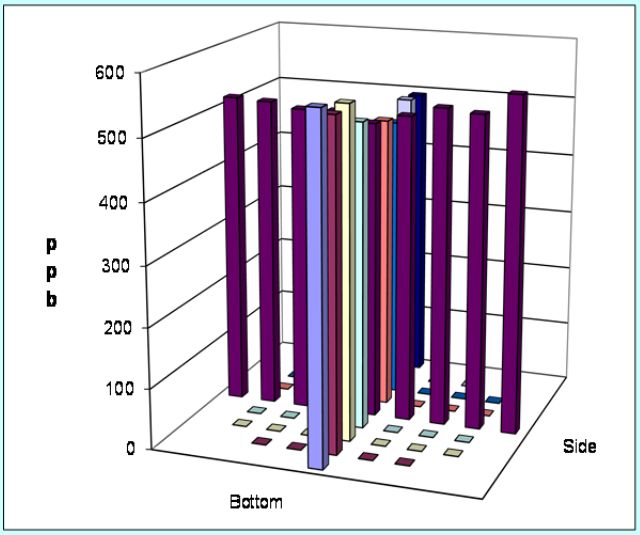
Avg. Conc. 512.50 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN	1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001		1/17/2013
Fisher Scientific	SN 90936818		12/7/2012

	Start	Finish	
Tracer tank pressure	10	10	psig
Injection flowmeter	30	30	sccm
Stack Temp	63	68.3	°F
Mean stack velocity	3067	3053	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1016	1016	mbar
Ambient humidity	32%	20%	RH
Ambient Temp	66.2	76.1	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	4, .6, 5, 2, 4	4, 3, 6, 5, .6	ppb
No. Bk-Gd samples	5	5	n

EA
5/7/2012



Gas analyzer checked: 5/7/2012 CA 5/7/12

Notes:

CA
5/7/2012

Entries made by:	EA, CA	Technical Data Review performed by:	Susan Sande
Signature/date	5/7/2012	Signature/date	7/10/2012
	Initials on file with Original		Signature on file with original TI-WTPSP-078

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S2 Model	Run No.	GT-12
Date	5/7/2012	Fan Configuration	Fan A
Testers	CA, EA	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	72 deg F
Stack X-Area	111.9 $in.^2$	Start/End Time	1018 / 1125
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	Center, Port E

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	552	559	577	**562.7**	590	521	579	**563.3**
2	1.25	569	558	569	**565.3**	536	549	548	**544.3**
3	2.32	514	537	530	**527.0**	528	550	524	**534.0**
4	3.86	506	505	529	**513.3**	528	512	512	**517.3**
Center	5.97	506	523	484	**504.3**	486	530	493	**503.0**
5	8.08	509	499	519	**509.0**	524	500	475	**499.7**
6	9.62	506	543	517	**522.0**	496	473	492	**487.0**
7	10.68	474	532	518	**508.0**	478	517	509	**501.3**
8	11.44	505	502	491	**499.3**	504	538	509	**517.0**
Averages ---------->		**515.7**	**528.7**	**526.0**	**523.4**	**518.9**	**521.1**	**515.7**	**518.6**

All	ppb	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	521.0		Mean	521.3	512.4	516.8
Min Point	487.0	-6.5%	Std. Dev.	21.0	20.5	20.5
Max Point	565.3	8.5%	COV as %	4.0	4.0	**4.0**

Avg. Conc. 523.17 ppb

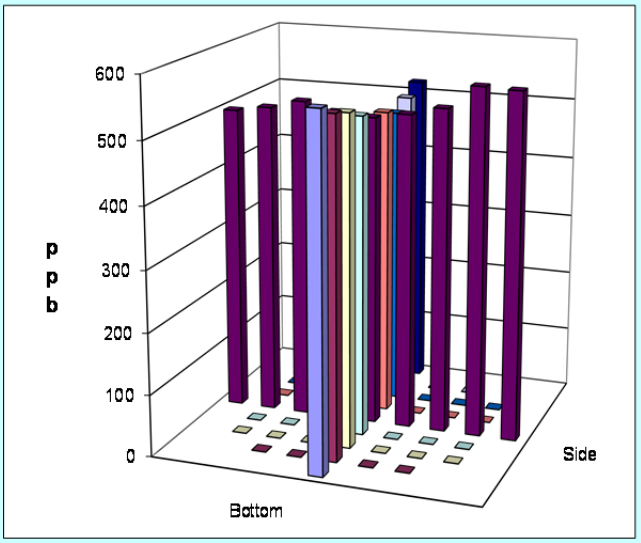
Instuments Used:

B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

EA

5/7/2012

	Start	Finish	
Tracer tank pressure	10	10	psig
Injection flowmeter	30	30	sccm
Stack Temp	68.3	75.6	°F
Mean stack velocity	3053	3134	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1016	1015	mbar
Ambient humidity	20%	29%	RH
Ambient Temp	76.1	70.7	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	4, 3, 6, 5, 0.6	2, 3, 6, 8, 2	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 5/7/2012 CA 5/7/12

Notes: Re-do of GT-10 due to finding injection probe in Port pointing upstream into the flow.

CA

5/7/2012

Entries made by:	EA, CA
Signature/date	5/7/2012
	Initials on file with Original

Technical Data Review performed by:	Susan Sande
Signature/date	7/10/2012
	Signature on file with original TI-WTPSP-078

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S2 Model	Run No.	GT-13
Date	6/20/2012	Fan Configuration	Fan B Only
Testers	XY, CA	Fan Setting	59.1 Hz
Stack Dia.	11.938 in.	Stack Temp	80 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	9:30/11:12
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C-Bottom

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	560	519	567	548.7	613	533	529	558.3
2	1.25	575	636	517	576.0	557	523	563	547.7
3	2.32	628	586	576	596.7	623	612	610	615.0
4	3.86	618	552	638	602.7	554	548	574	558.7
Center	5.97	576	641	623	613.3	528	679	585	597.3
5	8.08	585	524	599	569.3	536	540	541	539.0
6	9.62	548	623	591	587.3	608	591	556	585.0
7	10.68	600	554	496	550.0	595	587	666	616.0
8	11.44	666	564	549	593.0	580	572	636	596.0
Averages ---->		595.1	577.7	572.9	581.9	577.1	576.1	584.4	579.2

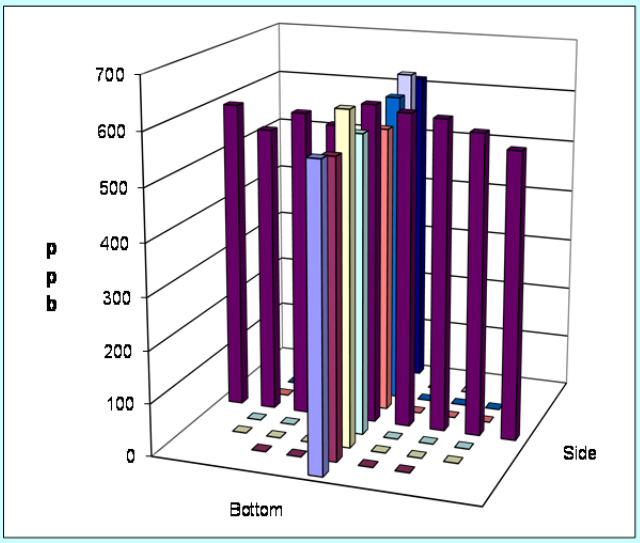
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	580.6		Mean	585.0	579.8	582.4
Min Point	539.0	-7.2%	Std. Dev.	21.6	31.7	26.2
Max Point	616.0	6.1%	COV as %	3.7	5.5	4.5

Avg. Conc. 577.46 ppb

	Start	Finish	
Tracer tank pressure	125	125	psig
Injection flowmeter	30	30	sccm
Stack Temp	79.4	79.6	°F
Mean stack velocity	2930	2938	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1009	1008	mbar
Ambient humidity	31%	31%	RH
Ambient Temp	70.7	74.3	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	7,2,10,2,13	6,12,9,5,6	ppb
No. Bk-Gd samples	5	5	n

Instuments Used:

B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012
		EA
		5/7/2012



Gas analyzer checked: 6/19/2012

Notes: Re-do of GT-4 Fan B max target 2619 to 3014 fpm at Bottom 3.

CA

6/20/2012

Entries made by:	CA
Signature/date	6/20/2012
	Initials on file with Original

Technical Data Review performed by:	Susan Sande
Signature/date	7/10/2012
	Signature on file with original TI-WTPSP-078

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S2 Model	Run No.	GT-14
Date	6/20/2012	Fan Configuration	Fan B only
Testers	XY, CA	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	83.65 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	11:16/12:45
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C-Top

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	593	595	575	587.7	607	604	583	598.0
2	1.25	590	599	622	603.7	587	617	604	602.7
3	2.32	610	605	586	600.3	650	596	613	619.7
4	3.86	597	584	578	586.3	602	595	599	598.7
Center	5.97	552	563	614	576.3	571	576	566	571.0
5	8.08	575	550	593	572.7	581	600	555	578.7
6	9.62	565	581	548	564.7	561	555	584	566.7
7	10.68	559	613	613	595.0	554	548	579	560.3
8	11.44	591	587	569	582.3	573	569	540	560.7
Averages ---->		581.3	586.3	588.7	585.4	587.3	584.4	580.3	584.0

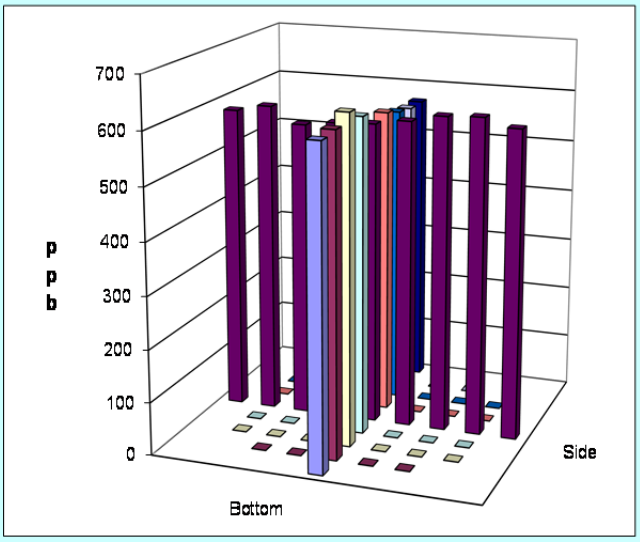
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	584.7		Mean	585.6	585.4	585.5
Min Point	560.3	-4.2%	Std. Dev.	14.9	21.9	18.0
Max Point	619.7	6.0%	COV as %	2.5	3.7	3.1

Avg. Conc. 586.13 ppb

Instuments Used:

B&K 1302 Gas Analyzer	SN	1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001		1/17/2013
Fisher Scientific	SN 90936818		12/7/2012

	Start	Finish	
Tracer tank pressure	250	250	psig
Injection flowmeter	30	30	sccm
Stack Temp	81.6	85.7	°F
Mean stack velocity	2997	3000	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1008	1007	mbar
Ambient humidity	31%	26%	RH
Ambient Temp	75.2	79.7	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	6,12,9,5,6	10,11,8,11,5	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 6/19/2012

Notes: Repeat of GT-5, Fan B max target 2619-3014 fpm
Bottom 3.

CA 6/20/12

Entries made by: CA
Signature/date 6/20/2012
Signature on file with original

Technical Data Review performed by: Susan Sande
Signature/date 7/10/2012
Signature on file with original TI-WTPSP-078

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S2 Model	Run No.	GT-15
Date	6/22/2012	Fan Configuration	Fan B only
Testers	CA, XY	Fan Setting	57.7 Hz
Stack Dia.	11.938 in.	Stack Temp	87 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	915/1100
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C- Near

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	577	637	582	598.7	601	552	577	576.7
2	1.25	592	600	627	606.3	637	626	562	608.3
3	2.32	606	636	598	613.3	586	613	566	588.3
4	3.86	563	577	567	569.0	622	598	623	614.3
Center	5.97	629	594	602	608.3	567	612	673	617.3
5	8.08	640	625	588	617.7	618	588	619	608.3
6	9.62	577	595	608	593.3	594	656	604	618.0
7	10.68	627	603	599	609.7	594	540	588	574.0
8	11.44	582	609	628	606.3	583	560	598	580.3
Averages ---->		599.2	608.4	599.9	602.5	600.2	593.9	601.1	598.4

All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	600.5		Mean	602.5	604.1	603.3
Min Point	569.0	-5.2%	Std. Dev.	16.6	16.7	16.0
Max Point	618.0	2.9%	COV as %	2.8	2.8	2.7

Avg. Conc. 598.92 ppb

Instuments Used:

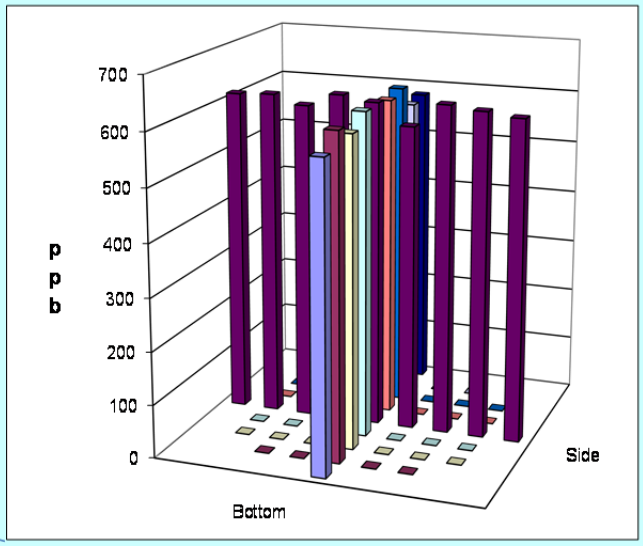
B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	250	250	psig
Injection flowmeter	30	30	sccm
Stack Temp	85.7	87.9	°F
Mean stack velocity	3009	2937	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	991	991	mbar
Ambient humidity	27%	27%	RH
Ambient Temp	90.5	89.6	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	0, -6, -6, -5, -9	5, 3, 9, 5, 5	ppb
No. Bk-Gd samples	5	5	n

Gas analyzer checked: 6/12/2012

Notes: Repeat of GT-6

CA 6/22/2012



Entries made by: Carmen Arimescu 6/22/2012
Signature/date
Signature on file with original

Technical Data Review performed by: Susan Sande
Signature/date 7/10/2012
Signature on file with original TI-WTPSP-078

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	HV-S2 Model	Run No.	GT-16
Date	6/22/2012	Fan Configuration	Fan B only
Testers	CA/XY	Fan Setting	59.1 Hz
Stack Dia.	11.938 in.	Stack Temp	89 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	11:11/13:00
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C - Far

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	587	572	594	584.3	616	570	572	586.0
2	1.25	604	587	593	594.7	606	545	626	592.3
3	2.32	579	616	593	596.0	602	592	578	590.7
4	3.86	595	575	564	578.0	595	580	601	592.0
Center	5.97	587	598	579	588.0	626	606	599	610.3
5	8.08	559	558	592	569.7	587	602	567	585.3
6	9.62	560	593	590	581.0	557	574	605	578.7
7	10.68	579	591	593	587.7	585	614	585	594.7
8	11.44	550	542	571	554.3	608	566	580	584.7
Averages ---->		577.8	581.3	585.4	581.5	598.0	583.2	590.3	590.5

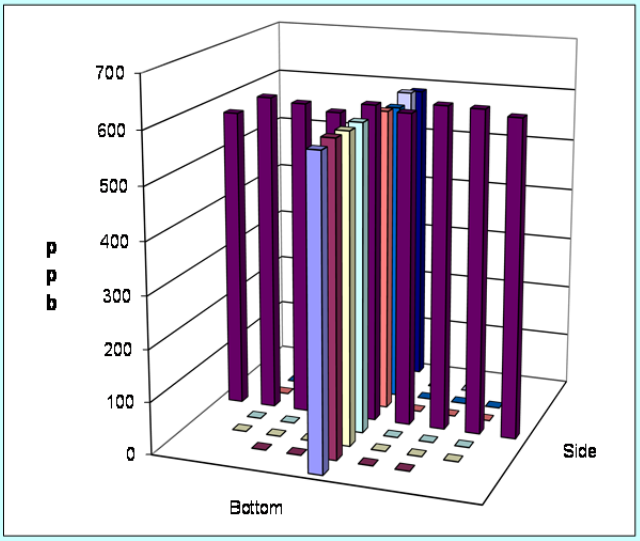
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	586.0		Mean	585.0	592.0	588.5
Min Point	554.3	-5.4%	Std. Dev.	9.4	9.7	9.9
Max Point	610.3	4.1%	COV as %	1.6	1.6	1.7

Avg. Conc. 584.38 ppb

Instuments Used:

B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	250	250	psig
Injection flowmeter	30	30	sccm
Stack Temp	86.3	91.3	°F
Mean stack velocity	2912	2974	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	991	990	mbar
Ambient humidity	27%	27%	RH
Ambient Temp	89.6	88.7	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	7, 5, 8, 12, 8	7, 1, 7, 1, 5	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 6/19/2012

Notes: Reapeat of GT-7

CA 6/22/2012

Entries made by:	Carmen Arimescu	6/22/2012	Technical Data Review performed by:	Susan Sande	
Signature/date			Signature/date	7/10/2012	
	Signature on file with original			Signature on file with original TI-WTPSP-078	

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	**HV-S2 Model**	Run No.	**GT-2**
Date	5/1/2012	Fan Configuration	**Fan B only**
Testers	XY, CA	Fan Setting	**26** **Hz**
Stack Dia.	11.938 in.	Stack Temp	67.2 deg F
Stack X-Area	111.9 $in.^2$	Start/End Time	1013 / 1130
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	**E -Center**

Order -->	1st				2nd			
Traverse-->	Side				Bottom			
Trial ---->	1	2	3	Mean	1	2	3	Mean
Point / Depth, in.	ppb				ppb			
1 / 0.50	700	740	732	724.0	736	735	751	740.7
2 / 1.25	743	716	731	730.0	727	729	706	720.7
3 / 2.32	697	730	737	721.3	747	713	737	732.3
4 / 3.86	741	768	770	759.7	727	744	754	741.7
Center / 5.97	720	711	729	720.0	729	762	727	739.3
5 / 8.08	777	722	710	736.3	677	715	739	710.3
6 / 9.62	700	727	718	715.0	725	750	706	727.0
7 / 10.68	729	718	712	719.7	737	753	733	741.0
8 / 11.44	692	719	725	712.0	703	738	726	722.3
Averages ---------->	722.1	727.9	729.3	726.4	723.1	737.7	731.0	730.6

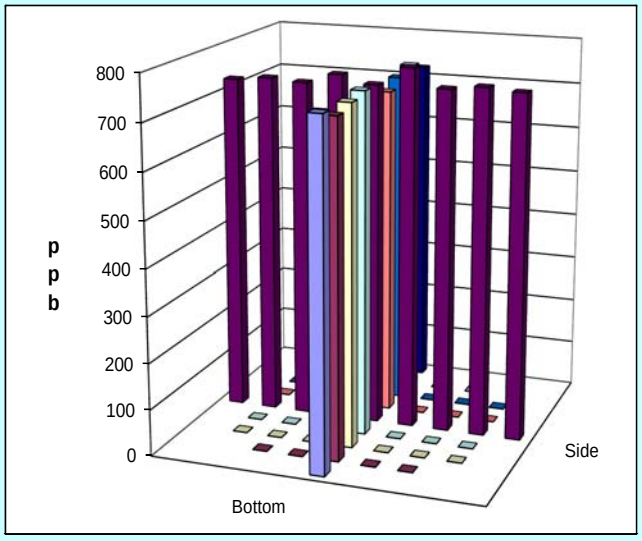
All	ppb	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	728.5		Mean	728.9	730.3	729.6
Min Point	710.3	-2.5%	Std. Dev.	15.4	11.8	13.2
Max Point	759.7	4.3%	COV as %	2.1	1.6	**1.8**

Avg. Conc. 728.38 ppb

Instuments Used:

B&K 1302 Gas Analyzer	SN	1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001		1/17/2013
Fisher Scientific	SN 90936818		12/7/2012

	Start	Finish	
Tracer tank pressure	125	125	psig
Injection flowmeter	15	15	sccm
Stack Temp	65.8	68.6	°F
Mean stack velocity	1042	1087	fpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1002	1002	mbar
Ambient humidity	28%	24%	RH
Ambient Temp	72.5	76.1	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	9,11,11,10,10	3,7,8,10,8	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/30/2012 CA 5/1/12

Notes:

CA 5/1/12

Entries made by: XY, CA
Signature/date 5/1/2012
Signature on file with original

Technical Data Review performed by: Susan Sande
Signature/date 7/10/2012
Signature on file with original TI-WTPSP-078

B.5 HV-S2 Particle Tracer Uniformity Data Sheets

Rev. 0
3 Aug. :

PARTICLE TRACER TRAVERSE DATA FORM

Site	HV-S2 Model	Run No.	PT-1
Date	5/7/2012	Fan configuration	A
Tester	JAG, XYY	Fan Setting	60 Hz
Stack Dia.	11.938 in.	Stack Temp	86 deg F
Stack X-Area	111.9 in.2	Start/End Time	13:30 / 15:38
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Measurement units	particles/ft3	Injection Point	E Center
Order ——>	2nd		1st

Traverse—>	Side				Bottom			
Trial —>	1	2	3	Mean	1	2	3	Mean
Point / Depth, in.	particles/ft3				particles/ft3			
1 / 0.50	1214	1235	1319	1256.0	1329	1370	1289	1329.3
2 / 1.25	1391	1249	1398	1346.0	1714	1624	1663	1667.0
3 / 2.32	1374	1375	1392	1380.3	1688	1741	1657	1695.3
4 / 3.86	1124	1320	1357	1267.0	1680	1646	1696	1674.0
Center / 5.97	1381	1443	1335	1386.3	1581	1608	1495	1561.3
5 / 8.08	1275	1382	1236	1297.7	1344	1261	1415	1340.0
6 / 9.62	1064	1239	1149	1150.7	1222	1306	1332	1286.7
7 / 10.68	1033	1001	943	992.3	1178	1122	1150	1150.0
8 / 11.56	922	754	887	854.3	981	986	1098	1021.7
Averages ——>	1197.6	1222.0	1224.0	1214.5	1413.0	1407.1	1421.7	1413.9

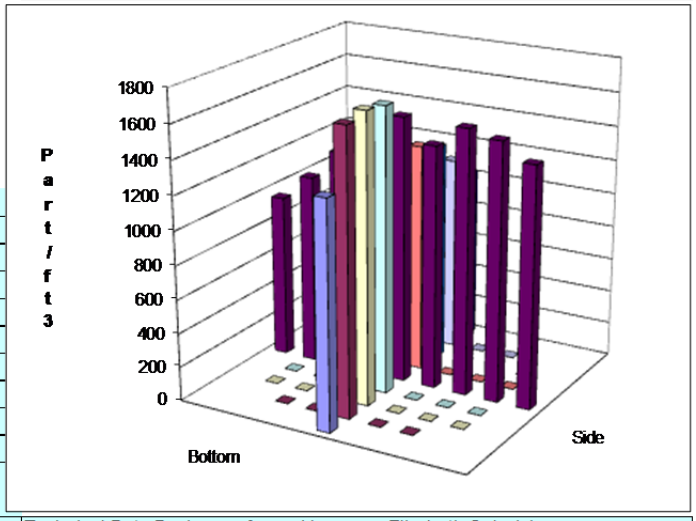
All	pt/ft3	Dev. from mean	*Center 2/3*	Side	Bottom	All	Normlzd
Mean	1314.2		Mean	1260.0	1482.0	1371.0	1450.58
Min Point	854.3	-35.0%	Std. Dev.	143.1	220.4	212.5	188.35
Max Point	1695.3	29.0%	COV as %	11.4	14.9	15.5	12.98

Avg Cc 1294 pt/ft3

	Start	Finish	
Generator Inlet Press	3.0	3.0	psig
Stack Temp	84	87	F
Mean velocity	3058	3079	sfpm
Ambient pressure	1013	1012	mbar
Ambient humidity	21%	22%	RH
Ambient temp	80.6	80	F
Back-Gd aerosol	0,0,0,0,0	8,8,15,12,8	pt/ft3
No. Bk-Gd samples	5	5	
Compressor output	30	30	psig

Instruments Used:

		Cal. Due
TSI VelociCalc	T95351203001	12/17/2012
Fisher Scientific	90936818	12/7/2012
Met One OPC	1011529010 Ref	2/1/2013
Met One OPC	1011529009 Sample	1/9/2013



Notes:

XYY 5/7/12

Oil Us Edwards
Ref. Probe Location: Center, end of stack
Probe Type / Configuration: L-shaped

Entries made by:	JAG	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	5/7/2012 signature on file with original	Signature/date	6/29/2012 Signature on file with Original TI-WTPSP-079

Rev. 0

3 Aug. 2006

PARTICLE TRACER TRAVERSE DATA FORM

Site	HV-S2 Model	Run No.	PT-2		
Date	5/8/2012	Fan configuration	Fan B only		
Tester	CA, JEF, XYY	Fan Setting	60	Hz	
Stack Dia.	11.938 in.	Stack Temp	72 deg F		
Stack X-Area	111.9 in.2	Start/End Time	8:30 / 11:01		
Test Port	2	Center 2/3 from	1.10	to:	10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2	to:	7
Measurement units	particles/ft3	Injection Point	E Center		
Order --->	1st		2nd		

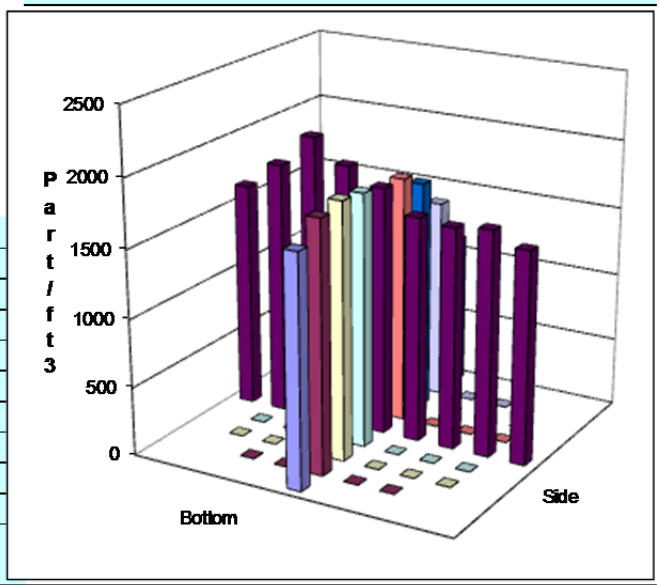
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	particles/ft3				particles/ft3			
1	0.50	1042	1118	1190	**1116.7**	1641	1692	1732	**1688.3**
2	1.25	1134	1182	1241	**1185.7**	1766	1842	1894	**1834.0**
3	2.32	1195	1129	1168	**1164.0**	1835	1879	1907	**1873.7**
4	3.86	1221	1160	1166	**1182.3**	1835	1793	1921	**1849.7**
Center	5.97	1354	1334	1214	**1300.7**	1768	1800	1855	**1807.7**
5	8.08	1536	1139	1480	**1385.0**	1808	1759	1837	**1801.3**
6	9.62	1573	1410	1529	**1504.0**	1631	1675	1767	**1691.0**
7	10.68	1444	1197	1350	**1330.3**	1595	1398	1407	**1466.7**
8	11.56	1315	1150	1095	**1186.7**	1472	912	949	**1111.0**
Averages ---->		1312.7	1202.1	1270.3	1261.7	1705.7	1638.9	1696.6	1680.4

All	pt/ft3	Dev. from mean	*Center 2/3*	Side	Bottom	All	Normlzd
Mean	1471.0		Mean	1293.1	1760.6	1526.9	1778.89
Min Point	1111.0	-24.5%	Std. Dev.	125.7	142.1	274.7	154.20
Max Point	1873.7	27.4%	COV as %	9.7	8.1	**18.0**	**8.67**

Avg Conc 1461 pt/ft3

	Start	Finish	
Generator Inlet Press	5.1	5.1	psig
Stack Temp	65.3	79.6	F
Mean velocity	3092	3053	sfpm
Ambient pressure	1007	1008	mbar
Ambient humidity	41%	25%	RH
Ambient temp	63.5	79.7	F
Back-Gd aerosol	11,10,13,5	4,6,9,9,6	pt/ft3
No. Bk-Gd samples	4	5	
Compressor output	30	30	psig

Instruments Used:		Cal. Due
TSI VelociCalc	T95351203001	12/17/2012
Fisher Scientific	90936818	12/7/2012
Met One OPC	1011529010	2/1/2013
Met One OPC	1011529009	1/9/2013



Notes: Heat tape set at 100F, does not appear to be heating much.

XY 5/8/12

Oil Used: Edwards

Ref. Probe Location: Center, Bottom, end of stack

Probe Type / Configuration: L-Shaped

Entries made by: CA, XY
Signature/date 5/8/2012
signature on file with original

Technical Data Review performed by: Elizabeth Golovich
Signature/date 6/29/2012
Signature on file with Original
TI-WTPSP-079

Rev. 0

PARTICLE TRACER TRAVERSE DATA FORM

3 Aug. 2006

Site	HV-S2 Model	Run No.	PT-3
Date	5/8/2012	Fan configuration	Fan B only
Tester	CA, XY	Fan Setting	22 Hz
Stack Dia.	11.938 in.	Stack Temp	84 deg F
Stack X-Area	111.9 in.2	Start/End Time	11:05 / 13:05
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Measurement units	particles/ft3	Injection Point	E Center
Order --->	2nd		1st

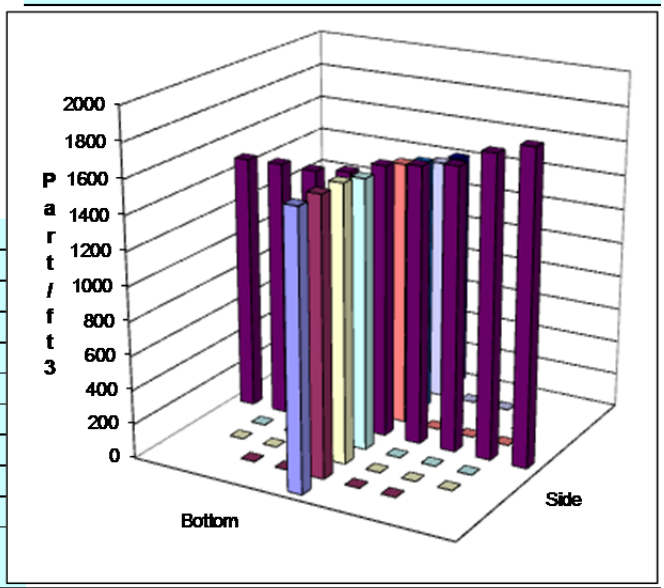
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	particles/ft3				particles/ft3			
1	0.50	1286	1209	1269	1254.7	1793	1657	1355	1601.7
2	1.25	1174	1226	1228	1209.3	1821	1627	1367	1605.0
3	2.32	1131	1111	1172	1138.0	1813	1602	1397	1604.0
4	3.86	1107	1098	1140	1115.0	1805	1656	1248	1569.7
Center	5.97	1060	1061	1159	1093.3	1738	1676	1335	1583.0
5	8.08	1091	1018	1025	1044.7	1607	1673	1322	1534.0
6	9.62	1012	958	1111	1027.0	1617	1569	1266	1484.0
7	10.68	996	1053	1043	1030.7	1602	1443	1233	1426.0
8	11.56	1006	1064	1012	1027.3	1566	1405	1215	1395.3
Averages ---------->		1095.9	1088.7	1128.8	1104.4	1706.9	1589.8	1304.2	1533.6

All	pt/ft3	Dev. from mean	*Center 2/3*	Side	Bottom	All	Normlzd
Mean	1319.0		Mean	1094.0	1543.7	1318.8	1563.82
Min Point	1027.0	-22.1%	Std. Dev.	66.6	67.2	242.0	82.55
Max Point	1605.0	21.7%	COV as %	6.1	4.4	18.4	5.28

Avg Conc 1317 pt/ft3

	Start	Finish	
Generator Inlet Press	2.5	2.5	psig
Stack Temp	80.8	86.8	F
Mean velocity	1023	1045	sfpm
Ambient pressure	1008	1007	mbar
Ambient humidity	23%	22%	RH
Ambient temp	82.4	81.5	F
Back-Gd aerosol	6,9,2,5	5,9,0,8	pt/ft3
No. Bk-Gd samples	4	4	
Compressor output	30	30	psig

Instruments Used:		Cal. Due
TSI VelociCalc	T95351203001	12/17/2012
Fisher Scientific	90936818	12/7/2012
Met One OPC	1011529010	2/1/2013
Met One OPC	1011529009	1/9/2013



Notes:

CA 5/8/12

Oil Used: Edwards

Ref. Probe Location: Center, bottom, end of stack

Probe Type / Configuration: L-Shaped

Entries made by:	XY, CA	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	5/8/2012	Signature/date	6/29/2012
	signature on file with original		Signature on file with Original
			TI-WTPSP-079

Rev. 0

3 Aug. 2006

PARTICLE TRACER TRAVERSE DATA FORM

Site	HV-S2 Model	Run No.	PT-4
Date	5/8/2012	Fan configuration	A - min
Tester	JAG, EA	Fan Setting	25 Hz
Stack Dia.	11.938 in.	Stack Temp	89 deg F
Stack X-Area	111.9 in.2	Start/End Time	13:35 / 15:15
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Measurement units	particles/ft3	Injection Point	E Center
Order ---->	1st		2nd

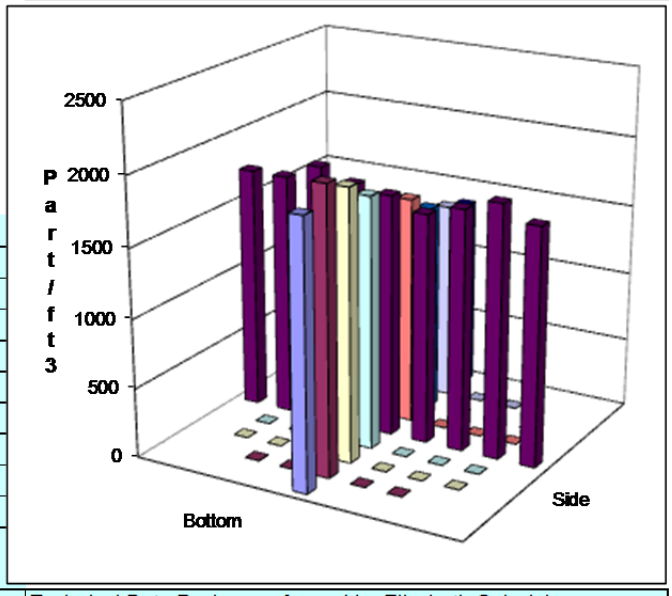
		Side				Bottom			
Traverse-->									
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	particles/ft3				particles/ft3			
1	0.50	1716	1597	1523	1612.0	1832	1919	2001	1917.3
2	1.25	1781	1692	1672	1715.0	1994	2142	2016	2050.7
3	2.32	1666	1622	1613	1633.7	1942	2006	1907	1951.7
4	3.86	1611	1522	1542	1558.3	1738	1841	1865	1814.7
Center	5.97	1679	1630	1610	1639.7	1749	1722	1751	1740.7
5	8.08	1730	1704	1588	1674.0	1573	1651	1686	1636.7
6	9.62	1729	1806	1718	1751.0	1413	1535	1530	1492.7
7	10.68	1574	1715	1637	1642.0	1364	1461	1454	1426.3
8	11.56	1558	1718	1654	1643.3	1316	1364	1415	1365.0
Averages ------>		1671.6	1667.3	1617.4	1652.1	1657.9	1737.9	1736.1	1710.6

All	pt/ft3	Dev. from mean	*Center 2/3*	Side	Bottom	All	Normlzd
Mean	1681.4		Mean	1659.1	1730.5	1694.8	1745.88
Min Point	1365.0	-18.8%	Std. Dev.	62.3	229.7	165.9	163.15
Max Point	2050.7	22.0%	COV as %	3.8	13.3	9.8	9.34

Avg Conc 1680 pt/ft3

	Start	Finish	
Generator Inlet Press	3.2	2.8	psig
Stack Temp	88	89.9	F
Mean velocity	1234	1069	sfpm
Ambient pressure	1007	1006	mbar
Ambient humidity	21%	20%	RH
Ambient temp	85	87	F
Back-Gd aerosol	1, 3, 5, 5, 2	6, 4, 8, 8, 4	pt/ft3
No. Bk-Gd samples	5	5	
Compressor output	32	31	psig

Instruments Used:			Cal. Due
TSI VelociCalc	T95351203001		12/17/2012
Fisher Scientific	90936818		12/7/2012
Met One OPC	1011529010	Reference	2/1/2013
Met One OPC	1011529009	Measurem	1/9/2013



Notes:

JAG 5/8/12

Oil Used: Edwards 19

Ref. Probe Location: End of duct

Probe Type / Configuration: L

Entries made by:	JAG	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	5/8/2012	Signature/date	6/29/2012
	signature on file with original		Signature on file with Original
			TI-WTPSP-079

Rev. 0

3 Aug. 2006

PARTICLE TRACER TRAVERSE DATA FORM

Site	HV-S2 Model	Run No.	PT-5
Date	5/8/2012	Fan configuration	B - Normal
Tester	JAG, EA	Fan Setting	54.0 Hz
Stack Dia.	11.938 in.	Stack Temp	91 deg F
Stack X-Area	111.9 in.2	Start/End Time	15:20 / 16:57
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Measurement units	particles/ft3	Injection Point	E Center
Order --->	2nd		1st

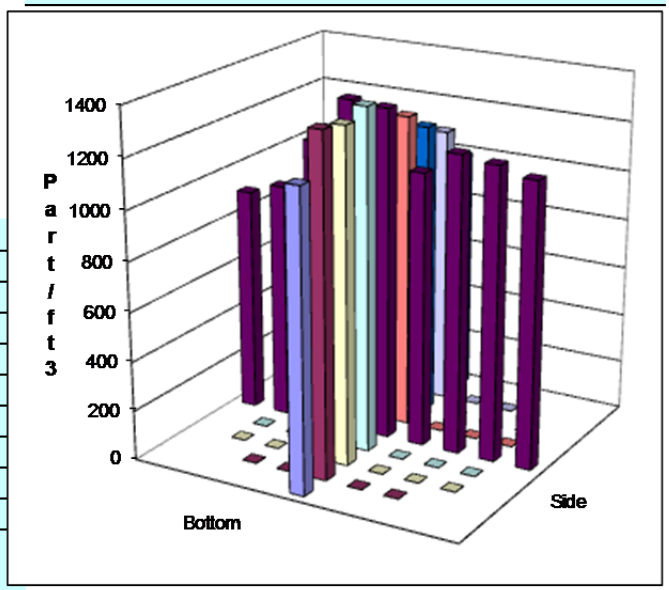
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	particles/ft3				particles/ft3			
1	0.50	799	780	762	780.3	1386	1104	1103	1197.7
2	1.25	887	805	718	803.3	1388	1449	1248	1361.7
3	2.32	869	799	780	816.0	1452	1280	1290	1340.7
4	3.86	801	719	733	751.0	1493	1357	1275	1375.0
Center	5.97	1019	912	786	905.7	1514	1198	1280	1330.7
5	8.08	1099	907	737	914.3	1528	1047	1211	1262.0
6	9.62	965	917	484	788.7	1473	990	1088	1183.7
7	10.68	879	595	472	648.7	1448	867	1063	1126.0
8	11.56	767	623	460	616.7	1281	797	888	988.7
Averages ------>		898.3	784.1	659.1	780.5	1440.3	1121.0	1160.7	1240.7

All	pt/ft3	Dev. from mean	*Center 2/3*	Side	Bottom	All	Normlzd
Mean	1010.6		Mean	804.0	1282.8	1043.4	1232.02
Min Point	616.7	-39.0%	Std. Dev.	91.1	95.9	264.2	123.69
Max Point	1375.0	36.1%	COV as %	11.3	7.5	25.3	10.04

Avg Conc 997 pt/ft3

	Start	Finish	
Generator Inlet Press	3.5	3.5	psig
Stack Temp	92	89	F
Mean velocity	2484	2341	sfpm
Ambient pressure	1006	1004	mbar
Ambient humidity	20%	19%	RH
Ambient temp	85	90	F
Back-Gd aerosol	6, 4, 8, 8, 4	5, 1, 2, 2, 7	pt/ft3
No. Bk-Gd samples	5	5	
Compressor output	30	30	psig

Instuments Used:			Cal. Due
TSI VelociCalc	T95351203001		12/17/2012
Fisher Scientific	90936818		12/7/2012
Met One OPC	1011529010	Reference	2/1/2013
Met One OPC	1011529009	Measurem	1/9/2013



Notes:

JAG 5/8/12

Oil Used: Edwards 19

Ref. Probe Location: End of duct

Probe Type / Configuration: L

Entries made by:	JAG	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	5/8/2012	Signature/date	6/29/2012
	signature on file with original		Signature on file with Original
			TI-WTPSP-079

Rev. 0

3 Aug. 2006

PARTICLE TRACER TRAVERSE DATA FORM

Site	HV-S2 Model	Run No.	PT-6
Date	5/9/2012	Fan configuration	Fan B only
Tester	XYY, YFS	Fan Setting	48.0 Hz
Stack Dia.	11.938 in.	Stack Temp	80 deg F
Stack X-Area	111.9 in.2	Start/End Time	13:10 / 15:10
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Measurement units	particles/ft3	Injection Point	E Center
Order --->	2nd		1st

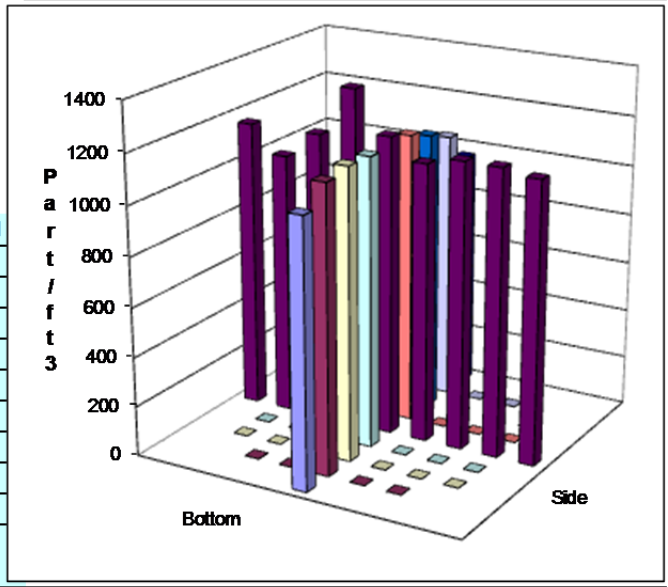
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	particles/ft3				particles/ft3			
1	0.50	689	568	410	555.7	1110	1100	1001	1070.3
2	1.25	585	559	554	566.0	1217	1146	1085	1149.3
3	2.32	580	606	512	566.0	1290	1112	1105	1169.0
4	3.86	516	614	520	550.0	1174	1133	1187	1164.7
Center	5.97	555	660	556	590.3	1241	1222	1142	1201.7
5	8.08	576	720	717	671.0	1251	1161	1092	1168.0
6	9.62	578	508	632	572.7	1157	1187	1039	1127.7
7	10.68	337	552	668	519.0	1138	1081	1032	1083.7
8	11.56	712	516	487	571.7	994	1021	873	962.7
Averages ------>		569.8	589.2	561.8	573.6	1174.7	1129.2	1061.8	1121.9

All	pt/ft3	Dev. from mean	*Center 2/3*	Side	Bottom	All	Normlzd
Mean	847.7		Mean	576.4	1152.0	864.2	1162.68
Min Point	519.0	-38.8%	Std. Dev.	47.2	37.5	301.4	70.94
Max Point	1201.7	41.7%	COV as %	8.2	3.3	34.9	6.10

Avg Conc 842 pt/ft3

	Start	Finish	
Generator Inlet Press	4.0	4.0	psig
Stack Temp	79.3	81.0	F
Mean velocity	2402	2405	sfpm
Ambient pressure	1006	1006	mbar
Ambient humidity	22%	19%	RH
Ambient temp	77.9	85.1	F
Back-Gd aerosol	3,0,2,5	11,3,4,5	pt/ft3
No. Bk-Gd samples	4	4	
Compressor output	30	30	psig

Instruments Used:			Cal. Due
TSI VelociCalc	T95351203001		12/17/2012
Fisher Scientific	90936818		12/7/2012
Met One OPC	1011529010	Reference	2/1/2013
Met One OPC	1011529009	Measurem	1/9/2013



Notes: Repeat of PT-5. Normal flow Fan B. Reduced frequency to meet target velocity.

XY 5/9/12

Particle number concentration dropped from ~1300 (avg. center, ref) to 850 after changing to side; it seems to be sensitive to cloud cover.

Oil Used: Edwards 19

Ref. Probe Location: Bottom Center, end of stack

Probe Type / Configuration: L-shaped

Entries made by:	XYY, YFS	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	5/9/2012	Signature/date	6/29/2012
	signature on file with original		Signature on file with Original
			TI-WTPSP-079

Rev. 0

3 Aug. 2006

PARTICLE TRACER TRAVERSE DATA FORM

Site	HV-S2 Model	Run No.	PT-7
Date	5/10/2012	Fan configuration	Fan A Max
Tester	YFS, EA	Fan Setting	60.0 Hz
Stack Dia.	11.938 in.	Stack Temp	67 deg F
Stack X-Area	111.9 in.2	Start/End Time	11:00 / 12:34
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Measurement units	particles/ft3	Injection Point	E Center
Order --->	1st		2nd

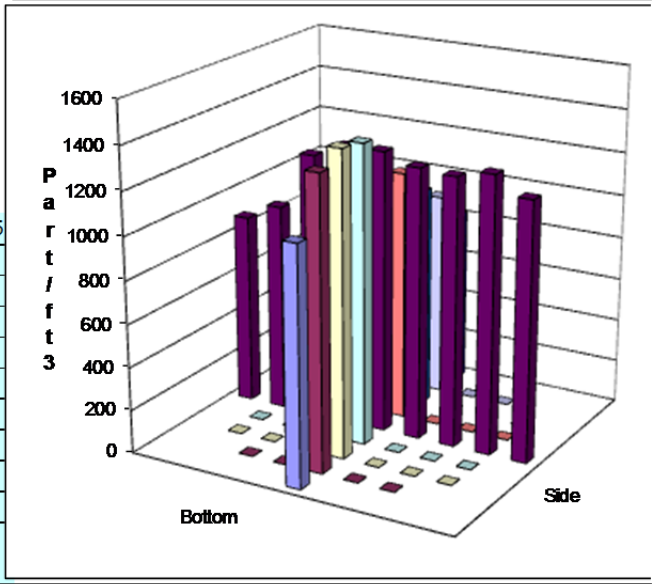
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	particles/ft3				particles/ft3			
1	0.50	1473	1260	868	1200.3	795	684	832	770.3
2	1.25	1773	1049	1025	1282.3	996	804	1036	945.3
3	2.32	1732	1007	994	1244.3	1011	911	1036	986.0
4	3.86	1608	1090	1071	1256.3	991	894	1026	970.3
Center	5.97	1744	1096	1068	1302.7	908	836	995	913.0
5	8.08	1777	1149	968	1298.0	734	801	897	810.7
6	9.62	1601	1099	997	1232.3	617	755	785	719.0
7	10.68	1153	923	819	965.0	543	729	724	665.3
8	11.56	1235	792	631	886.0	436	606	666	569.3
Averages ---->		1566.2	1051.7	937.9	1185.3	781.2	780.0	888.6	816.6

All	pt/ft3	Dev. from mean	*Center 2/3*	Side	Bottom	All	Normlzd
Mean	1000.9		Mean	1225.9	858.5	1042.2	1225.40
Min Point	569.3	-43.1%	Std. Dev.	118.1	128.0	224.3	147.76
Max Point	1302.7	30.1%	COV as %	9.6	14.9	21.5	12.06

Avg Conc 988 pt/ft3

	Start	Finish	
Generator Inlet Press	7.0	6.9	psig
Stack Temp	67.1	67.8	F
Mean velocity	3279	3107	sfpm
Ambient pressure	30.00	29.97	inHg
Ambient humidity	22%	19%	RH
Ambient temp	77.9	85.1	F
Back-Gd aerosol	3,0,2,5	11,3,4,5	pt/ft3
No. Bk-Gd samples	4	4	
Compressor output	30	30	psig

Instruments Used:		Cal. Due
TSI VelociCalc	T95351203001	12/17/2012
Fisher Scientific	90936818	12/7/2012
Met One OPC	1011529010 Ref	2/1/2013
Met One OPC	1011529009 Sample	1/9/2013



Notes: Stack velocity measured at bottom port, point 5

YFS 5/10/12

Oil Used: Edwards 19

Ref. Probe Location: End of duct, center

Probe Type / Configuration: L

Entries made by:	YFS, EA	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	5/10/2012	Signature/date	6/29/2012
	signature on file with original		Signature on file with Original
			TI-WTPSP-079

Rev. 0

3 Aug. 2006

PARTICLE TRACER TRAVERSE DATA FORM

Site	HV-S2 Model	Run No.	PT-8
Date	5/10/2012	Fan configuration	Fan A only
Tester	EA, YFS, XYY	Fan Setting	49 Hz
Stack Dia.	11.938 in.	Stack Temp	73 deg F
Stack X-Area	111.9 in.2	Start/End Time	12:45 / 14:30
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	96.4 inches	Points in Center 2/3	2 to: 7
Measurement units	particles/ft3	Injection Point	E Center
Order —>	2nd		1st

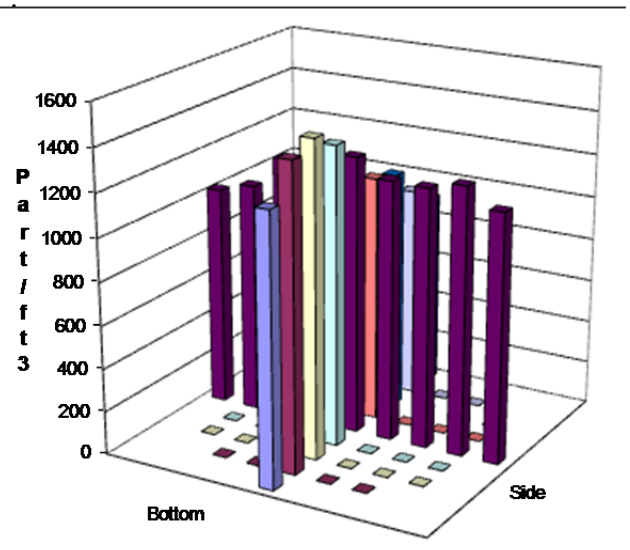
Traverse-->		Side				Bottom			
Trial —>		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	particles/ft3				particles/ft3			
1	0.50	936	844	911	897.0	1238	1325	1183	1248.7
2	1.25	957	965	971	964.3	1473	1443	1317	1411.0
3	2.32	981	924	900	935.0	1536	1453	1387	1458.7
4	3.86	932	958	925	938.3	1426	1368	1356	1383.3
Center	5.97	976	990	1035	1000.3	1306	1330	1220	1285.3
5	8.08	1015	961	974	983.3	1180	1176	1065	1140.3
6	9.62	994	906	953	951.0	1143	1149	1036	1109.3
7	10.68	807	853	841	833.7	1008	985	963	985.3
8	11.56	866	799	727	797.3	933	938	840	903.7
Averages ------>		940.4	911.1	915.2	922.3	1249.2	1240.8	1151.9	1214.0

All	pt/ft3	Dev. from mean	*Center 2/3*	Side	Bottom	All	Normlzd
Mean	1068.1		Mean	943.7	1253.3	1098.5	1232.96
Min Point	797.3	-25.4%	Std. Dev.	54.0	178.1	204.4	131.54
Max Point	1458.7	36.6%	COV as %	5.7	14.2	18.6	10.67

Avg Conc 1059 pt/ft3

	Start	Finish	
Generator Inlet Press	4.5	4.5	psig
Stack Temp	70.3	75.4	F
Mean velocity	2450	2418	sfpm
Ambient pressure	29.97	29.97	inHg, 101
Ambient humidity	24%	24%	RH
Ambient temp	68	68	F
Back-Gd aerosol	6,8,8,7,8	3,3,4,8,3	pt/ft3
No. Bk-Gd samples	5	5	
Compressor output	30	30	psig

Instuments Used:		Cal. Due
TSI VelociCalc	T95351203001	12/17/2012
Fisher Scientific	90936818	12/7/2012
Met One OPC	1011529010 Ref	2/1/2013
Met One OPC	1011529009 Sample	1/9/2013



Notes: Stack velocity measured at bottom port, point 5

XY 5/10/12

Oil Used: Edwards 19

Ref. Probe Location: Center, end at stack

Probe Type / Configuration: L-shaped

Entries made by: XY

Signature/date 5/10/2012

signature on file with original

Technical Data Review performed by: Elizabeth Golovich

Signature/date 6/29/2012

Signature on file with Original

TI-WTPSP-079

Appendix C

IHLW-S1 Data Sheets

C.1 IHLW-S1 Calibration of Ventilation Flow Controller

VELOCITY TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	FC-1
Date	3/1/12	Fan Configuration	Fan A
Testers	EA JEF	Fan Setting	30 Hz
Stack Dia.	11.938 in.	Stack Temp	56.0 deg F
Stack X-Area	111.9 in.2	Start/End Time	1500 / 1532 h
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

Order -->		1st				2nd			
Traverse-->		Bottom				Side			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	1230	1260	1210	1233	1220	1230	1250	1233
2	1.25	1380	1390	1420	1397	1400	1420	1420	1413
3	2.32	1480	1480	1490	1483	1580	1550	1520	1550
4	3.86	1560	1570	1560	1563	1630	1640	1570	1613
Center	5.97	1640	1620	1590	1617	1610	1580	1580	1590
5	8.08	1630	1700	1640	1657	1600	1600	1600	1600
6	9.62	1650	1760	1640	1683	1620	1620	1570	1603
7	10.68	1590	1630	1600	1607	1620	1540	1590	1583
8	11.44	1430	1350	1350	1377	1560	1440	1420	1473
Averages ---------->		1510	1529	1500	1513	1538	1513	1502	1518

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	1515.4		Mean	1572.4	1564.8	1568.6
Min Point	1233.3	-18.6%	Std. Dev.	101.2	69.8	83.6
Max Point	1683.3	11.1%	COV as %	6.4	4.5	5.3

Flow w/o C-Pt 1169 scfm
Vel Avg w/o C-Pt 1504 sfpm

Instuments Used:

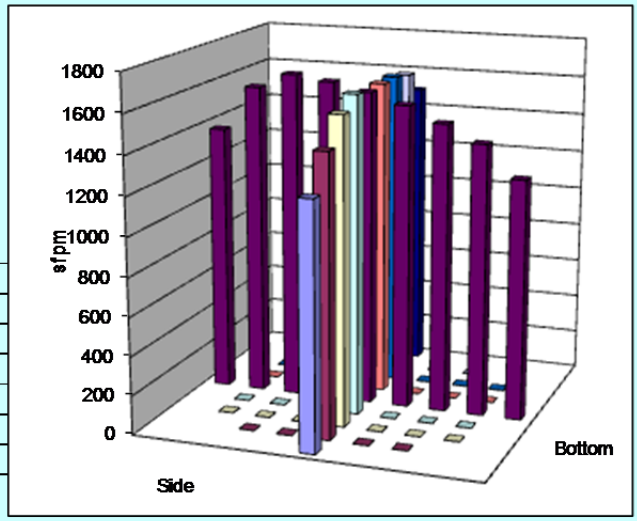
		Cal Due
TSI VelociCalc	T95351203001	01/17/13
Fisher Scientific	90936818	12/7/2012

JEF 3/1/12

	Start	Finish	
Stack temp	52.5	58.4	F
Equipment temp	N/A	N/A	F
Ambient temp	53.6	56.3	F
Stack static	N/A	N/A	mbars
Ambient pressure	30.03	30.06	in Hg
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	27%	27%	RH

Notes: Moderately windy day but less than 20 mph. (~15 mph)

JEF 3/1/12



Entries made by:	Ernest Antonio		Technical Data Review performed by:	RL Aaberg	
Signature/date	On File with Original	3/1/2012	Signature/date	On file with Original	5/16/2012

VELOCITY TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	FC-2
Date	3/1/12	Fan Configuration	Fan B
Testers	EA JEF	Fan Setting	30 Hz
Stack Dia.	11.938 in.	Stack Temp	56.0 deg F
Stack X-Area	111.9 in.2	Start/End Time	1542 / 1600
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

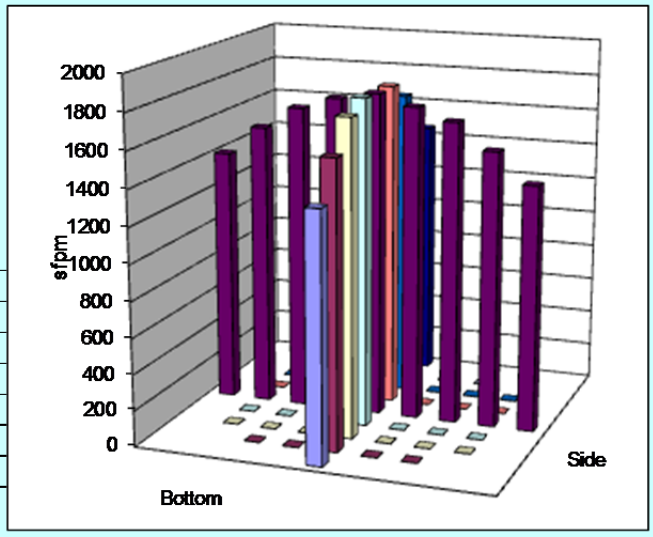
Order -->		1 st				2nd				
Traverse-->		Side				Bottom				
Trial -->		1	2	3	Mean	1	2	3	Mean	
Point	Depth, in.	Velocity				Velocity				
1	0.50	1350	1360	1390	**1367**	1330	1320	1320	**1323**	
2	1.25	1540	1530	1530	**1533**	1560	1530	1500	**1530**	
3	2.32	1660	1670	1700	**1677**	1740	1660	1680	**1693**	
4	3.86	1700	1780	1750	**1743**	1760	1740	1760	**1753**	
Center	5.97	1740	1860	1810	**1803**	1720	1750	1750	**1740**	
5	8.08	1730	1790	1770	**1763**	1740	1720	1770	**1743**	
6	9.62	1690	1730	1670	**1697**	1670	1630	1670	**1657**	
7	10.68	1560	1570	1590	**1573**	1560	1510	1540	**1537**	
8	11.44	1410	1420	1410	**1413**	1350	1440	1420	**1403**	
Averages ---------->		**1598**	**1634**	**1624**	**1619**	**1603**	**1589**	**1601**	**1598**	

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	1608.3		Mean	1684.3	1664.8	1674.5
Min Point	1323.3	-17.7%	Std. Dev.	99.3	95.9	94.3
Max Point	1803.3	12.1%	COV as %	5.9	5.8	5.6

Flow w/o C-Pt	1234	scfm
Vel Avg w/o C-Pt	1588	sfpm

Instuments Used:		Cal Due
TSI VelociCalc	T95351203001	01/17/13
Fisher Scientific	90936818	12/7/2012
	JEF 3/1/12	

	Start	Finish	
Stack temp	56.7	56.3	F
Equipment temp	N/A	N/A	F
Ambient temp	55.4	50.9	F
Stack static	N/A	N/A	mbars
Ambient pressure	30.06	30.06	in Hg
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	27%	28%	RH



Notes: Moderately windy day but less than 20 mph. (~15 mph)

JEF 3/1/12

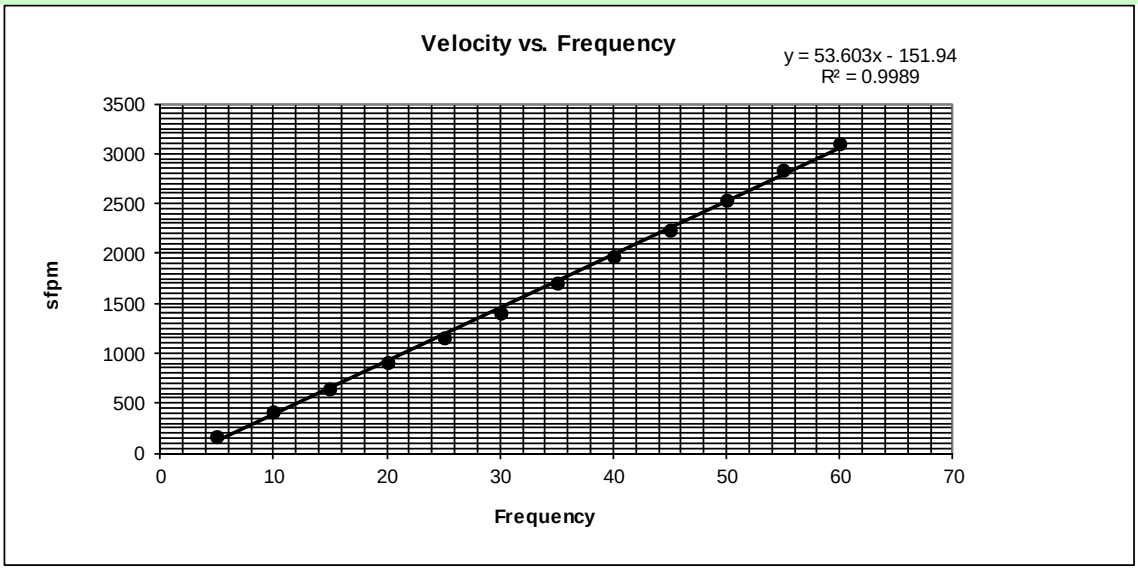
Entries made by:	Julia Flaherty		Technical Data Review performed by:	RL Aaberg	
Signature/date	On File with Original	3/1/2012	Signature/date	On file with Original	5/16/2012

VELOCITY vs. FREQUENCY DATA FORM

Site	**IHLW-S1 model**	Run No.	**VF-1**
Date	3/2/2012	Stack Temp	49 deg F
Tester	EA	Stack RH%	35% ambient
Stack Dia.	11.938 in.	Baro Press	30.36 in Hg
Stack X-Area	111.9 in2	Fan Configuration	Fan A only
Test Port	2	Start/End Time	1330 / 1440
Dist. from disturbance	240 inches	Reference point from velocity test VC :	Side 3
Velocity Readings, units =	standard fpm		

					Target	Target	Estmtd
					scfm	sfpm	Hz
					11,198	1776	36
	sfpm				5,351	849	19
Hz	1	2	3	Mean	StDev	2 StDev	cfm
5	160	200	140	167	31	61	130
10	400	460	390	417	38	76	324
15	640	650	660	650	10	20	505
20	920	890	900	903	15	31	702
25	1160	1160	1130	1150	17	35	894
30	1440	1380	1410	1410	30	60	1096
35	1780	1670	1680	1710	61	122	1329
40	1980	1950	1960	1963	15	31	1526
45	2250	2220	2260	2243	21	42	1744
50	2570	2500	2530	2533	35	70	1969
55	2910	2770	2830	2837	70	140	2205
60	3120	3100	3075	3098	23	45	2408

Instuments Used:		**Cal Exp. Date:**
TSI VelociCalc	T95351203001	1/17/2013
Fisher Scientific Barometer	90936818	12/7/2012
	JEF 3/26/2012	



Entries made by:	Ernest Antonio	Technical Data Review performed by:	RL Aaberg
Signature/date	On File with Original	Signature/date	On file with Original
	2-Mar-12		5/16/2012

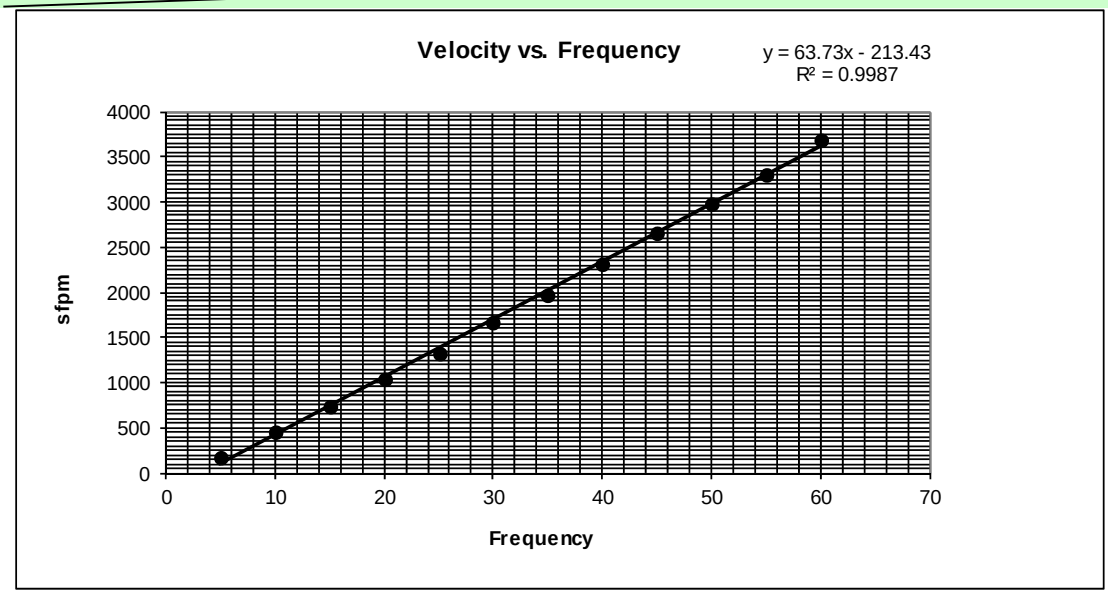
FREQUENCY DATA FORM

Site	**LW-S1 model**		Run No.	**VF-2**	
Date	3/2/2012		Stack Temp	53	deg F
Tester	EA		Stack RH%	35% ambient	
Stack Dia.	11.938	in.	Baro Press	30.36	in Hg
Stack X-Area	111.9	in2	Fan Configuration	Fan B Only	
Test Port	2		Start/End Time	1450 / 1550	
Dist. from disturbance	240	inches	Reference point from velocity test VC :		Side 7
Velocity Readings, units	standard	fpm			

					Target scfm	Target sfpm	Estmtd Hz
					11,198	1776	22
	sfpm				5,351	849	17
Hz	1	2	3	Mean	StDev	2 StDev	cfm
5	200	170	160	177	21	42	137
10	450	430	470	450	20	40	350
15	750	750	740	747	6	12	580
20	1060	1000	1050	1037	32	64	806
25	1310	1340	1320	1323	15	31	1029
30	1640	1670	1700	1670	30	60	1298
35	1940	1960	2010	1970	36	72	1531
40	2260	2300	2370	2310	56	111	1796
45	2610	2700	2670	2660	46	92	2068
50	2920	3040	2950	2970	62	125	2309
55	3200	3340	3350	3297	84	168	2563
60	3650	3660	3740	3683	49	99	2863

Instuments Used: **Cal Exp. Date:**

TSI VelociCalc	T95351203001	1/17/2013
Fisher Scientific Barometer	90936818	12/7/2012
	JEF	3/26/2012



Entries made by:	Ernest Antonio	Technical Data Review performed by:	RL Aaberg
Signature/date	On File with Original	Signature/date	On file with Original
	2-Mar-12		5/16/2012

C.2 IHLW-S1 & Velocity Uniformity Data Sheets

VELOCITY TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	VT-1
Date	3/8/12	Fan Configuration	Fan A only
Testers	CA, JEF, YFS	Fan Setting	43 Hz
Stack Dia.	11.938 in.	Stack Temp	66 deg F
Stack X-Area	111.9 in.2	Start/End Time	1430 / 1500
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	1800	1810	1800	1803.3	2000	2010	2000	2003.3
2	1.25	2010	2000	1980	1996.7	2150	2260	2200	2203.3
3	2.32	2200	2150	2230	2193.3	2320	2330	2320	2323.3
4	3.86	2330	2290	2260	2293.3	2310	2340	2310	2320.0
Center	5.97	2360	2310	2320	2330.0	2340	2330	2300	2323.3
5	8.08	2380	2340	2360	2360.0	2390	2400	2370	2386.7
6	9.62	2390	2380	2410	2393.3	2400	2420	2420	2413.3
7	10.68	2300	2320	2340	2320.0	2320	2300	2250	2290.0
8	11.44	2180	2160	2100	2146.7	2050	2080	2050	2060.0
Averages -->		2216.7	2195.6	2200.0	2204.1	2253.3	2274.4	2246.7	2258.1

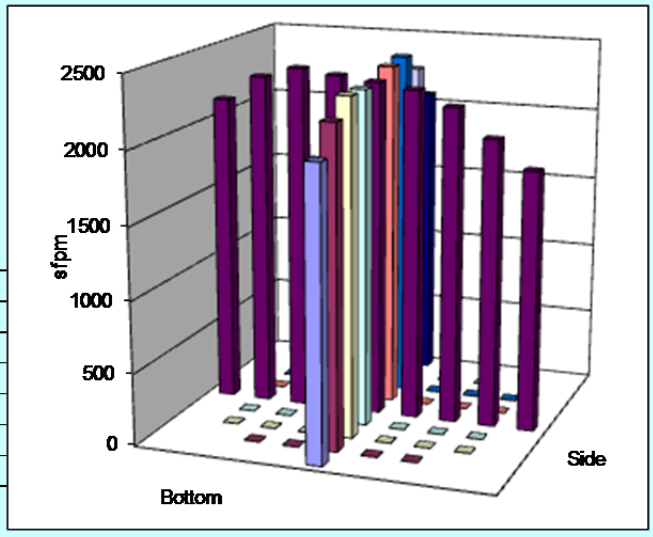
All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	2231.1		Mean	2269.5	2322.9	2296.2
Min Point	1803.3	-19.2%	Std. Dev.	135.7	67.9	106.7
Max Point	2413.3	8.2%	COV as %	6.0	2.9	4.6

Flow w/o C-Pt	1725	scfm
Vel Avg w/o C-Pt	2219	sfpm

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012

JEF 3/8/12

	Start	Finish	
Stack temp	67	64	F
Equipment temp	N/A	N/A	F
Ambient temp	64	64	F
Stack static	N/A	N/A	mbars
Ambient pressure	1032	1032	mbars
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	25%	25%	RH



Notes: None

CA 3/8/12

Entries made by:	Carmen Arimescu	Technical Data Review performed by:	RL Aaberg
Signature/date	On file with Original	Signature/date	Signature on File with original
	3/8/2012	TI-WTPSP-082	6/5/2012

VELOCITY TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	VT-2
Date	3/8/12	Fan Configuration	Fan A only
Testers	CA, JEF, YFS	Fan Setting	20 Hz
Stack Dia.	11.938 in.	Stack Temp	66 deg F
Stack X-Area	111.9 in.2	Start/End Time	1500 / 1525
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

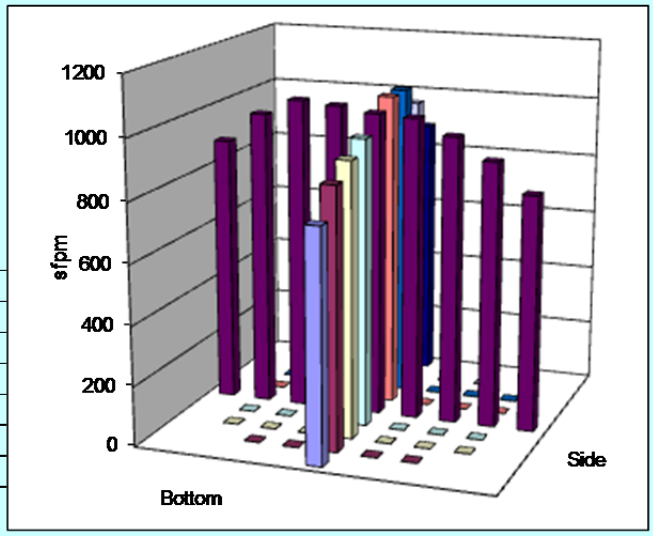
Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	730	800	780	770.0	740	790	780	770.0
2	1.25	870	860	870	866.7	860	870	870	866.7
3	2.32	930	950	930	936.7	920	920	910	916.7
4	3.86	980	1000	980	986.7	940	960	980	960.0
Center	5.97	990	990	1000	993.3	1030	1010	1010	1016.7
5	8.08	1010	1000	1020	1010.0	1050	1050	1050	1050.0
6	9.62	1030	1000	1030	1020.0	1040	1060	1050	1050.0
7	10.68	950	990	960	966.7	990	980	980	983.3
8	11.44	860	860	890	870.0	870	870	900	880.0
Averages -->		927.8	938.9	940.0	935.6	937.8	945.6	947.8	943.7

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	939.6		Mean	968.6	977.6	973.1
Min Point	770.0	-18.1%	Std. Dev.	52.8	68.8	59.1
Max Point	1050.0	11.7%	COV as %	5.4	7.0	6.1

Flow w/o C-Pt	724	scfm	
Vel Avg w/o C-Pt	931	sfpm	

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012
JEF 3/8/12	

	Start	Finish	
Stack temp	64	68	F
Equipment temp	N/A	N/A	F
Ambient temp	71	64	F
Stack static	N/A	N/A	mbars
Ambient pressure	1032	1032	mbars
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	23%	25%	RH



Notes:

JEF 3/8/12

Entries made by:	JEF	Technical Data Review performed by:	RL Aaberg
Signature/date	On File with Original 3/8/2012	Signature/date	Signature on File with original TI-WTPSP-082 6/5/2012

VELOCITY TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	VT-3
Date	3/8/12	Fan Configuration	FAN B ONLY
Testers	JEF, YFS	Fan Setting	43 Hz
Stack Dia.	11.938 in.	Stack Temp	65 deg F
Stack X-Area	111.9 in.2	Start/End Time	1525 / 1600
Test Port	1	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	300 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

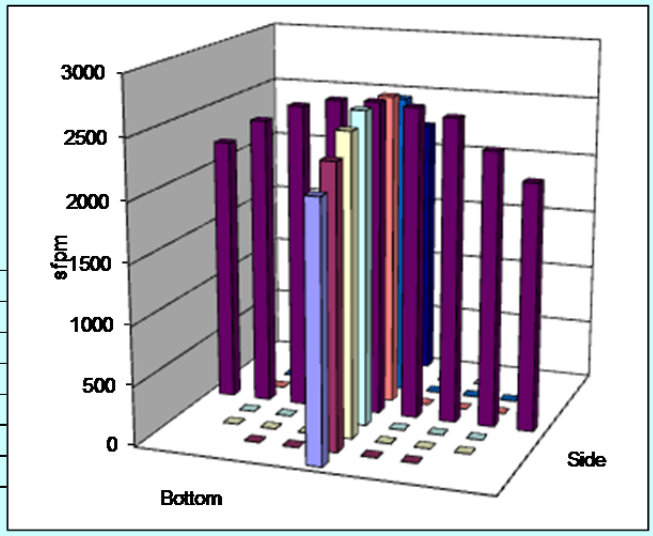
Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	2040	2090	2070	2066.7	2130	2170	2150	2150.0
2	1.25	2300	2310	2280	2296.7	2340	2310	2400	2350.0
3	2.32	2490	2470	2660	2540.0	2530	2530	2510	2523.3
4	3.86	2600	2630	2580	2603.3	2610	2640	2630	2626.7
Center	5.97	2630	2640	2610	2626.7	2630	2630	2650	2636.7
5	8.08	2620	2640	2600	2620.0	2610	2620	2650	2626.7
6	9.62	2550	2540	2570	2553.3	2550	2530	2580	2553.3
7	10.68	2430	2400	2400	2410.0	2410	2400	2370	2393.3
8	11.44	2210	2200	2200	2203.3	2230	2200	2180	2203.3
Averages ---------->		2430.0	2435.6	2441.1	2435.6	2448.9	2447.8	2457.8	2451.5

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	2443.5		Mean	2521.4	2530.0	2525.7
Min Point	2066.7	-15.4%	Std. Dev.	123.7	116.7	115.6
Max Point	2636.7	7.9%	COV as %	4.9	4.6	4.6

Flow w/o C-Pt	1881	scfm
Vel Avg w/o C-Pt	2420	sfpm

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012
JEF 3/8/12	

	Start	Finish	
Stack temp	68	62	F
Equipment temp	N/A	N/A	F
Ambient temp	64	64	F
Stack static	N/A	N/A	mbars
Ambient pressure	1032	1030	mbars
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	25%	25%	RH



Notes:

YFS 3/8/12

Entries made by:	YFS	Technical Data Review performed by:	RL Aaberg
Signature/date	On file with Original 3/8/2012	Signature/date	Signature on File with original TI-WTPSP-082 6/5/2012

VELOCITY TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	VT-4
Date	3/12/12	Fan Configuration	FAN B ONLY
Testers	CA, EA	Fan Setting	43 Hz
Stack Dia.	11.938 in.	Stack Temp	48 deg F
Stack X-Area	111.9 in.2	Start/End Time	1027 / 1041
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

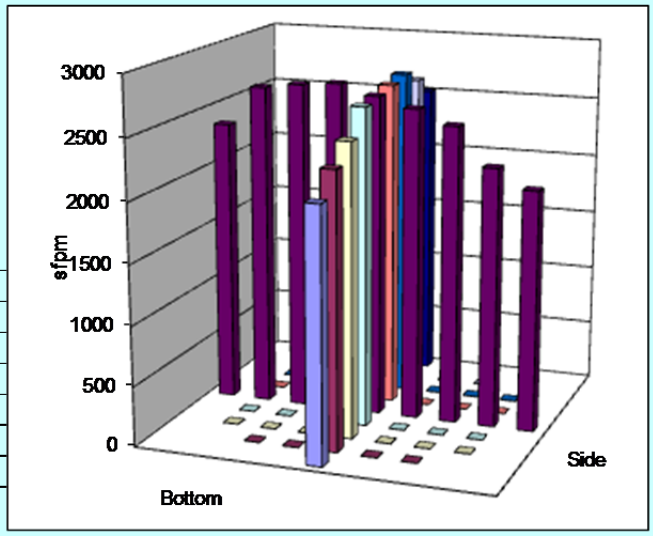
Order —>		2nd				1st			
Traverse—>		Side				Bottom			
Trial —>		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	1850	2175	2000	2008.3	2000	1900	1820	1906.7
2	1.25	2150	2150	2200	2166.7	2100	2100	2050	2083.3
3	2.32	2450	2500	2500	2483.3	2200	2170	2300	2223.3
4	3.86	2500	2600	2700	2600.0	2400	2400	2450	2416.7
Center	5.97	2700	2750	2600	2683.3	2400	2450	2480	2443.3
5	8.08	2750	2800	2750	2766.7	2450	2480	2500	2476.7
6	9.62	2760	2750	2710	2740.0	2520	2500	2510	2510.0
7	10.68	2700	2700	2690	2696.7	2410	2400	2450	2420.0
8	11.44	2590	2000	2510	2366.7	2250	2350	2250	2283.3
Averages ——>		2494.4	2491.7	2517.8	2501.3	2303.3	2305.6	2312.2	2307.0

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	2404.2		Mean	2591.0	2367.6	2479.3
Min Point	1906.7	-20.7%	Std. Dev.	210.0	155.3	211.9
Max Point	2766.7	15.1%	COV as %	8.1	6.6	8.5

Flow w/o C-Pt	1853	scfm	
Vel Avg w/o C-Pt	2384	sfpm	

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012
EA 3/12/12	

	Start	Finish	
Stack temp	47	48	F
Equipment temp	N/A	N/A	F
Ambient temp	50	50	F
Stack static	N/A	N/A	mbars
Ambient pressure	1008	1008	mbars
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	47%	47%	RH



Notes: Ambient Pressure was not input into the TSI VelociCalc.

EA
3/12/2012

Entries made by:	Carmen Arimescu & EA	Technical Data Review performed by:	RL Aaberg
Signature/date	On file with Original 3/12/2012	Signature/date	Signature on File with original TI-WTPSP-082 6/5/2012

VELOCITY TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	VT-5
Date	3/12/12	Fan Configuration	FAN B ONLY
Testers	CA, EA	Fan Setting	20 Hz
Stack Dia.	11.938 in.	Stack Temp	48 deg F
Stack X-Area	111.9 in.2	Start/End Time	1044 / 1055
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

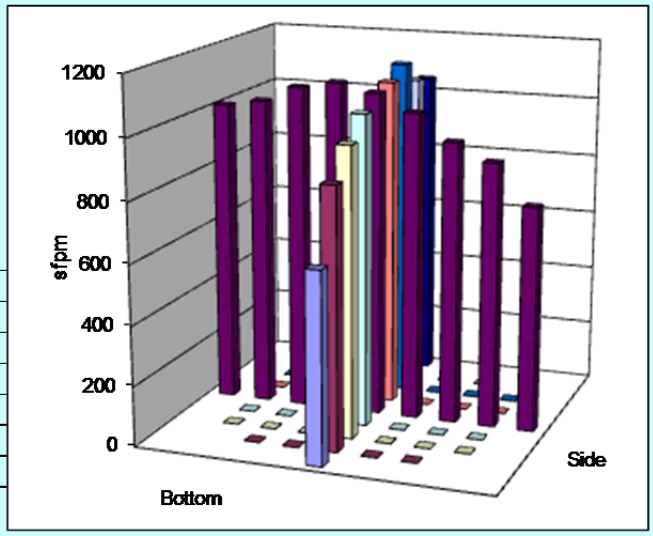
Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	450	920	879	749.7	350	800	690	613.3
2	1.25	850	900	900	883.3	830	870	820	840.0
3	2.32	930	920	970	940.0	925	950	930	935.0
4	3.86	1010	1020	1050	1026.7	990	1000	1030	1006.7
Center	5.97	1100	1119	1030	1083.0	1050	1050	1050	1050.0
5	8.08	1099	1110	1120	1109.7	1070	1010	1110	1063.3
6	9.62	1120	1050	1090	1086.7	1120	1070	1115	1101.7
7	10.68	1050	1035	1015	1033.3	1050	1030	1010	1030.0
8	11.44	1025	1010	1000	1011.7	1030	1006	1010	1015.3
Averages ---------->		959.3	1009.3	1006.0	991.6	935.0	976.2	973.9	961.7

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	976.6		Mean	1023.2	1003.8	1013.5
Min Point	613.3	-37.2%	Std. Dev.	83.3	89.0	83.4
Max Point	1109.7	13.6%	COV as %	8.1	8.9	8.2

Flow w/o C-Pt	750	scfm
Vel Avg w/o C-Pt	965	sfpm

	Start	Finish	
Stack temp	48	48	F
Equipment temp	N/A	N/A	F
Ambient temp	49.1	49.1	F
Stack static	N/A	N/A	mbars
Ambient pressure	1008	1008	mbars
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	48%	49%	RH

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012
EA 3/12/12	



Notes: Ambient Pressure was not input into the TSI VelociCalc. EA 5/4/2012

Entries made by:	Carmen Arimescu & EA	Technical Data Review performed by:	RL Aaberg
Signature/date	On file with Original 3/12/2012	Signature/date	Signature on File with original TI-WTPSP-082 6/5/2012

VELOCITY TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	VT-6
Date	3/12/12	Fan Configuration	FAN B ONLY
Testers	CA, EA	Fan Setting	10 Hz
Stack Dia.	11.938 in.	Stack Temp	49 deg F
Stack X-Area	111.9 in.2	Start/End Time	1100 / 1113
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

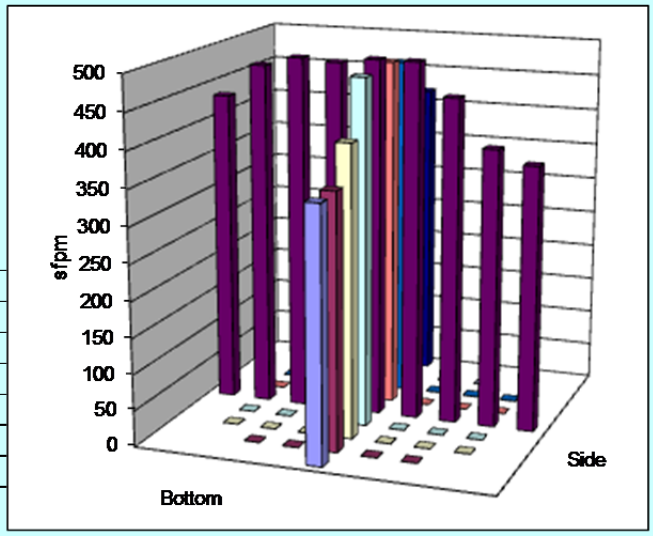
Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	350	400	350	366.7	300	400	350	350.0
2	1.25	390	380	385	385.0	320	360	380	353.3
3	2.32	450	450	450	450.0	355	410	450	405.0
4	3.86	510	490	485	495.0	430	515	500	481.7
Center	5.97	490	475	520	495.0	480	500	510	496.7
5	8.08	485	470	510	488.3	500	486	470	485.3
6	9.62	510	475	490	491.7	470	500	460	476.7
7	10.68	500	465	470	478.3	465	472	465	467.3
8	11.44	450	425	425	433.3	410	415	430	418.3
Averages ---------->		459.4	447.8	453.9	453.7	414.4	450.9	446.1	437.1

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	445.4		Mean	469.0	452.3	460.7
Min Point	350.0	-21.4%	Std. Dev.	40.3	52.9	46.0
Max Point	496.7	11.5%	COV as %	8.6	11.7	10.0

Flow w/o C-Pt	341	scfm	
Vel Avg w/o C-Pt	439	sfpm	

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012
EA 3/12/12	

	Start	Finish	
Stack temp	48	49	F
Equipment temp	N/A	N/A	F
Ambient temp	49.1	50	F
Stack static	N/A	N/A	mbars
Ambient pressure	1008	1008	mbars
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	49%	49%	RH



Notes: Ambient Pressure was not input into the TSI VelociCalc. EA 5/4/2012

Entries made by:	Carmen Arimescu & EA	Technical Data Review performed by:	RL Aaberg
Signature/date	On file with Original 3/12/2012	Signature/date	Signature on File with original TI-WTPSP-082 6/5/2012

VELOCITY TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	VT-7
Date	3/12/12	Fan Configuration	FAN B ONLY
Testers	CA, EA	Fan Setting	38 Hz
Stack Dia.	11.938 in.	Stack Temp	50 deg F
Stack X-Area	111.9 in.2	Start/End Time	1115 / 1135
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

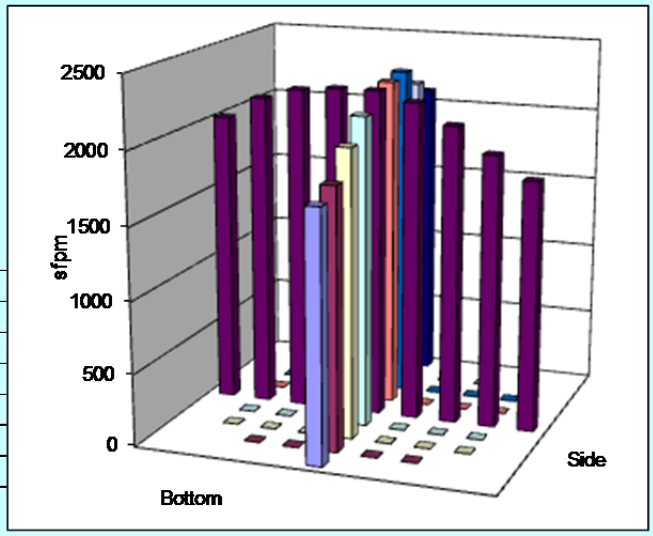
Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	1700	1750	1760	1736.7	1720	1710	1703	1711.0
2	1.25	1850	1950	1880	1893.3	1770	1800	1790	1786.7
3	2.32	2000	2160	2050	2070.0	1960	1970	2000	1976.7
4	3.86	2220	2240	2170	2210.0	2130	2130	2130	2130.0
Center	5.97	2260	2310	2250	2273.3	2230	2290	2240	2253.3
5	8.08	2270	2315	2230	2271.7	2245	2285	2275	2268.3
6	9.62	2235	2290	2220	2248.3	2285	2290	2310	2295.0
7	10.68	2125	2245	2150	2173.3	2160	2250	2100	2170.0
8	11.44	2000	2050	2021	2023.7	2020	2150	2055	2075.0
Averages ---------->		2073.3	2145.6	2081.2	2100.0	2057.8	2097.2	2067.0	2074.0

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	2087.0		Mean	2162.9	2125.7	2144.3
Min Point	1711.0	-18.0%	Std. Dev.	138.4	184.6	157.9
Max Point	2295.0	10.0%	COV as %	6.4	8.7	7.4

Flow w/o C-Pt	1605	scfm	
Vel Avg w/o C-Pt	2065	sfpm	

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012
EA 3/12/12	

	Start	Finish	
Stack temp	50	49.6	F
Equipment temp	N/A	N/A	F
Ambient temp	50	50	F
Stack static	N/A	N/A	mbars
Ambient pressure	1008	1008	mbars
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	49%	52%	RH



Notes: Ambient Pressure was not input into the TSI VelociCalc. EA 5/4/2012

Entries made by:	Carmen Arimescu	Technical Data Review performed by:	RL Aaberg
Signature/date	On file with Original 3/12/2012	Signature/date	Signature on File with original TI-WTPSP-082 6/5/2012

VELOCITY TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	VT-8
Date	3/12/12	Fan Configuration	FAN B ONLY
Testers	CA, EA	Fan Setting	38 Hz
Stack Dia.	11.938 in.	Stack Temp	50 deg F
Stack X-Area	111.9 in.2	Start/End Time	1140 / 1150
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

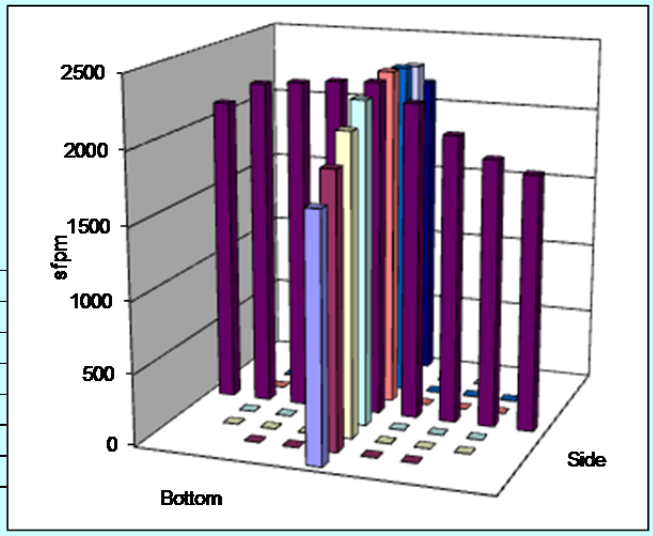
Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	1750	1750	1842	1780.7	1530	1630	1690	1616.7
2	1.25	1890	1820	1875	1861.7	1895	1750	1760	1801.7
3	2.32	2000	2020	1997	2005.7	2000	1970	1980	1983.3
4	3.86	2230	2130	2250	2203.3	2130	2150	2110	2130.0
Center	5.97	2290	2330	2370	2330.0	2200	2200	2195	2198.3
5	8.08	2285	2325	2350	2320.0	2250	2220	2210	2226.7
6	9.62	2280	2310	2299	2296.3	2235	2250	2150	2211.7
7	10.68	2330	2295	2190	2271.7	2190	2190	2170	2183.3
8	11.44	2100	2150	2110	2120.0	2100	1990	2010	2033.3
Averages ---------->		2128.3	2125.6	2142.6	2132.1	2058.9	2038.9	2030.6	2042.8

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	2087.5		Mean	2184.1	2105.0	2144.5
Min Point	1616.7	-22.6%	Std. Dev.	180.8	157.3	167.9
Max Point	2330.0	11.6%	COV as %	8.3	7.5	7.8

Flow w/o C-Pt	1605	scfm	
Vel Avg w/o C-Pt	2065	sfpm	

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012
EA 3/12/12	

	Start	Finish	
Stack temp	50	50.5	F
Equipment temp	N/A	N/A	F
Ambient temp	50	50	F
Stack static	N/A	N/A	mbars
Ambient pressure	1008	1008	mbars
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	52%	52%	RH



Notes: Ambient Pressure was not input into the TSI VelociCalc. EA 5/4/2012

Entries made by:	Carmen Arimescu & EA	Technical Data Review performed by:	RL Aaberg
Signature/date	On file with Original 3/12/2012	Signature/date	Signature on File with original TI-WTPSP-082 6/5/2012

VELOCITY TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	VT-9
Date	3/12/12	Fan Configuration	FAN B ONLY
Testers	CA, EA	Fan Setting	38 Hz
Stack Dia.	11.938 in.	Stack Temp	50 deg F
Stack X-Area	111.9 in.2	Start/End Time	11:50 / 12:00
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

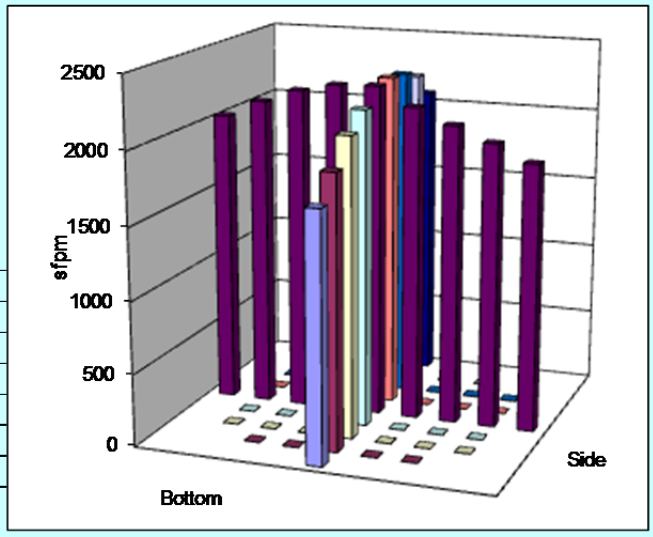
Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	1850	1900	1810	1853.3	1720	1690	1570	1660.0
2	1.25	1960	1950	2000	1970.0	1820	1850	1815	1828.3
3	2.32	2000	2030	2185	2071.7	2030	1990	2000	2006.7
4	3.86	2120	2210	2200	2176.7	2110	2130	2130	2123.3
Center	5.97	2285	2280	2350	2305.0	2250	2235	2210	2231.7
5	8.08	2250	2310	2327	2295.7	2260	2240	2230	2243.3
6	9.62	2235	2220	2270	2241.7	2235	2215	2225	2225.0
7	10.68	2140	2150	2160	2150.0	2175	2150	2185	2170.0
8	11.44	2035	2045	2021	2033.7	2020	2000	2010	2010.0
Averages ---------->		2097.2	2121.7	2147.0	2122.0	2068.9	2055.6	2041.7	2055.4

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	2088.7		Mean	2173.0	2118.3	2145.6
Min Point	1660.0	-20.5%	Std. Dev.	121.9	152.3	135.5
Max Point	2305.0	10.4%	COV as %	5.6	7.2	6.3

Flow w/o C-Pt	1606	scfm	
Vel Avg w/o C-Pt	2066	sfpm	

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012
EA 3/12/12	

	Start	Finish	
Stack temp	50	50.5	F
Equipment temp	N/A	N/A	F
Ambient temp	50.9	50.9	F
Stack static	N/A	N/A	mbars
Ambient pressure	1008	1008	mbars
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	52%	52%	RH



Notes: Ambient Pressure was not input into the TSI VelociCalc.

EA
5/4/2012

Entries made by:	Carmen Arimescu & EA	Technical Data Review performed by:	RL Aaberg
Signature/date	On file with Original	Signature/date	Signature on File with original
	3/12/2012	TI-WTPSP-082	6/5/2012

VELOCITY TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	VT-10
Date	3/21/12	Fan Configuration	FAN B ONLY
Testers	CA, EA	Fan Setting	32 Hz
Stack Dia.	11.938 in.	Stack Temp	42 deg F
Stack X-Area	111.9 in.2	Start/End Time	9:40 / 10:10
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

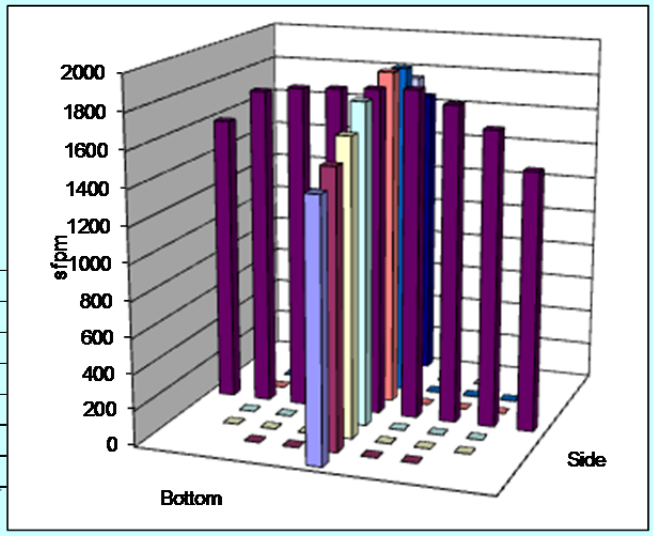
Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	1344	1395	1371	1370.0	1478	1421	1434	1444.3
2	1.25	1554	1554	1592	1566.7	1514	1540	1569	1541.0
3	2.32	1710	1626	1701	1679.0	1623	1694	1651	1656.0
4	3.86	1704	1763	1770	1745.7	1810	1823	1761	1798.0
Center	5.97	1724	1737	1746	1735.7	1880	1838	1764	1827.3
5	8.08	1730	1718	1725	1724.3	1912	1908	1835	1885.0
6	9.62	1724	1736	1687	1715.7	1910	1879	1827	1872.0
7	10.68	1669	1704	1688	1687.0	1817	1783	1752	1784.0
8	11.44	1556	1504	1487	1515.7	1688	1654	1586	1642.7
Averages -->		1635.0	1637.4	1640.8	1637.7	1736.9	1726.7	1686.6	1716.7

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	1677.2		Mean	1693.4	1766.2	1729.8
Min Point	1370.0	-18.3%	Std. Dev.	60.9	124.7	101.5
Max Point	1885.0	12.4%	COV as %	3.6	7.1	5.9

Flow w/o C-Pt	1294	scfm	
Vel Avg w/o C-Pt	1664	sfpm	

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012
EA 3/21/12	

	Start	Finish	
Stack temp	42.8	42	F
Equipment temp	N/A	N/A	F
Ambient temp	47.3	46.4	F
Stack static	N/A	N/A	mbars
Ambient pressure	29.68	29.68	in Hg
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	62%	65%	RH



Notes: None

CA
3/21/2012

Entries made by:	Carmen Arimescu & EA	Technical Data Review performed by:	RL Aaberg
Signature/date	On file with Original 3/21/2012	Signature/date	Signature on File with original TI-WTPSP-082 6/5/2012

VELOCITY TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	VT-11
Date	3/21/12	Fan Configuration	FAN A ONLY
Testers	CA, EA	Fan Setting	35 Hz
Stack Dia.	11.938 in.	Stack Temp	42 deg F
Stack X-Area	111.9 in.2	Start/End Time	10:15/ 10:45
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

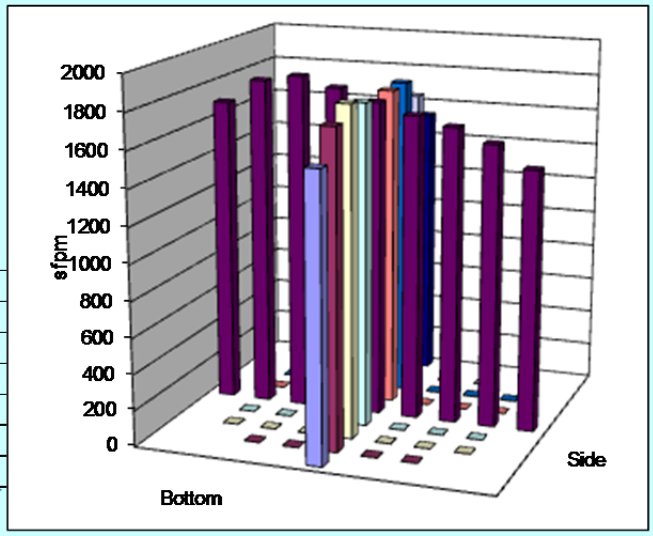
Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	1463	1383	1463	1436.3	1579	1582	1564	1575.0
2	1.25	1563	1550	1560	1557.7	1736	1748	1756	1746.7
3	2.32	1630	1628	1641	1633.0	1826	1834	1812	1824.0
4	3.86	1695	1676	1673	1681.3	1796	1789	1793	1792.7
Center	5.97	1752	1754	1715	1740.3	1769	1748	1754	1757.0
5	8.08	1833	1785	1790	1802.7	1797	1748	1804	1783.0
6	9.62	1868	1860	1837	1855.0	1810	1768	1795	1791.0
7	10.68	1832	1807	1817	1818.7	1635	1679	1727	1680.3
8	11.44	1699	1657	1705	1687.0	1563	1519	1512	1531.3
Averages -->		1703.9	1677.8	1689.0	1690.2	1723.4	1712.8	1724.1	1720.1

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	1705.2		Mean	1727.0	1767.8	1747.4
Min Point	1436.3	-15.8%	Std. Dev.	108.2	46.1	82.7
Max Point	1855.0	8.8%	COV as %	6.3	2.6	4.7

Flow w/o C-Pt	1321	scfm	
Vel Avg w/o C-Pt	1700	sfpm	

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012
EA 3/21/12	

	Start	Finish	
Stack temp	42	42.6	F
Equipment temp	N/A	N/A	F
Ambient temp	46.4	45.5	F
Stack static	N/A	N/A	mbars
Ambient pressure	29.68	29.68	in Hg
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	64%	65%	RH



Notes: None CA 3/21/12

Entries made by:	Carmen Arimescu & EA	Technical Data Review performed by:	RL Aaberg
Signature/date	On file with Original 3/21/2012	Signature/date	Signature on File with original TI-WTPSP-082 6/5/2012

VELOCITY TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	VT-12
Date	4/20/12	Fan Configuration	FAN A ONLY
Testers	XY, YS	Fan Setting	39 Hz
Stack Dia.	11.938 in.	Stack Temp	74 deg F
Stack X-Area	111.9 in.2	Start/End Time	1:00 / 2:00
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

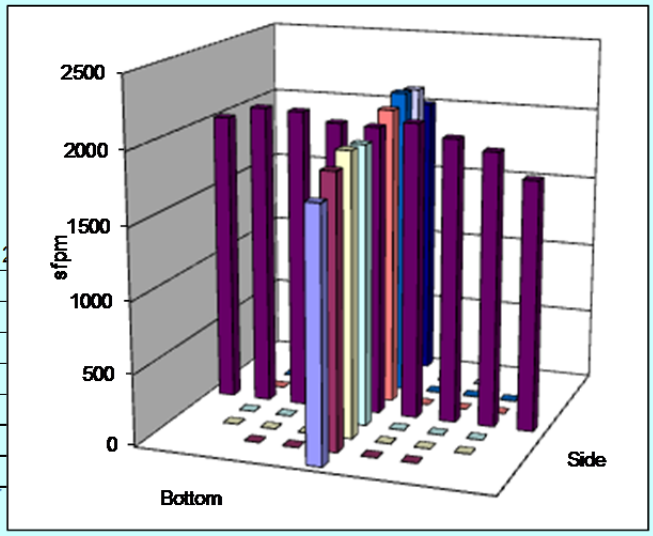
Order —>		1st				2nd			
Traverse—>		Side				Bottom			
Trial —>		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	1745	1692	1717	1718.0	1756	1770	1726	1750.7
2	1.25	1874	1879	1909	1887.3	1944	1879	1861	1894.7
3	2.32	1962	2004	1901	1955.7	1967	1987	1971	1975.0
4	3.86	2041	2040	2040	2040.3	1977	1969	1938	1961.3
Center	5.97	1987	2007	1993	1995.7	2026	2025	2025	2025.3
5	8.08	2007	2003	2005	2005.0	2089	2099	2098	2095.3
6	9.62	2087	2070	2041	2066.0	2168	2173	2159	2166.7
7	10.68	2103	2066	2052	2073.7	2145	2136	2159	2146.7
8	11.44	2018	1978	1975	1990.3	2001	1964	2018	1994.3
Averages ——>		1980.4	1971.0	1959.2	1970.2	2008.1	2000.2	1995.0	2001.1

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	1985.7		Mean	2003.4	2037.9	2020.6
Min Point	1718.0	-13.5%	Std. Dev.	65.9	101.8	84.3
Max Point	2166.7	9.1%	COV as %	3.3	5.0	4.2

Flow w/o C-Pt	1541	scfm	
Vel Avg w/o C-Pt	1983	sfpm	

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012
YFS 4/20/12	

	Start	Finish	
Stack temp	74.4	73.4	F
Equipment temp	N/A	N/A	F
Ambient temp	70.7	79.7	F
Stack static	N/A	N/A	mbars
Ambient pressure	1007	1007	mbars
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	38%	29%	RH



Notes: Slightly overcast, no wind. XY 4/20/12

Adjust fan frequency by measuring @point 3 (side) until it is close to the targeted velocity of 2078 fpm.

XY 4/20/12

Entries made by:	XY, YFS	Technical Data Review performed by:	RL Aaberg
Signature/date	On file with Original 4/20/2012	Signature/date	Signature on File with original TI-WTPSP-082 6/5/2012

VELOCITY TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	VT-13
Date	4/20/12	Fan Configuration	FAN B ONLY
Testers	XY, YFS	Fan Setting	32 Hz
Stack Dia.	11.938 in.	Stack Temp	72 deg F
Stack X-Area	111.9 in.2	Start/End Time	1400 / 1430
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

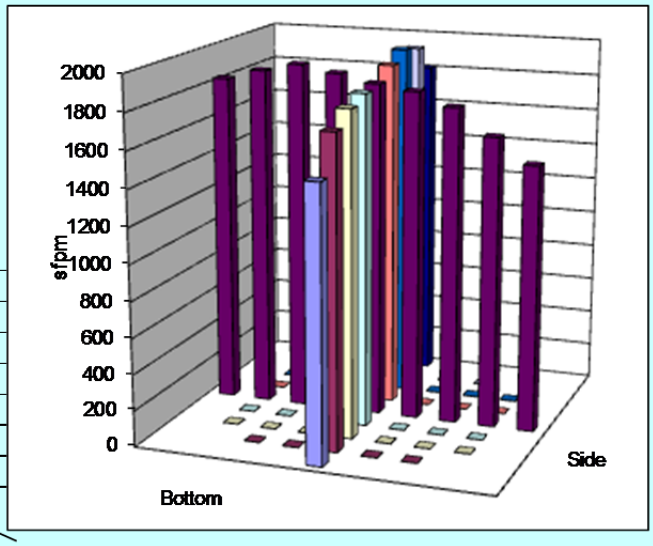
Order —>		2nd				1st			
Traverse—>		Side				Bottom			
Trial —>		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	1459	1456	1507	1474.0	1539	1452	1488	1493.0
2	1.25	1603	1604	1625	1610.7	1738	1661	1708	1702.3
3	2.32	1803	1732	1730	1755.0	1786	1759	1797	1780.7
4	3.86	1850	1767	1866	1827.7	1825	1806	1839	1823.3
Center	5.97	1850	1832	1886	1856.0	1842	1837	1836	1838.3
5	8.08	1916	1899	1885	1900.0	1889	1919	1904	1904.0
6	9.62	1958	1910	1944	1937.3	1956	1968	1949	1957.7
7	10.68	1917	1871	1884	1890.7	1934	1929	1936	1933.0
8	11.44	1979	1754	1769	1834.0	1800	1801	1776	1792.3
Averages ——>		1815.0	1758.3	1788.4	1787.3	1812.1	1792.4	1803.7	1802.7

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	1795.0		Mean	1825.3	1848.5	1836.9
Min Point	1474.0	-17.9%	Std. Dev.	111.3	90.2	98.1
Max Point	1957.7	9.1%	COV as %	6.1	4.9	5.3

Flow w/o C-Pt	1390	scfm	
Vel Avg w/o C-Pt	1788	sfpm	

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012
YFS 4/20/12	

	Start	Finish	
Stack temp	72.1	71.2	F
Equipment temp	N/A	N/A	F
Ambient temp	79.7	77.9	F
Stack static	N/A	N/A	mbars
Ambient pressure	1007	1007	mbars
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	29%	31%	RH



Notes: Overcast, no wind. XY 4/20/12

Entries made by:	XY, YFS	Technical Data Review performed by:	RL Aaberg
Signature/date	On file with Original 4/20/2012	Signature/date	Signature on File with original TI-WTPSP-082 6/5/2012

VELOCITY TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	VT-14
Date	4/20/12	Fan Configuration	FAN B ONLY
Testers	XY, YFS	Fan Setting	32 Hz
Stack Dia.	11.938 in.	Stack Temp	72 deg F
Stack X-Area	111.9 in.2	Start/End Time	1430 / 1500
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

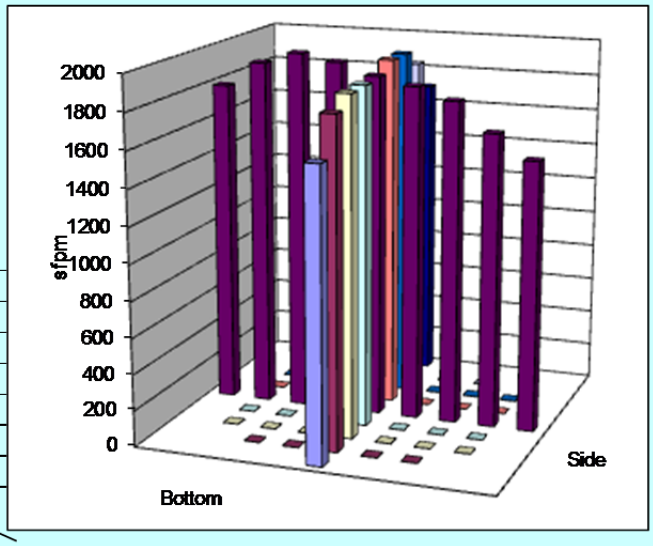
Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	1510	1504	1454	1489.3	1569	1614	1616	1599.7
2	1.25	1615	1644	1601	1620.0	1830	1792	1810	1810.7
3	2.32	1782	1783	1771	1778.7	1899	1883	1850	1877.3
4	3.86	1820	1854	1858	1844.0	1897	1882	1876	1885.0
Center	5.97	1879	1906	1873	1886.0	1880	1902	1908	1896.7
5	8.08	1925	1986	1938	1949.7	1958	1930	1967	1951.7
6	9.62	1985	1964	2009	1986.0	1996	1940	1921	1952.3
7	10.68	1929	1945	1891	1921.7	1882	1830	1883	1865.0
8	11.44	1758	1826	1773	1785.7	1702	1718	1678	1699.3
Averages -->		1800.3	1823.6	1796.4	1806.8	1845.9	1832.3	1834.3	1837.5

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	1822.1		Mean	1855.1	1891.2	1873.2
Min Point	1489.3	-18.3%	Std. Dev.	124.3	49.7	92.9
Max Point	1986.0	9.0%	COV as %	6.7	2.6	5.0

Flow w/o C-Pt	1410	scfm
Vel Avg w/o C-Pt	1814	sfpm

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012
YFS 4/20/12	

	Start	Finish	
Stack temp	71.0	73.6	F
Equipment temp	N/A	N/A	F
Ambient temp	77.0	77.9	F
Stack static	N/A	N/A	mbars
Ambient pressure	1007	1007	mbars
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	31%	29%	RH



Notes: Overcast, no wind. XY 4/20/12

Entries made by:	XY, YFS	Technical Data Review performed by:	RL Aaberg
Signature/date	On file with Original 4/20/2012	Signature/date	Signature on File with original TI-WTPSP-082 6/5/2012

VELOCITY TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	VT-15
Date	4/20/12	Fan Configuration	FAN B ONLY
Testers	XY, YFS	Fan Setting	35 Hz
Stack Dia.	11.938 in.	Stack Temp	74 deg F
Stack X-Area	111.9 in.2	Start/End Time	1500 / 1540
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	300 inches	Points in Center 2/3	2 to: 7
Velocity units	s ft/min	Data Files:	NA

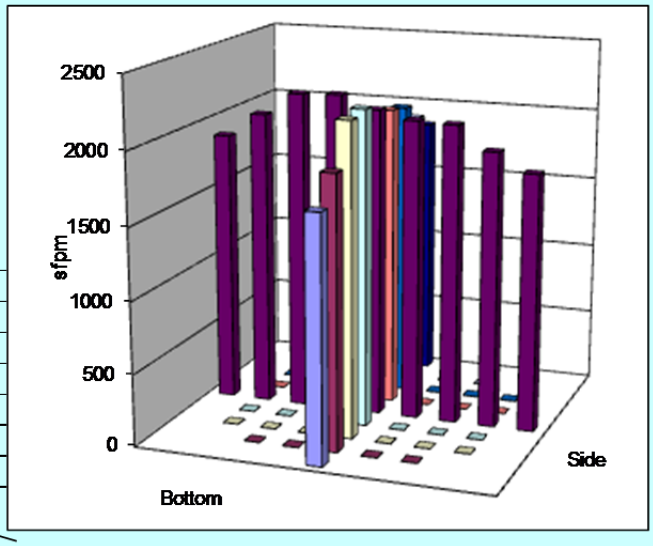
Order —>		2nd				1st			
Traverse—>		Side				Bottom			
Trial —>		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	Velocity				Velocity			
1	0.50	1791	1770	1765	1775.3	1717	1689	1667	1691.0
2	1.25	1876	1925	1909	1903.3	1984	1999	1665	1882.7
3	2.32	2078	2012	2105	2065.0	2189	2166	2164	2173.0
4	3.86	2110	2066	2050	2075.3	2241	2177	2173	2197.0
Center	5.97	2131	2136	2125	2130.7	2160	2141	2128	2143.0
5	8.08	2174	2245	2231	2216.7	2109	2093	2078	2093.3
6	9.62	2189	2233	2197	2206.3	2067	2079	2044	2063.3
7	10.68	2061	2026	2055	2047.3	1949	1947	1933	1943.0
8	11.44	1925	1826	1894	1881.7	1893	1824	1813	1843.3
Averages ——>		2037.2	2026.6	2036.8	2033.5	2034.3	2012.8	1962.8	2003.3

All	s ft/min	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	2018.4		Mean	2092.1	2070.8	2081.4
Min Point	1691.0	-16.2%	Std. Dev.	107.0	118.2	108.9
Max Point	2216.7	9.8%	COV as %	5.1	5.7	5.2

Flow w/o C-Pt	1557	scfm
Vel Avg w/o C-Pt	2004	sfpm

Instuments Used:	Cal Due
Fisher Scientific Barometer SN 90936818	12/07/12
TSI VelociCalc SN T95351203001	12/17/2012
YFS 4/20/12	

	Start	Finish	
Stack temp	74.3	74.3	F
Equipment temp	N/A	N/A	F
Ambient temp	80.6	73.4	F
Stack static	N/A	N/A	mbars
Ambient pressure	1007	1008	mbars
Total Stack pressure	N/A	N/A	mbars
Ambient humidity	29%	32%	RH



Notes: Overcast, no wind. XY 4/20/12

Initally set frequency at 38 Hz, but the reading are higher than the targeted value, e.g., 2078 fpm.

Reduce to 35 Hz and continue testing. XY 4/20/12

Entries made by:	XY, YFS	Technical Data Review performed by:	RL Aaberg
Signature/date	On file with Original 4/20/2012	Signature/date	Signature on File with original TI-WTPSP-082 6/5/2012

C.3 IHLW-S1 Flow Angle Data Sheets

FLOW ANGLE DATA FORM IHLW-S1_FlowAngle.xls

Site	IHLW-S1 scale model	Run No.	FA-1
Date	3/6/2012	Fan Setting	42 Hz
Tester	EA, JEF, CA	Fan configuration	Fan A Only
Stack Dia.	11.938 in	Approx. air vel.	2500 sfpm at point >> 1 bottom center
Stack X-Area	111.9 in2	Units	degrees (clockwise > pos. nos.)
Elevation	N.A. ft	Port	2
Distance to disturbance	240 in	Stack Temp	59 °F
Start/End Time	1455h / 1535h		

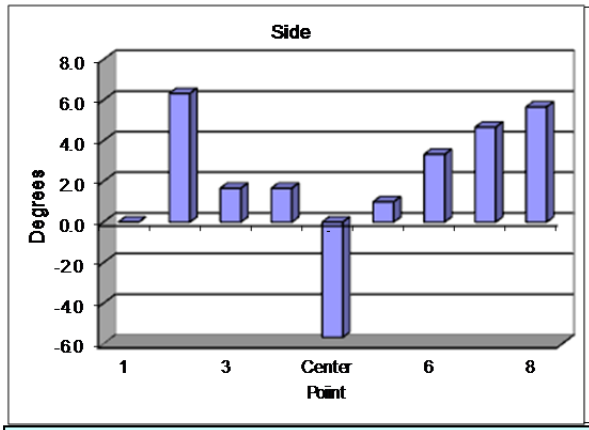
Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3		1	2	3	
Point	Depth, in.	deg. cw	deg. cw	deg. cw	deg. Avg.	deg. cw	deg. cw	deg. cw	deg. Avg.
1	0.50	4	8	-12	0.0	7	2	3	4.0
2	1.25	5	7	7	6.3	8	9	11	9.3
3	2.32	-1	5	1	1.7	12	7	10	9.7
4	3.86	-2	4	3	1.7	5	6	3	4.7
Center	5.97	-3	-7	-7	-5.7	1	-2	2	0.3
5	8.08	2	0	1	1.0	4	4	2	3.3
6	9.62	3	4	3	3.3	4	3	3	3.3
7	10.68	5	5	4	4.7	5	4	3	4.0
8	11.44	6	5	6	5.7	4	3	4	3.7
Mean of absolute values:					3.3				4.7
" "w/o points by wall:					3.5				5.0
								Grand mean ABS	4.0
								" "w/o wall pts	4.2

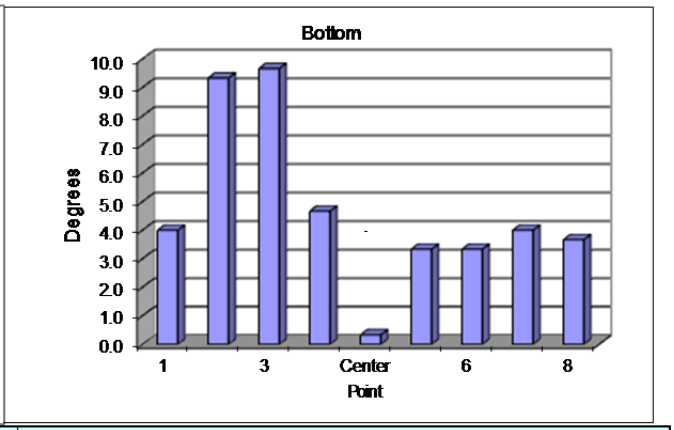
Instruments Used:			Cal. Due
S-type pitot	Dwyer 24-inch S-type Pitot#10		Cert. of conformance
Velocity sensor	TSI Velocicalc SN#T95351203001		17-Dec-12
Angle indicator	Shop built		Cat. 3
Manometer	Dwyer 400-5, S36N	MAN-5	Cat. 3

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: The Side port readings are reversed (8=1) on the original.
Side Port data have been entered in correct order in this transcribed datasheet.

JEF 3/26/12





Entries made by:	Carmen Arimescu	Technical Data Review performed by:	RL Aaberg
Signature/date	On file with original 3/6/2012	Signature/date	Signature on file 5/15/2012 TI-WTPSP-083

FLOW ANGLE DATA FORM

IHLW-S1_FlowAngle.xls

Site	IHLW-S1 scale model	Run No.	FA-2
Date	3/6/2012	Fan Setting	10 Hz
Tester	EA, JEF, CA	Fan configuration	Fan A Only
Stack Dia.	11.938 in	Approx. air vel.	500 sfpm at point >> 1 bottom center
Stack X-Area	111.9 in2	Units	degrees (clockwise > pos. nos.)
Elevation	N.A. ft	Port	2
Distance to disturbance	240 in	Stack Temp	62 °F
Start/End Time	1543h / 1627h		

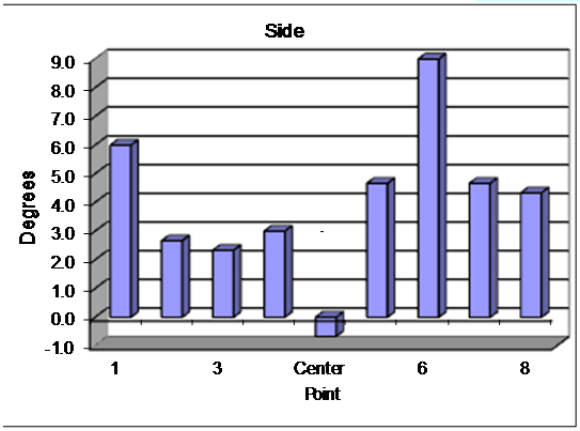
Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3		1	2	3	
Point	Depth, in.	deg. cw	deg. cw	deg. cw	deg. Avg.	deg. cw	deg. cw	deg. cw	deg. Avg.
1	0.50	3	10	5	**6.0**	-1	1	-1	**-0.3**
2	1.25	0	0	8	**2.7**	12	23	4	**13.0**
3	2.32	0	5	2	**2.3**	-2	-1	-1	**-1.3**
4	3.86	-3	3	9	**3.0**	23	1	-6	**6.0**
Center	5.97	-5	3	0	**-0.7**	0	27	1	**9.3**
5	8.08	0	0	14	**4.7**	1	8	3	**4.0**
6	9.62	16	1	10	**9.0**	3	1	4	**2.7**
7	10.68	5	1	8	**4.7**	3	1	2	**2.0**
8	11.44	4	1	8	**4.3**	2	2	3	**2.3**
Mean of absolute values:					**4.1**				**4.6**
" " w/o points by wall:					**3.9**				**5.5**
								Grand mean ABS	**4.4**
								" " w/o wall pts	**4.7**

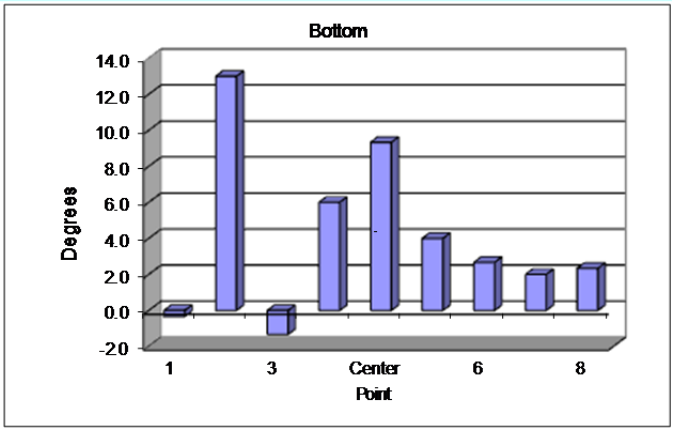
Instruments Used:			Cal. Due
S-type pitot	Dwyer 24-inch S-type Pitot#10		Cert. of conformance
Velocity sensor	TSI Velocicalc SN#T95351203001		17-Dec-12
Angle indicator	Shop built		Cat. 3
Manometer	Dwyer 400-5, S36N	MAN-5	Cat. 3

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: Low velocity - manometer is very insensitive to angle changes.

JEF 3/26/12





Entries made by:	Carmen Arimescu	Technical Data Review performed by:	RL Aaberg
Signature/date	On file with original 3/6/2012	Signature/date	Signature on file 5/15/2012 TI-WTPSP-083

FLOW ANGLE DATA FORM

IHLW-S1_FlowAngle.xls

Site	IHLW-S1 scale model	Run No.	FA-3
Date	3/7/2012	Fan Setting	42 Hz
Tester	EA, CA	Fan configuration	Fan B Only
Stack Dia.	11.938 in	Approx. air vel.	2570 sfpm at point >> 1 bottom center
Stack X-Area	111.9 in2	Units	degrees (clockwise > pos. nos.)
Elevation	N.A. ft	Port	2
Distance to disturbance	240 in	Stack Temp	60.4 °F
Start/End Time	1405h / 1507h		

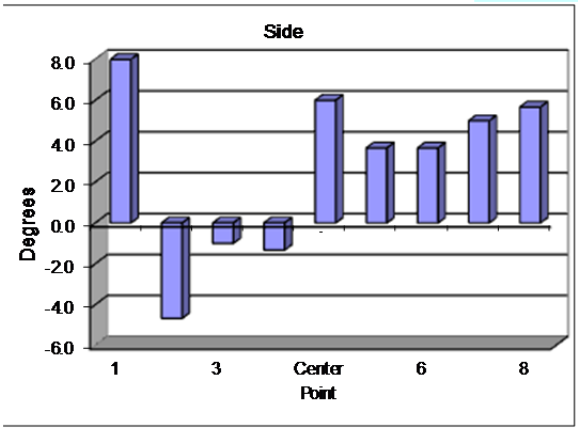
Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3		1	2	3	
Point	Depth, in.	deg. cw	deg. cw	deg. cw	deg. Avg.	deg. cw	deg. cw	deg. cw	deg. Avg.
1	0.50	6	9	9	8.0	3	3	8	4.7
2	1.25	-4	-5	-5	-4.7	11	10	-4	5.7
3	2.32	6	-4	-5	-1.0	11	-3	-2	2.0
4	3.86	5	-5	-4	-1.3	1	0	1	0.7
Center	5.97	5	8	5	6.0	1	0	0	0.3
5	8.08	3	4	4	3.7	1	1	-1	0.3
6	9.62	3	3	5	3.7	2	0	1	1.0
7	10.68	5	5	5	5.0	2	2	3	2.3
8	11.44	7	5	5	5.7	3	3	2	2.7
Mean of absolute values:					4.3				2.2
" " w/o points by wall:					3.6				1.8
								Grand mean ABS	3.3
								" " w/o wall pts	2.7

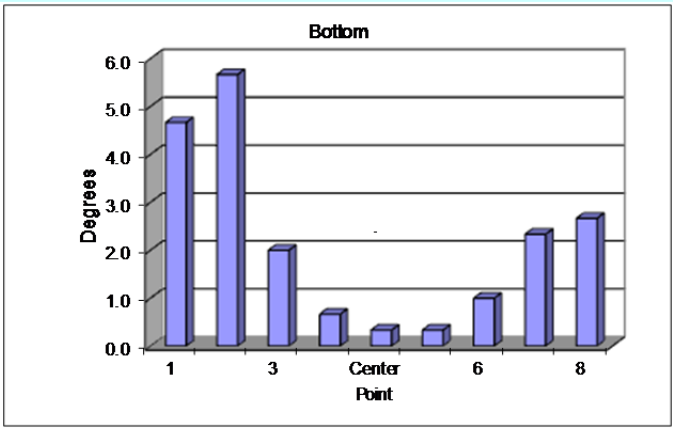
Instruments Used:			Cal. Due
S-type pitot	Dwyer 24-inch S-type Pitot#10		Cert. of conformance
Velocity sensor	TSI Velocicalc SN#T95351203001		17-Dec-12
Angle indicator	Shop built		Cat. 3
Manometer	Dwyer 400-5, S36N	MAN-5	Cat. 3

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:

JEF 3/26/12





Entries made by:	Carmen Arimescu	Technical Data Review performed by:	RL Aaberg
Signature/date	On file with Original 3/7/2012	Signature/date	Signature on file 5/15/2012 TI-WTPSP-083

FLOW ANGLE DATA FORM

IHLW-S1_FlowAngle.xls

Site	IHLW-S1 scale model	Run No.	FA-4
Date	3/7/2012	Fan Setting	40 Hz
Tester	EA, CA	Fan configuration	Fan B only
Stack Dia.	11.938 in	Approx. air vel.	2590 sfpm at point >> 1 bottom center
Stack X-Area	111.9 in2	Units	degrees (clockwise > pos. nos.)
Elevation	N.A. ft	Port	1
Distance to disturbance	300 in	Stack Temp	59 °F
Start/End Time	1515h / 1610h		

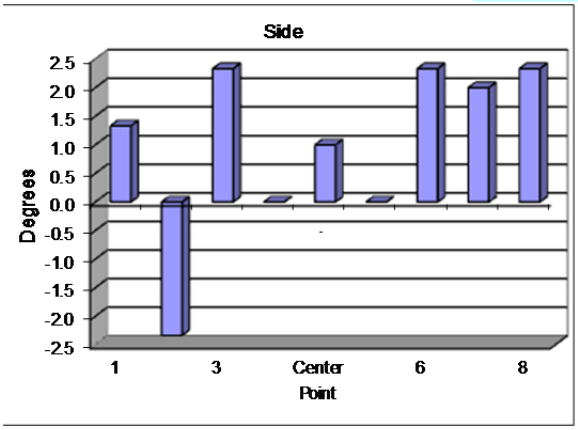
Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3		1	2	3	
Point	Depth, in.	deg. cw	deg. cw	deg. cw	deg. Avg.	deg. cw	deg. cw	deg. cw	deg. Avg.
1	0.50	0	5	-1	1.3	9	0	0	3.0
2	1.25	-2	-3	-2	-2.3	-7	-10	5	-4.0
3	2.32	-1	9	-1	2.3	7	6	6	6.3
4	3.86	0	0	0	0.0	4	2	0	2.0
Center	5.97	3	0	0	1.0	6	0	0	2.0
5	8.08	0	0	0	0.0	4	-5	-2	-1.0
6	9.62	3	2	2	2.3	3	-3	-3	-1.0
7	10.68	2	2	2	2.0	3	-3	-2	-0.7
8	11.44	3	2	2	2.3	2	-2	-2	-0.7
Mean of absolute values:					1.5				2.3
" "w/o points by wall:					1.4				2.4
								Grand mean ABS	1.9
								" "w/o wall pts	1.9

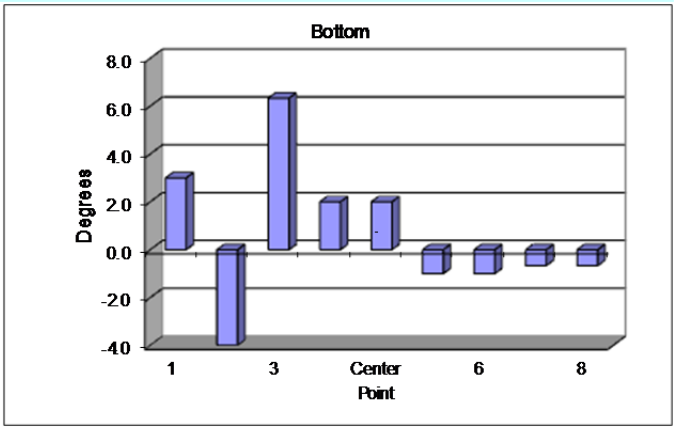
Instruments Used:			Cal Due
S-type pitot	Dwyer 24-inch S-type Pitot#10		Cert. of conformance
Velocity sensor	TSI Velocicalc SN#T95351203001		17-Dec-12
Angle indicator	Shop built		Cat. 3
Manometer	Dwyer 400-5, S36N	MAN-5	Cat. 3

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:

JEF 3/26/12





Entries made by:	Carmen Arimescu	Technical Data Review performed by:	RL Aaberg
Signature/date	On file with original 3/7/2012	Signature/date	Signature on file 5/15/2012 TI-WTPSP-083

FLOW ANGLE DATA FORM

IHLW-S1_FlowAngle.xls

Site	IHLW-S1 scale model	Run No.	FA-5
Date	3/8/2012	Fan Setting	10 Hz
Tester	CA, JEF	Fan configuration	Fan B Only
Stack Dia.	11.938 in	Approx. air vel.	500 sfpm at point >> 2 bottom center
Stack X-Area	111.9 in2	Units	degrees (clockwise > pos. nos.)
Elevation	N.A. ft	Port	2
Distance to disturbance	240 in	Stack Temp	71 °F
Start/End Time	1300h / 1335		

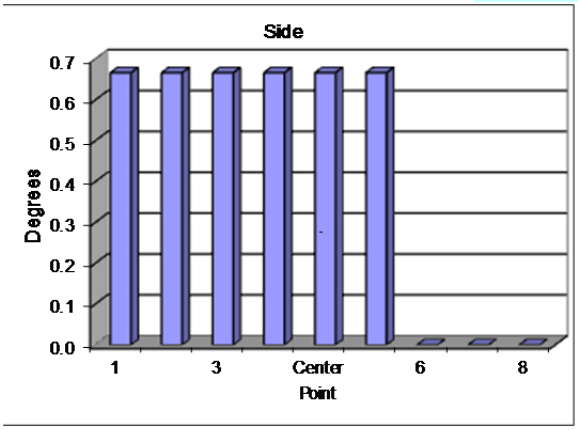
Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3		1	2	3	
Point	Depth, in.	deg. cw	deg. cw	deg. cw	deg. Avg.	deg. cw	deg. cw	deg. cw	deg. Avg.
1	0.50	2	0	0	0.7	0	1	3	1.3
2	1.25	2	0	0	0.7	1	1	2	1.3
3	2.32	2	0	0	0.7	1	1	2	1.3
4	3.86	2	0	0	0.7	0	1	1	0.7
Center	5.97	2	0	0	0.7	0	0	1	0.3
5	8.08	2	0	0	0.7	15	0	1	5.3
6	9.62	0	0	0	0.0	14	0	1	5.0
7	10.68	0	0	0	0.0	8	0	1	3.0
8	11.44	0	0	0	0.0	0	0	1	0.3
Mean of absolute values:					0.4				2.1
" "w/o points by wall:					0.5				2.4
								Grand mean ABS	1.3
								" "w/o wall pts	1.5

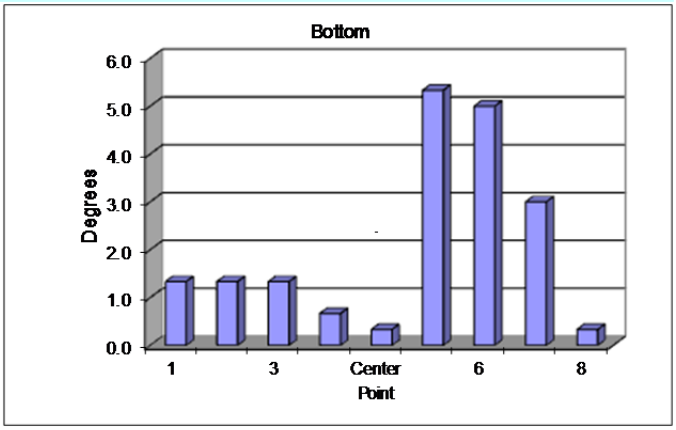
Instruments Used:			Cal Due
S-type pitot	Dwyer 24-inch S-type Pitot#10		Cert. of conformance
Velocity sensor	TSI Velocicalc SN#T95351203001		17-Dec-12
Angle indicator	Shop built		Cat. 3
Manometer	Dwyer 400-5, S36N	MAN-5	Cat. 3

Notes: Highly insensitive to angle. Oil level remains at zero -15 to + 15 deg.

JEF 3/8/12

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).





Entries made by:	Carmen Arimescu	Technical Data Review performed by:	RL Aaberg
Signature/date	On file with Original 3/8/2012	Signature/date	Signature on file 5/15/2012 TI-WTPSP-083

FLOW ANGLE DATA FORM

IHLW-S1_FlowAngle.xls

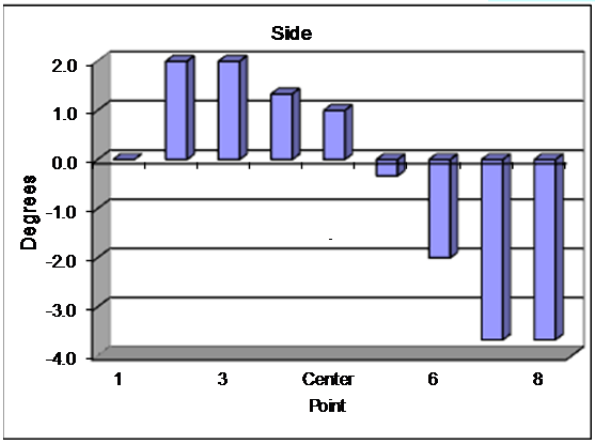
Site	IHLW-S1 scale model	Run No.	FA-6
Date	3/8/2012	Fan Setting	33 Hz
Tester	CA, JEF, YFS	Fan configuration	Fan B Only
Stack Dia.	11.938 in	Approx. air vel.	1800 sfpm at point >> side center
Stack X-Area	111.9 in2	Units	degrees (clockwise > pos. nos.)
Elevation	N.A. ft	Port	2
Distance to disturbance	240 in	Stack Temp	69 °F
Start/End Time	1345h / 1410h		

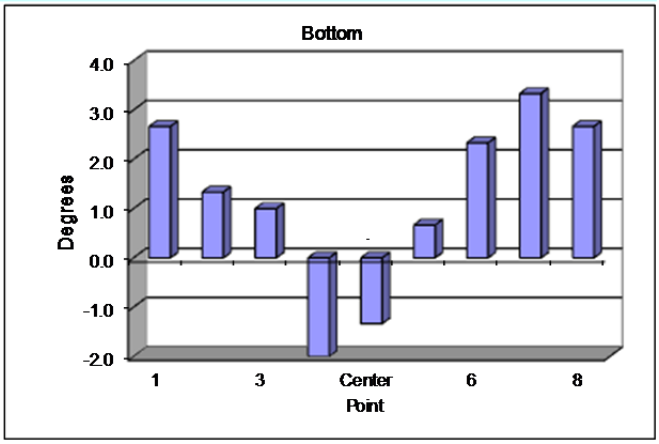
Order -->	1st				2nd			
Traverse-->	Side				Bottom			
Trial -->	1	2	3		1	2	3	
Point	Depth, in.	deg. cw	deg. cw	deg. cw	deg. Avg.	deg. cw	deg. cw	deg. cw	deg. Avg.
1	0.50	0	1	-1	0.0	-3	2	9	2.7
2	1.25	4	1	1	2.0	-6	-2	12	1.3
3	2.32	4	1	1	2.0	-6	-2	11	1.0
4	3.86	1	2	1	1.3	-7	1	0	-2.0
Center	5.97	0	2	1	1.0	-3	-1	0	-1.3
5	8.08	0	-2	1	-0.3	3	-1	0	0.7
6	9.62	-2	-2	-2	-2.0	2	2	3	2.3
7	10.68	-4	-5	-2	-3.7	5	2	3	3.3
8	11.44	-4	-2	-5	-3.7	3	2	3	2.7
Mean of absolute values:					1.8				1.9
" " w/o points by wall:					1.8				1.7
								Grand mean ABS	1.9
								" " w/o wall pts	1.7

Instruments Used:			Cal. Due
S-type pitot	Dwyer 24-inch S-type Pitot#10		Cert. of conformance
Velocity sensor	TSI Velocicalc SN#T95351203001		17-Dec-12
Angle indicator	Shop built		Cat. 3
Manometer	Dwyer 400-5, S36N	MAN-5	Cat. 3

Notes: None CA 3/8/12

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).





Entries made by:	Carmen Arimescu	Technical Data Review performed by:	RL Aaberg
Signature/date	On file with Original 3/8/2012	Signature/date	Signature on file 5/15/2012 TI-WTPSP-083

FLOW ANGLE DATA FORM

IHLW-S1_FlowAngle.xls

Site	IHLW-S1 scale model	Run No.	FA-7
Date	3/21/2012	Fan Setting	35.5 Hz
Tester	CA, JAG	Fan configuration	FAN B ONLY
Stack Dia.	11.938 in	Approx. air vel.	1775 sfpm at point >> side 7
Stack X-Area	111.9 in2	Units	degrees (clockwise > pos. nos.)
Elevation	N.A. ft	Port	2
Distance to disturbance	240 in	Stack Temp	45.2 °F
Start/End Time	14:10/ 15:15		

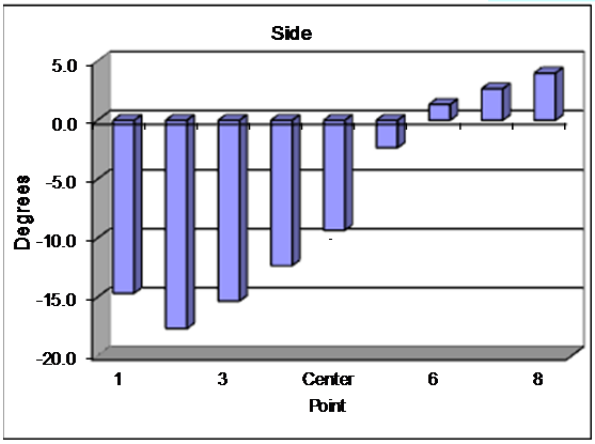
Order -->	1st					2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3		1	2	3	
Point	Depth, in.	deg. cw	deg. cw	deg. cw	deg. Avg.	deg. cw	deg. cw	deg. cw	deg. Avg.
1	0.50	-13	-14	-17	**-14.7**	-2	-8	-8	**-6.0**
2	1.25	-17	-19	-17	**-17.7**	-10	-14	-17	**-13.7**
3	2.32	-17	-14	-15	**-15.3**	-9	11	-13	**-3.7**
4	3.86	-14	-12	-11	**-12.3**	-8	-3	-11	**-7.3**
Center	5.97	-10	-8	-10	**-9.3**	3	0	-4	**-0.3**
5	8.08	-1	-3	-3	**-2.3**	5	3	3	**3.7**
6	9.62	1	3	0	**1.3**	5	3	6	**4.7**
7	10.68	2	3	3	**2.7**	4	6	7	**5.7**
8	11.44	4	3	5	**4.0**	6	7	7	**6.7**
Mean of absolute values:					**8.9**				**5.7**
" "w/o points by wall:					**8.7**				**5.6**
								Grand mean ABS	**7.3**
								" "w/o wall pts	**7.1**

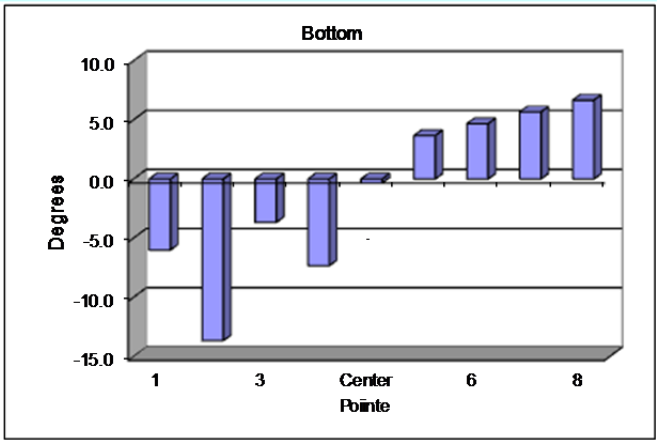
Instruments Used:			Cal. Due
S-type pitot	Dwyer 24-inch S-type Pitot#10		Cert. of conformance
Velocity sensor	TSI Velocicalc SN#T95351203001		17-Dec-12
Angle indicator	Shop built		Cat. 3
Manometer	Dwyer 400-5, S36N	MAN-5	Cat. 3

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:

JAG 3/21/12





Entries made by: Carmen Arimescu	Technical Data Review performed by: RL Aaberg
Signature/date 3/21/2012	Signature/date Signature on file 5/15/2012 TI-WTPSP-083

FLOW ANGLE DATA FORM

IHLW-S1_FlowAngle.xls

Site	IHLW-S1 scale model	Run No.	FA-8
Date	3/21/2012	Fan Setting	35.1 Hz
Tester	CA, JAG	Fan configuration	FAN A ONLY
Stack Dia.	11.938 in	Approx. air vel.	1797 sfpm at point >> Side, 7
Stack X-Area	111.9 in2	Units	degrees (clockwise > pos. nos.)
Elevation	N.A. ft	Port	2
Distance to disturbance	240 in	Stack Temp	42.5 °F
Start/End Time	15:25/ 16:15		

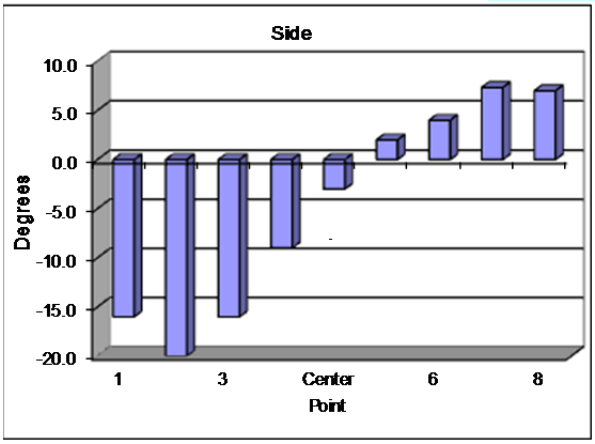
Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3		1	2	3	
Point	Depth, in.	deg. cw	deg. cw	deg. cw	deg. Avg.	deg. cw	deg. cw	deg. cw	deg. Avg.
1	0.50	-13	-18	-17	**-16.0**	-1	-3	-9	**-4.3**
2	1.25	-19	-20	-21	**-20.0**	-14	-17	-15	**-15.3**
3	2.32	-16	-17	-15	**-16.0**	-13	-16	-14	**-14.3**
4	3.86	-11	-9	-7	**-9.0**	-6	-8	-7	**-7.0**
Center	5.97	-5	-2	-2	**-3.0**	3	6	2	**3.7**
5	8.08	0	5	1	**2.0**	6	6	7	**6.3**
6	9.62	2	6	4	**4.0**	9	10	8	**9.0**
7	10.68	7	8	7	**7.3**	10	12	12	**11.3**
8	11.44	7	7	7	**7.0**	11	12	11	**11.3**
Mean of absolute values:					**9.4**				**9.2**
" "w/o points by wall:					**8.8**				**9.6**
								Grand mean ABS	**9.3**
								" "w/o wall pts	**9.2**

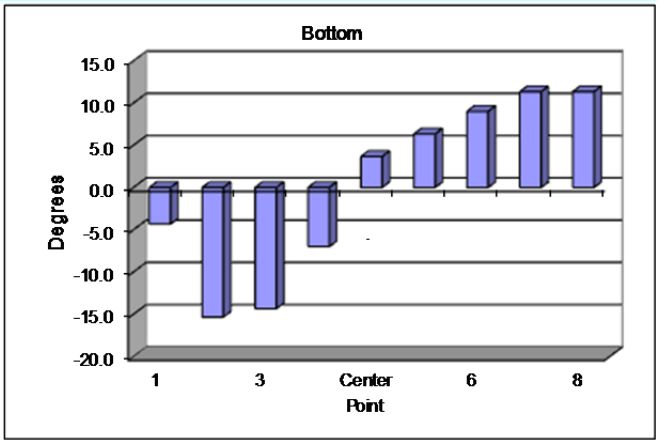
Instruments Used:			**Cal. Due**
S-type pitot	Dwyer 24-inch S-type Pitot#10		Cert. of conformance
Velocity sensor	TSI Velocicalc SN#T95351203001		17-Dec-12
Angle indicator	Shop built		Cat. 3
Manometer	Dwyer 400-5, S36N	MAN-5	Cat. 3

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:

JAG 3/21/12





Entries made by: Carmen Arimescu	Technical Data Review performed by: RL Aaberg
Signature/date 3/21/2012	Signature/date Signature on file 5/15/2012 TI-WTPSP-083

C.4 IHLW-S1 Gas Tracer Calibration and Uniformity Data Sheets

SULFUR HEXAFLUORIDE GAS INSTRUMENT CALIBRATION

Site	HV-S1 Model	Instrument	B&K Model 1302
Date/Time	4/16/2012 12:35 PM	Serial No.	1765299
Testers	CA, XY, EA	Property No.	WD17210

Setup:
- 7.7 ft — B&K sample inlet tube length
- 1004 mbar station pressure
- 59.9 deg F ambient temp — analyzer corrects to 20 deg C
- 65% percent RH ambient humidity

Pre-Test background, ppb

Not compensating for water vapor, monitoring task 2

34,33,32,29,34

Compensating for water vapor, monitoring task 1

-3,0.6,-5,0,0

	100 ppb		4.97 ppm
Cylinder	CAL11936	Cylinder	FF34346
start P =	1600 psi	start P =	1500 psi
end P =	1600 psi	end P =	1500 psi

B&K Calibration readings: (ppb)

Compensating for water vapor

108
110
106
105
104

Not compensating for water vapor

108
108
110
107
107

107 = avg

1.07 = avg/standard

B&K Calibration readings: (ppm)

Compensating for water vapor

5.04
5.03
5.02
5.01
5.04

Not compensating for water vapor

5.01
5.01
5.00
5.00
5.00

5.02 = avg

1.01 = avg/standard

Standards Used:	Expiration date:
Air Liquide 0.1 ppm SF6 in air, CAL11936	3/19/2013
Air Liquide 4.97 ppm SF6 in air, FF34346	3/19/2014
Weather Station Used:	
Fisher Scientific S/N 90936818	12/7/2012

Entries made by: EA, CA	Technical Data Review performed by: E. G.
Signature/date 4/16/2012	Signature/date Signature on file with Original TI-WTPSP-084 7/10/2012

SULFUR HEXAFLUORIDE GAS INSTRUMENT CALIBRATION

Site	IHLW-S1 Model	Instrument	B&K Model 1302
Date/Time	4/23/12 7:55AM	Serial No.	1765299
Testers	JEF, CA	Property No.	WD17210

Setup:
- 7.7 ft B&K sample inlet tube length
- 999 mbar station pressure
- 70.7 deg F ambient temp analyzer corrects to 20 deg C
- 34% percent RH ambient humidity

Pre-Test background, ppb

Not compensating for water vapor, monitoring task 2

40.5, 41.2, 43.9, 42.0, 38.1

Compensating for water vapor, monitoring task 1

5.7, 6.2, 2.4, 2.5, 0.3

	100 ppb		4.97 ppm
Cylinder	CAL11936	Cylinder	FF34346
start P =	1600 psi	start P =	1500 psi
end P =	1600 psi	end P =	1500 psi

B&K Calibration readings: (ppb)	B&K Calibration readings: (ppm)
Compensating for water vapor	**Compensating for water vapor**
106	5.13
107	5.13
107	5.13
104	5.11
108	5.11
Not compensating for water vapor	**Not compensating for water vapor**
103	5.09
108	5.08
108	5.08
108	5.07
109	5.08
107 = avg	**5.10** = avg
1.07 = avg/standard	**1.03** = avg/standard

Standards Used:	Expiration date:
Air Liquide 0.1 ppm SF6 in air, CAL11936	3/19/2013
Air Liquide 4.97 ppm SF6 in air, FF34346	3/19/2014
Weather Station Used:	
Fisher Scientific S/N 90936818	12/7/2012

Entries made by: JEF 4/23/2012 Signature/date	Technical Data Review performed by: E. G. Signature/date Signature on file with Original TI-WTPSP-084 7/10/2012

SULFUR HEXAFLUORIDE GAS INSTRUMENT CALIBRATION

Site	IHLW-S1 Model	Instrument	B&K Model 1302
Date/Time	4/23/12 11:15AM	Serial No.	SN 1765299
Testers	JEF, CA	Property No.	WD17210

Setup:
- 7.7 ft B&K sample inlet tube length
- 999 mbar station pressure
- 76 deg F ambient temp analyzer corrects to 20 deg C
- 36 percent RH ambient humidity

Pre-Test background, ppb

Not compensating for water vapor, monitoring task 2

42, 44, 45, 42, 39

Compensating for water vapor, monitoring task 1

5.3, -1, 0, 2.6, -1

	100 ppb		4.97 ppm
Cylinder	CAL11936	Cylinder	FF34346
start P =	1550 psi	start P =	1500 psi
end P =	1550 psi	end P =	1500 psi

B&K Calibration readings: (ppb)	B&K Calibration readings: (ppm)
Compensating for water vapor	**Compensating for water vapor**
104	5.00
105	4.99
106	4.99
105	4.98
106	4.97
Not compensating for water vapor	**Not compensating for water vapor**
106	4.98
104	4.96
103	4.94
110	4.93
105	4.93
105 = avg	**4.97** = avg
1.05 = avg/standard	**1.00** = avg/standard

Standards Used:	Expiration date:
Air Liquide 0.1 ppm SF6 in air, CAL11936	3/19/2013
Air Liquide 4.97 ppm SF6 in air, FF34346	3/19/2014
Weather Station Used:	
Fisher Scientific S/N 90936818	12/7/2012

Entries made by: JEF 4/23/2012 Signature/date	Technical Data Review performed by: E. G. Signature/date Signature on file with Original TI-WTPSP-084 7/10/2012

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	IHLW-S1 Model	Run No.	GT-1
Date	4/17/2012	Fan Configuration	Fan B only
Testers	CA, XY	Fan Setting	43 Hz
Stack Dia.	11.938 in.	Stack Temp	62.3 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	9:30/11:40
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	1-center
Order -->	2nd		1st

Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	562	550	571	**561.00**	575	567	570	**570.67**
2	1.24	562	549	583	**564.67**	577	576	567	**573.33**
3	2.29	557	549	550	**552.00**	565	574	572	**570.33**
4	3.82	587	582	582	**583.67**	581	576	577	**578.00**
Center	5.91	564	561	582	**569.00**	567	575	578	**573.33**
5	8.00	591	561	575	**575.67**	589	569	552	**570.00**
6	9.52	574	572	568	**571.33**	586	585	575	**582.00**
7	10.57	572	574	572	**572.67**	578	578	563	**573.00**
8	11.31	581	586	576	**581.00**	577	606	556	**579.67**
Averages ---------->		**572.22**	**564.89**	**573.22**	**570.11**	**577.22**	**578.44**	**567.78**	**574.48**

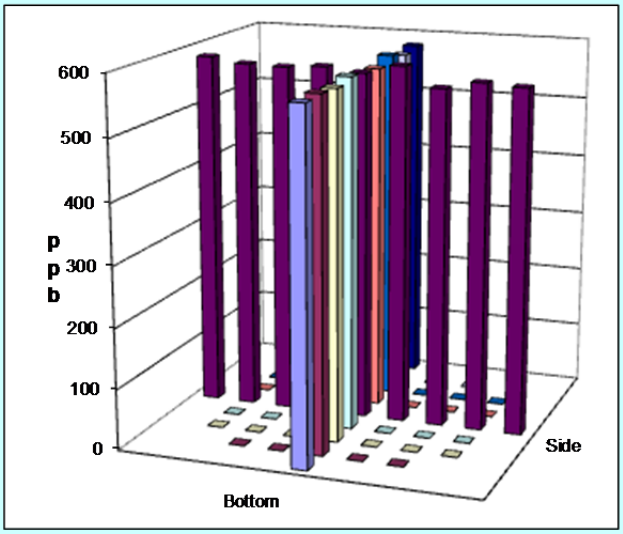
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	572.30		Mean	569.86	574.29	572.07
Min Point	552.00	-3.5%	Std. Dev.	9.84	4.30	7.65
Max Point	583.67	2.0%	COV as %	1.7	0.7	1.3

Avg. Conc. 572.438 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SI 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	125	125	psig
Injection flowmeter	30	30	sccm
Stack Temp	63.3	61.3	°F
Mean stack velocity	2941	2910	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1010	1010	mbar
Ambient humidity	32%	33%	RH
Ambient Temp	68.0	63.5	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	3,4,4,4,5	17,13,8,11,8	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/16/2012 XY 4/17/12

Notes: Velocity measured @ side 7.

CA 4/17/12

Entries made by: XY, CA
Signature/date 4/17/2012

Technical Data Review performed by: Elizabeth Golovich
Signature/date Signature on file with Original
TI-WTPSP-084
7/10/2012

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	IHLW-S1 Model	Run No.	GT-2
Date	4/17/2012	Fan Configuration	Fan A only
Testers	XY, CA	Fan Setting	43 Hz
Stack Dia.	11.938 in.	Stack Temp	62.4 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	11:50/13:02
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	1 Center

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	647	675	639	653.67	645	633	647	641.67
2	1.24	663	660	655	659.33	636	645	645	642.00
3	2.29	644	637	635	638.67	660	638	676	658.00
4	3.82	657	636	641	644.67	673	658	662	664.33
Center	5.91	646	621	650	639.00	639	662	628	643.00
5	8.00	662	647	655	654.67	663	647	658	656.00
6	9.52	662	650	652	654.67	655	645	640	646.67
7	10.57	649	660	650	653.00	649	656	656	653.67
8	11.31	646	660	644	650.00	646	639	639	641.33
Averages ------>		652.89	649.56	646.78	649.74	651.78	647.00	650.11	649.63

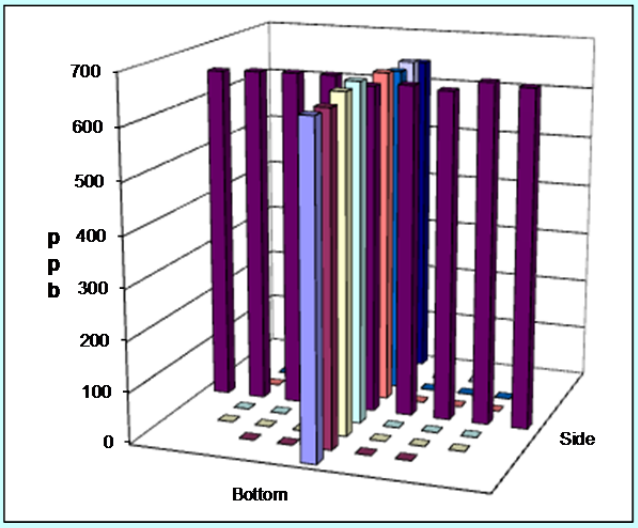
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	649.69		Mean	649.14	651.95	650.55
Min Point	638.67	-1.7%	Std. Dev.	8.29	8.33	8.12
Max Point	664.33	2.3%	COV as %	1.3	1.3	1.2

Avg. Conc. 650.771 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN	1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001		1/17/2013
Fisher Scientific	SN 90936818		12/7/2012

	Start	Finish	
Tracer tank pressure	125	125	psig
Injection flowmeter	30	30	sccm
Stack Temp	63.6	61.2	°F
Mean stack velocity	2430	2432	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1010	1010	mbar
Ambient humidity	32%	33%	RH
Ambient Temp	61.7	62.6	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	12,14,5,8,4	10, 12, 10, 11, 11	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/16/2012 CA 4/17/12

Notes: Velocity measured @ side 3.

CA 4/17/12

Entries made by:	CA, XY	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	4/17/2012	Signature/date	Signature on file with Original TI-WTPSP-084 7/10/2012

Rev. 0

31-Jul-06

TRACER GAS TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	GT-3
Date	4/17/2012	Fan Configuration	Fan A Only
Testers	JAG, YFS	Fan Setting	8.6 Hz
Stack Dia.	11.938 in.	Stack Temp	64 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	1335 / 1452
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppm SF6	Injection Point	1 Center

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppm SF6				ppm			
1	0.50	3.99	4.08	4.00	4.023	3.91	4.09	4.16	4.053
2	1.24	4.09	3.98	4.04	4.037	4.01	3.95	4.02	3.993
3	2.29	3.98	4.01	3.82	3.937	4.15	4.04	3.86	4.017
4	3.82	3.93	4.05	4.10	4.027	3.99	4.13	4.04	4.053
Center	5.91	4.06	3.98	4.01	4.017	4.02	4.07	3.87	3.987
5	8.00	4.01	4.10	4.08	4.063	4.17	4.00	3.88	4.017
6	9.52	3.95	4.05	4.01	4.003	4.04	4.09	4.08	4.070
7	10.57	4.00	4.02	4.09	4.037	4.07	4.08	4.07	4.073
8	11.31	4.07	4.01	4.06	4.047	4.12	3.95	3.91	3.993
Averages ---->		4.009	4.031	4.023	4.021	4.053	4.044	3.988	4.029

All	ppm	Dev. from mean
Mean	4.02	
Min Point	3.94	-2.2%
Max Point	4.07	1.2%

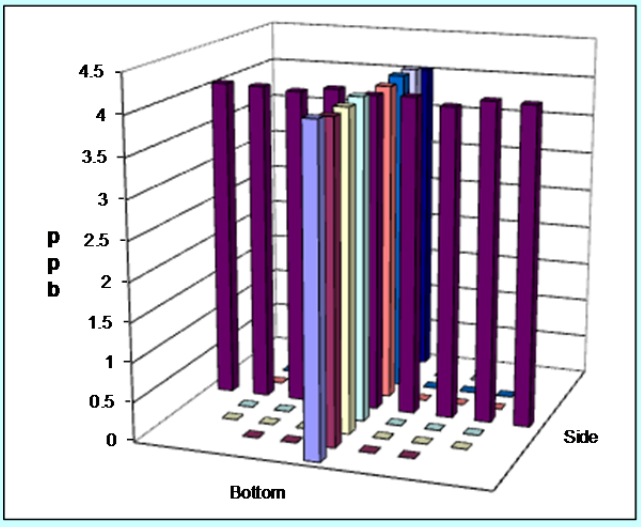
Center 2/3	Side	Bottom	All
Mean	4.02	4.03	4.02
Std. Dev.	0.04	0.04	0.04
COV as %	1.0	0.9	0.9

Avg. Conc. 4.028 ppm

Instruments Used:

B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	120	125	psig
Injection flowmeter	30	29.7	sccm
Stack Temp	61.6	66.4	°F
Mean stack velocity	384	381	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1009	1009	mbar
Ambient humidity	31	31	RH
Ambient Temp	64.4	67.1	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	2, 3, 4, 1, 0	5, 5, 3, 4, 5	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/16/2012

Notes:

JAG 4/17/12

Entries made by:	JAG	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	Signature on file with Original 4/17/2012	Signature/date	Signature on file with Original TI-WTPSP-084 7/10/2012

Rev. 0

31-Jul-06

TRACER GAS TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	GT-4
Date	4/17/2012	Fan Configuration	Fan B
Testers	JAG, YFS	Fan Setting	8.0 Hz
Stack Dia.	11.938 in.	Stack Temp	64.7 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	1454 / 1605
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppm SF6	Injection Point	1 Center

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppm				ppm			
1	0.50	3.85	3.94	3.74	**3.843**	3.78	3.86	3.86	**3.833**
2	1.24	3.86	3.84	3.90	**3.867**	3.79	3.91	3.84	**3.847**
3	2.29	3.80	3.81	3.81	**3.807**	4.00	3.80	3.87	**3.890**
4	3.82	3.77	3.74	3.77	**3.760**	3.67	3.75	3.88	**3.767**
Center	5.91	3.85	3.74	3.95	**3.847**	3.84	3.72	3.85	**3.803**
5	8.00	3.69	3.84	3.88	**3.803**	3.83	3.86	3.85	**3.847**
6	9.52	3.84	3.74	3.91	**3.830**	3.85	3.82	3.79	**3.820**
7	10.57	3.77	3.81	3.90	**3.827**	3.89	3.95	3.84	**3.893**
8	11.31	3.54	3.69	3.91	**3.713**	3.88	4.00	--	**3.940**
Averages ---->		**3.774**	**3.794**	**3.863**	**3.811**	**3.837**	**3.852**	**3.848**	**3.849**

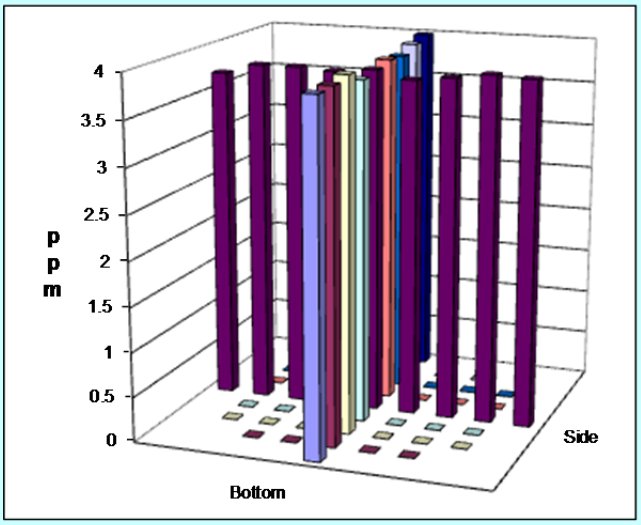
All	ppm	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	3.83		Mean	3.82	3.84	3.83
Min Point	3.71	-3.0%	Std. Dev.	0.03	0.05	0.04
Max Point	3.94	2.9%	COV as %	0.9	1.2	1.0

Avg. Conc. 3.830 ppm

Instruments Used:

B&K 1302 Gas Analyzer SN	1765299 Cat2 M&TE
TSI VelociCalc SN T95351203001	1/17/2013
Fisher Scientific SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	125	125	psig
Injection flowmeter	29.8	30.0	sccm
Stack Temp	65	64.4	°F
Mean stack velocity	386	380	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1009	1008	mbar
Ambient humidity	30	33	RH
Ambient Temp	67.1	63.5	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	5, 5, 3, 4, 5	6, 6, 4, 4, 4	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/16/2012

Notes:

4/17/12 JAG

Entries made by:	JAG	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	Signature on file with Original 4/17/2012	Signature/date	Signature on file with Original TI-WTPSP-084 7/10/2012

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06	Site	IHLW-S1 Model	Run No.	GT-5	
	Date	4/18/2012	Fan Configuration	Fan B only	
	Testers	XY, CA	Fan Setting	32	Hz
	Stack Dia.	11.938 in.	Stack Temp	63.1	deg F
	Stack X-Area	111.9 in.^{2}	Start/End Time	930/1100	
	Test Port	2	Center 2/3 from	1.10	to: 10.84
	Distance to disturbance	240 inches	Points in Center 2/3	2	to: 7
	Measurement units	ppb SF6	Injection Point	1 Center	

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	798	806	803	**802.33**	813	822	805	**813.33**
2	1.24	795	823	809	**809.00**	798	808	798	**801.33**
3	2.29	813	791	795	**799.67**	798	819	803	**806.67**
4	3.82	821	807	770	**799.33**	817	837	812	**822.00**
Center	5.91	821	795	793	**803.00**	796	811	816	**807.67**
5	8.00	791	808	816	**805.00**	806	815	812	**811.00**
6	9.52	806	809	810	**808.33**	800	832	820	**817.33**
7	10.57	787	822	789	**799.33**	813	808	792	**804.33**
8	11.31	808	807	826	**813.67**	801	808	819	**809.33**
Averages ---->		**804.44**	**807.56**	**801.22**	**804.41**	**804.67**	**817.78**	**808.56**	**810.33**

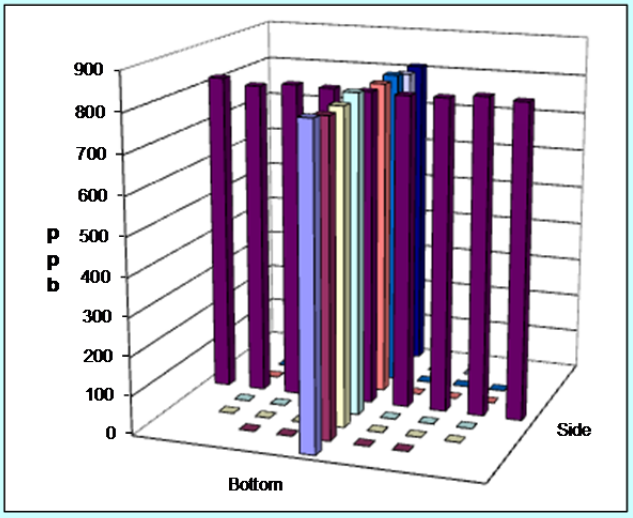
All	ppb	Dev. from mean	***Center 2/3***	Side	Bottom	All
Mean	807.37		Mean	803.38	810.05	806.71
Min Point	799.33	-1.0%	Std. Dev.	4.19	7.33	6.70
Max Point	822.00	1.8%	COV as %	0.5	0.9	**0.8**

Avg. Conc. 807.625 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN	1765299	Cat2 M&TE
TSI VelociCalc	SN	T95351203001	1/17/2013
Fisher Scientific	SN	90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	100	125	psig
Injection flowmeter	30	30	sccm
Stack Temp	58.5	67.7	°F
Mean stack velocity	1754	1744	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1005	1005	mbar
Ambient humidity	46%	36%	RH
Ambient Temp	57.2	66.2	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	7,9,5,7,7	13,18,15,9,12	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/16/2012 CA 4/18/12

Notes:

CA 4/18/12

Entries made by: CA, XY 4/18/12
Signature/date

Technical Data Review performed by: Elizabeth Golovich
Signature/date Signature on file with Original TI-WTPSP-084 7/10/2012

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	IHLW-S1 Model	Run No.	GT-6
Date	4/18/2012	Fan Configuration	Fan A only
Testers	XY, CA	Fan Setting	35 Hz
Stack Dia.	11.938 in.	Stack Temp	68 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	11:05/12:30
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	1 Center

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	834	828	824	828.67	820	794	814	809.33
2	1.24	850	833	815	832.67	813	790	789	797.33
3	2.29	806	843	843	830.67	814	862	821	832.33
4	3.82	819	810	802	810.33	856	830	809	831.67
Center	5.91	845	840	820	835.00	799	809	811	806.33
5	8.00	811	838	843	830.67	833	793	809	811.67
6	9.52	815	800	849	821.33	812	828	832	824.00
7	10.57	851	843	835	843.00	844	849	809	834.00
8	11.31	810	839	843	830.67	811	805	824	813.33
Averages ---->		826.78	830.44	830.44	829.22	822.44	817.78	813.11	817.78

All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	823.50		Mean	829.10	819.62	824.36
Min Point	797.33	-3.2%	Std. Dev.	10.47	14.54	13.13
Max Point	843.00	2.4%	COV as %	1.3	1.8	1.6

Avg. Conc. 823.854 ppb

Instruments Used:

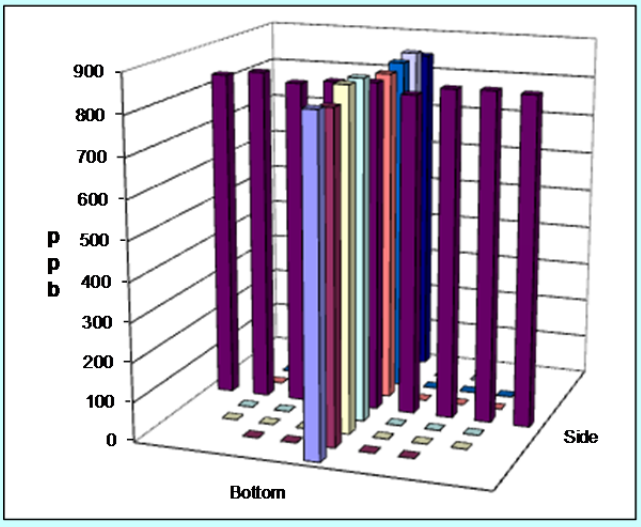
B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	125	125	psig
Injection flowmeter	30	30	sccm
Stack Temp	67.3	68.7	°F
Mean stack velocity	1906	1986	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1005	1005	mbar
Ambient humidity	38%	27%	RH
Ambient Temp	63.5	77.0	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	12, 7, 11, 6, 10	9, 11, 12, 12, 8	ppb
No. Bk-Gd samples	5	5	n

Gas analyzer checked: 4/16/2012 CA 4/18/12

Notes:

CA 4/18/12



Entries made by: CA, XY 4/18/12
Signature/date

Technical Data Review performed by: Elizabeth Golovich
Signature/date Signature on file with Original TI-WTPSP-084 7/10/2012

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	IHLW-S1 Model	Run No.	GT-7
Date	4/18/2012	Fan Configuration	Fan B Only
Testers	YFS, ES	Fan Setting	37 Hz
Stack Dia.	11.938 in.	Stack Temp	71.6 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	1313 / 1435
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C Far Wall

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	683	683	675	680.33	689	688	680	685.67
2	1.24	637	702	662	667.00	670	680	654	668.00
3	2.29	658	667	673	666.00	674	657	656	662.33
4	3.82	684	633	669	662.00	667	674	662	667.67
Center	5.91	678	668	645	663.67	679	678	627	661.33
5	8.00	671	677	676	674.67	666	656	650	657.33
6	9.52	673	669	658	666.67	666	689	660	671.67
7	10.57	668	661	633	654.00	688	672	659	673.00
8	11.31	667	680	639	662.00	677	668	667	670.67
Averages ---->		668.78	671.11	658.89	666.26	675.11	673.56	657.22	668.63

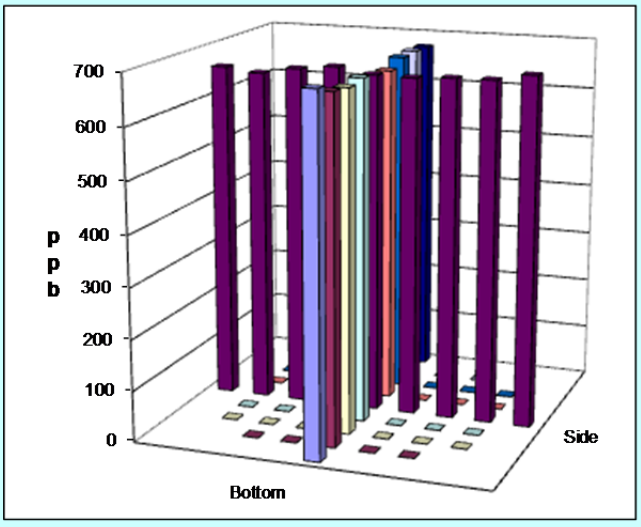
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	667.44		Mean	664.86	665.90	665.38
Min Point	654.00	-2.0%	Std. Dev.	6.23	5.75	5.78
Max Point	685.67	2.7%	COV as %	0.9	0.9	0.9

Avg. Conc. 668.063 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	200	200	psig
Injection flowmeter	30	30	sccm
Stack Temp	69.5	73.7	°F
Mean stack velocity	2210	2207	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1005	1005	mbar
Ambient humidity	29%	27%	RH
Ambient Temp	75	75	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas			ppb
	3, 6, 4, 4, 2	7, 5, 3, 2, -1	
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/16/2012

Notes:

EA 4/18/12

Entries made by:	EA	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	Signature on file with Original 4/18/2012	Signature/date	Signature on file with Original TI-WTPSP-084 7/10/2012

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	IHLW-S1 Model	Run No.	GT-8
Date	4/18/2012	Fan Configuration	Fan B Only
Testers	YFS, ES	Fan Setting	37 Hz
Stack Dia.	11.938 in.	Stack Temp	72.05 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	1440 / 1540
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C Near Wall

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	684	701	691	692.00	655	692	694	680.33
2	1.24	658	698	677	677.67	675	701	705	693.67
3	2.29	671	708	689	689.33	679	689	681	683.00
4	3.82	681	668	674	674.33	686	693	663	680.67
Center	5.91	682	669	703	684.67	676	711	688	691.67
5	8.00	680	687	665	677.33	670	683	662	671.67
6	9.52	698	685	661	681.33	681	679	652	670.67
7	10.57	682	686	681	683.00	659	678	684	673.67
8	11.31	682	672	684	679.33	672	650	639	653.67
Averages ---->		679.78	686.00	680.56	682.11	672.56	686.22	674.22	677.67

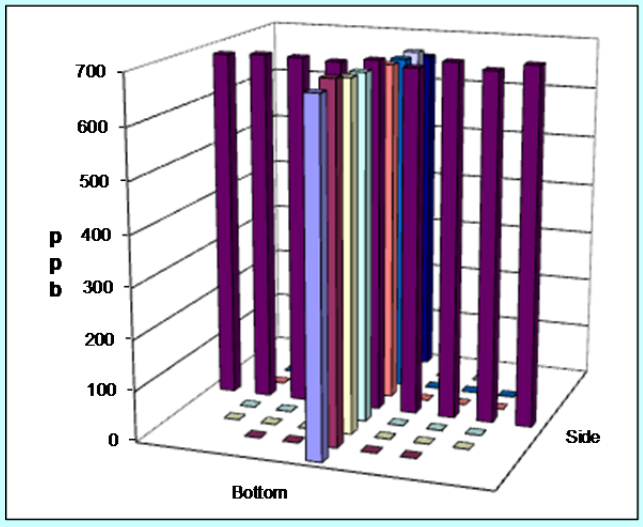
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	679.89		Mean	681.10	680.71	680.90
Min Point	653.67	-3.9%	Std. Dev.	5.10	9.36	7.24
Max Point	693.67	2.0%	COV as %	0.7	1.4	1.1

Avg. Conc. 678.854 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN	1765299 Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	200	200	psig
Injection flowmeter	30	30	sccm
Stack Temp	73.7	70.4	°F
Mean stack velocity	2267	2254	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1005	1004	mbar
Ambient humidity	28%	28%	RH
Ambient Temp	73	71	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	3, 4, 3, -0.7, -0.4	3, -1, 3, 3, 0.4	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/16/2012

Notes:

EA 4/18/12

Entries made by:	EA & YFS	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	Signature on file with Original 4/18/2012	Signature/date	Signature on file with Original TI-WTPSP-084 7/10/2012

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	IHLW-S1 Model	Run No.	GT-9
Date	4/19/2012	Fan Configuration	Fan B Only
Testers	CA, JEF	Fan Setting	37 Hz
Stack Dia.	11.938 in.	Stack Temp	57.3 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	0820 / 0939
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	Center Bottom

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	682	726	653	687.00	751	658	660	689.67
2	1.24	639	741	645	675.00	697	602	709	669.33
3	2.29	686	685	676	682.33	690	717	698	701.67
4	3.82	741	703	648	697.33	713	686	648	682.33
Center	5.91	710	718	695	707.67	717	693	641	683.67
5	8.00	598	678	677	651.00	689	651	739	693.00
6	9.52	718	668	774	720.00	700	725	726	717.00
7	10.57	637	632	686	651.67	664	722	678	688.00
8	11.31	640	641	699	660.00	757	691	788	745.33
Averages ---->		672.33	688.00	683.67	681.33	708.67	682.78	698.56	696.67

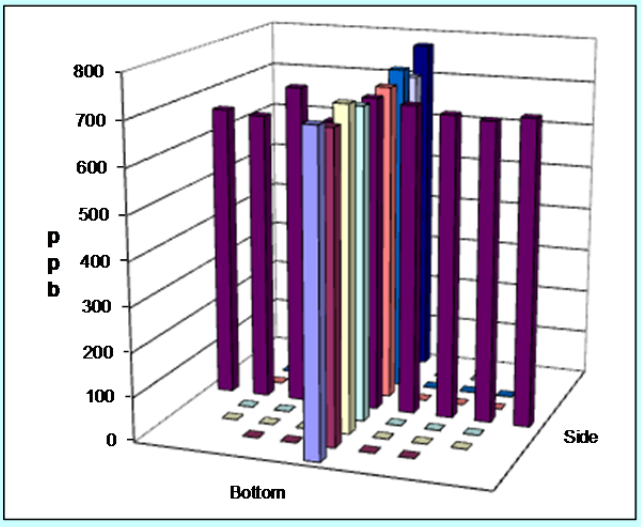
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	689.00		Mean	683.57	690.71	687.14
Min Point	651.00	-5.5%	Std. Dev.	26.62	15.28	21.18
Max Point	745.33	8.2%	COV as %	3.9	2.2	3.1

Avg. Conc. 688.167 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN	1765299 Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	10	10	psig
Injection flowmeter	30	30	sccm
Stack Temp	53.8	60.8	°F
Mean stack velocity	2169	2230	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1006	1007	mbar
Ambient humidity	48%	39%	RH
Ambient Temp	50.9	59.9	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	0.5, 2, 4, 6, 4	14, 14, 10, 11, 12	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/16/2012 CA 4/19/12

Notes: Tracer tank pressure appears very low, just barely of the zero bar, perhaps due to low air temperature.

JEF 4/19/12

Entries made by:	JEF, CA	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	Signatures on file with Original 4/19/2012	Signature/date	Signature on file with Original TI-WTPSP-084 7/10/2012

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	IHLW-S1 Model	Run No.	GT-10
Date	4/19/2012	Fan Configuration	Fan B Only
Testers	CA, JEF, XY	Fan Setting	37 Hz
Stack Dia.	11.938 in.	Stack Temp	61.45 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	0955 / 1108
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C TOP

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	773	689	690	717.33	678	727	627	677.33
2	1.24	654	672	704	676.67	644	696	653	664.33
3	2.29	704	708	702	704.67	625	729	705	686.33
4	3.82	651	630	688	656.33	606	692	622	640.00
Center	5.91	627	676	662	655.00	684	660	628	657.33
5	8.00	724	720	636	693.33	672	676	635	661.00
6	9.52	744	715	664	707.67	621	672	684	659.00
7	10.57	643	696	648	662.33	716	693	726	711.67
8	11.31	740	640	633	671.00	658	644	654	652.00
Averages ---->		695.56	682.89	669.67	682.70	656.00	687.67	659.33	667.67

All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	675.19		Mean	679.43	668.52	673.98
Min Point	640.00	-5.2%	Std. Dev.	22.57	23.39	22.80
Max Point	717.33	6.2%	COV as %	3.3	3.5	3.4

Avg. Conc. 677.563 ppb

Instruments Used:

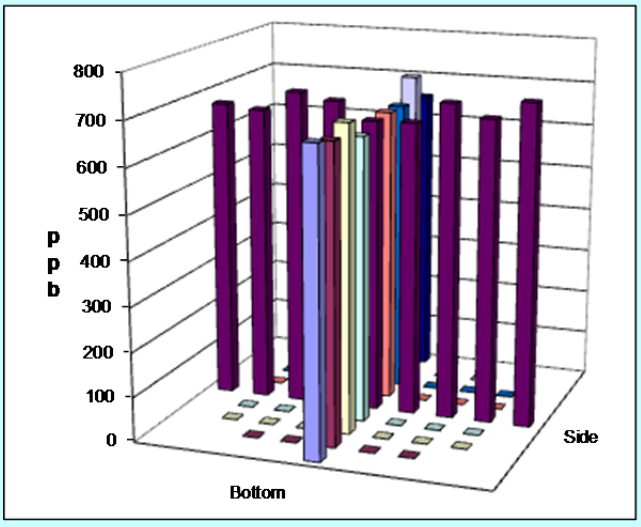
B&K 1302 Gas Analyzer	SN	1765299 Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	100	125	psig
Injection flowmeter	30	30	sccm
Stack Temp	58.9	64.0	°F
Mean stack velocity	2212	2218	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1007	1007	mbar
Ambient humidity	35%	32%	RH
Ambient Temp	63.5	67.1	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	14, 10, 11, 12, 8	7, 6, 14, 10, 10	ppb
No. Bk-Gd samples	5	5	n

Gas analyzer checked: 4/16/2012 CA 4/19/12

Notes:

CA 4/19/12



Entries made by:	CA, XY, JEF	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	Signatures on file with Original 4/19/2012	Signature/date	Signature on file with Original TI-WTPSP-084 7/10/2012

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	IHLW-S1 Model	Run No.	GT-11
Date	4/19/2012	Fan Configuration	Fan B Only
Testers	XY, CA	Fan Setting	37 Hz
Stack Dia.	11.938 in.	Stack Temp	64.15 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	1110 / 1220 / 1358
Test Port	1	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	300 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C TOP

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	709	680	661	683.33	722	651	675	682.67
2	1.24	673	696	693	687.33	645	728	655	676.00
3	2.29	718	685	692	698.33	681	688	652	673.67
4	3.82	756	657	673	695.33	635	650	636	640.33
Center	5.91	664	677	711	684.00	665	649	715	676.33
5	8.00	683	671	658	670.67	707	652	719	692.67
6	9.52	623	660	644	642.33	676	722	658	685.33
7	10.57	712	739	681	710.67	748	667	719	711.33
8	11.31	657	636	--	646.50	695	704	645	681.33
Averages ---->		688.33	677.89	676.63	679.83	686.00	679.00	674.89	679.96

All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	679.90		Mean	684.10	679.38	681.74
Min Point	640.33	-5.8%	Std. Dev.	22.25	21.64	21.23
Max Point	711.33	4.6%	COV as %	3.3	3.2	3.1

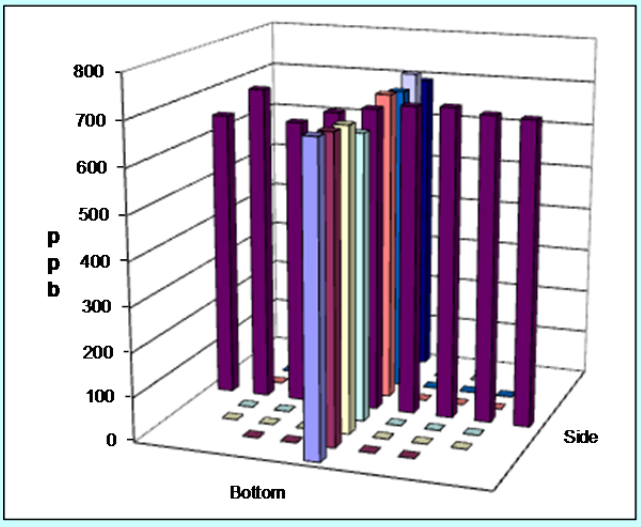
Avg. Conc. 679.865 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	125	125	psig
Injection flowmeter	30	30	sccm
Stack Temp	62.1	66.2	°F
Mean stack velocity	2358	2247	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1007	1008	mbar
Ambient humidity	32%	31%	RH
Ambient Temp	68.0	72.5	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	9,5,7,9,9	5, 4, -0.2, 2, 3	ppb
No. Bk-Gd samples	5	5	n

Gas analyzer checked: 4/16/2012 CA 4/19/12



Notes: Stop the test because of a power interruption.
CA 4/19/12
EA 4/19/12 Restarted test after power restored at 1340h.

Entries made by:	CA	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	Signature on file with Original 4/19/2012	Signature/date	Signature on file with Original TI-WTPSP-084 7/10/2012

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	IHLW-S1 Model	Run No.	GT-12
Date	4/20/2012	Fan Configuration	Fan B Only
Testers	CA, JEF, EA	Fan Setting	37 Hz
Stack Dia.	11.938 in.	Stack Temp	65.75 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	0810 / 0932
Test Port	1	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	300 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C Bottom

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	711	622	720	684.33	660	734	673	689.00
2	1.24	625	689	622	645.33	708	725	618	683.67
3	2.29	702	721	720	714.33	678	680	674	677.33
4	3.82	713	694	689	698.67	692	682	716	696.67
Center	5.91	650	634	648	644.00	726	645	613	661.33
5	8.00	674	714	723	703.67	684	719	617	673.33
6	9.52	698	711	714	707.67	703	706	718	709.00
7	10.57	671	693	685	683.00	676	734	687	699.00
8	11.31	742	655	653	683.33	687	664	722	691.00
Averages ---->		687.33	681.44	686.00	684.93	690.44	698.78	670.89	686.70

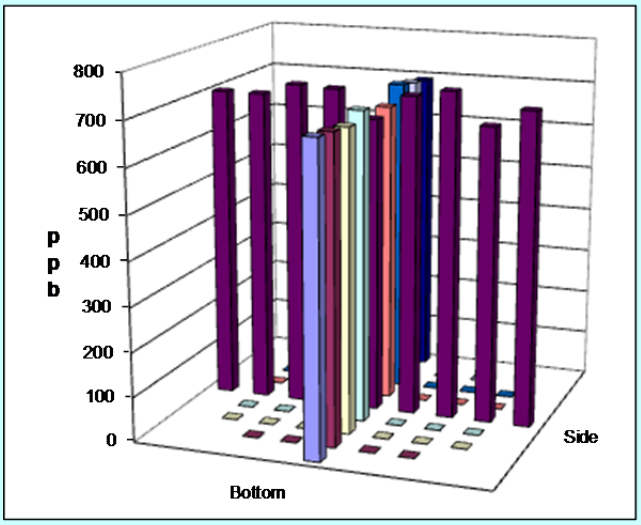
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	685.81		Mean	685.24	685.76	685.50
Min Point	644.00	-6.1%	Std. Dev.	29.35	16.64	22.92
Max Point	714.33	4.2%	COV as %	4.3	2.4	3.3

Avg. Conc. 689.958 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN	1765299 Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	10	100	psig
Injection flowmeter	30	30	sccm
Stack Temp	66.0	65.5	°F
Mean stack velocity	2195	2261	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1005	1005	mbar
Ambient humidity	46%	45%	RH
Ambient Temp	61.5	67.4	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	6, 2, 5, 3, 3	2, -3, -3, -5, -2	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/16/2012 CA 4/20/12

Notes:

EA, CA
4/20/2012

Entries made by:	EA CA	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	Signature on file with Original 4/20/2012	Signature/date	Signature on file with Original TI-WTPSP-084 7/10/2012

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	IHLW-S1 Model	Run No.	GT-13
Date	4/20/2012	Fan Configuration	Fan B Only
Testers	CA, EA	Fan Setting	37 Hz
Stack Dia.	11.938 in.	Stack Temp	68.25 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	0936 / 1035
Test Port	1	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	300 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C Near Wall

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	665	691	688	681.33	684	679	691	684.67
2	1.24	688	690	704	694.00	697	682	696	691.67
3	2.29	685	689	679	684.33	693	685	682	686.67
4	3.82	686	700	696	694.00	682	681	696	686.33
Center	5.91	689	696	673	686.00	701	676	690	689.00
5	8.00	680	679	691	683.33	704	697	687	696.00
6	9.52	683	685	678	682.00	682	692	671	681.67
7	10.57	689	713	678	693.33	685	692	686	687.67
8	11.31	694	684	686	688.00	689	693	690	690.67
Averages ---->		684.33	691.89	685.89	687.37	690.78	686.33	687.67	688.26

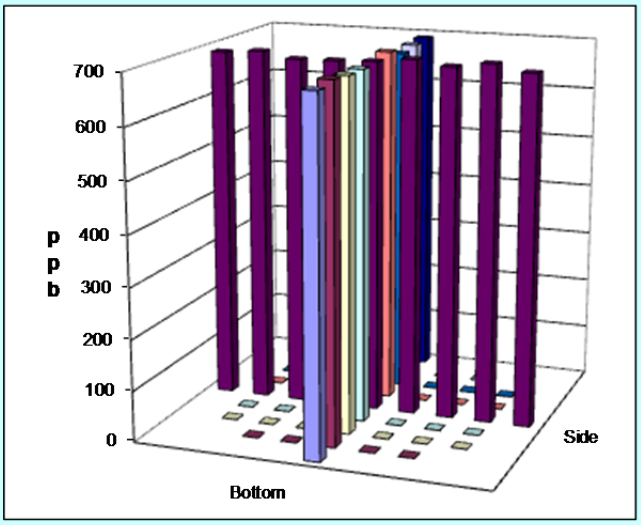
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	687.81		Mean	688.14	688.43	688.29
Min Point	681.33	-0.9%	Std. Dev.	5.41	4.51	4.79
Max Point	696.00	1.2%	COV as %	0.8	0.7	0.7

Avg. Conc. 687.854 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	100	100	psig
Injection flowmeter	30	30	sccm
Stack Temp	65.5	71.0	°F
Mean stack velocity	2261	2449	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1005	1005	mbar
Ambient humidity	45%	41%	RH
Ambient Temp	67.1	69.8	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	2, -3, -3, -5, -2	-4, -2, -2, 0.8, 1	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/16/2012 CA 4/20/12

Notes:

CA
4/20/2012

Entries made by:	EA CA	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	Signature on file with Original 4/20/2012	Signature/date	Signature on file with Original TI-WTPSP-084 7/10/2012

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	IHLW-S1 Model	Run No.	GT-14
Date	4/20/2012	Fan Configuration	Fan B Only
Testers	CA, EA	Fan Setting	37 Hz
Stack Dia.	11.938 in.	Stack Temp	69.35 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	1040 / 1138
Test Port	1	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	300 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C Far Wall

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	680	659	692	677.00	695	691	691	692.33
2	1.24	678	672	675	675.00	677	689	682	682.67
3	2.29	693	680	675	682.67	682	685	689	685.33
4	3.82	672	667	697	678.67	678	696	677	683.67
Center	5.91	671	682	701	684.67	692	684	698	691.33
5	8.00	676	691	691	686.00	683	669	692	681.33
6	9.52	676	681	686	681.00	693	681	684	686.00
7	10.57	675	687	693	685.00	691	682	694	689.00
8	11.31	678	681	682	680.33	676	678	680	678.00
Averages ---->		677.67	677.78	688.00	681.15	685.22	683.89	687.44	685.52

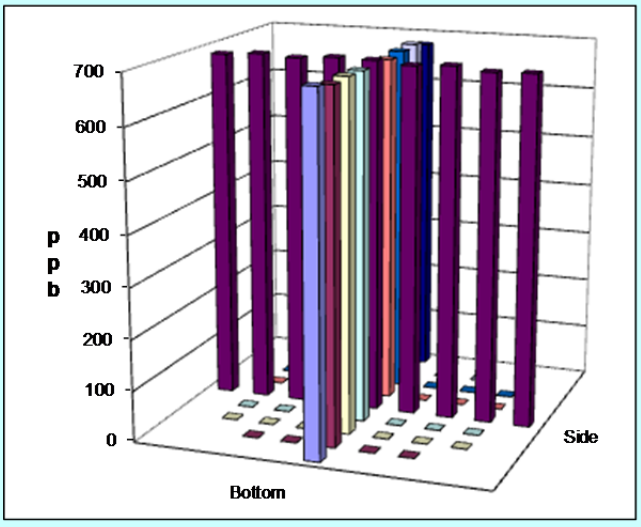
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	683.33		Mean	681.86	685.62	683.74
Min Point	675.00	-1.2%	Std. Dev.	3.95	3.54	4.10
Max Point	692.33	1.3%	COV as %	0.6	0.5	0.6

Avg. Conc. 682.75 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN	1765299 Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	100	100	psig
Injection flowmeter	30	30	sccm
Stack Temp	71.0	67.7	°F
Mean stack velocity	2449	2458	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1005	1005	mbar
Ambient humidity	41%	35%	RH
Ambient Temp	69.8	69.8	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	-4, -2, -2, 0.8, 1	4, -0.9, 0.1, 5, 0.2	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/16/2012 CA 4/20/12

Notes:

CA
4/20/2012

Entries made by:	EA CA	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	Signature on file with Original 4/20/2012	Signature/date	Signature on file with Original TI-WTPSP-084 7/10/2012

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	IHLW-S1 Model	Run No.	GT-15
Date	4/20/2012	Fan Configuration	Fan B Only
Testers	CA, EA	Fan Setting	37 Hz
Stack Dia.	11.938 in.	Stack Temp	66.8 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	1143 / 1241
Test Port	1	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	300 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C Center

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	679	700	692	690.33	682	682	684	682.67
2	1.24	696	684	701	693.67	680	680	680	680.00
3	2.29	686	683	701	690.00	700	679	698	692.33
4	3.82	696	702	685	694.33	705	688	694	695.67
Center	5.91	702	695	686	694.33	692	692	699	694.33
5	8.00	691	694	728	704.33	698	689	680	689.00
6	9.52	687	686	681	684.67	673	692	682	682.33
7	10.57	699	698	699	698.67	690	672	685	682.33
8	11.31	706	700	701	702.33	673	691	701	688.33
Averages ---->		693.56	693.56	697.11	694.74	688.11	685.00	689.22	687.44

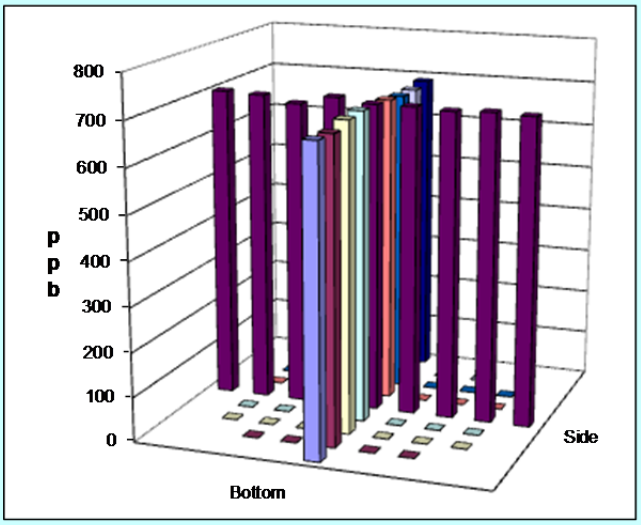
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	691.09		Mean	694.29	688.00	691.14
Min Point	680.00	-1.6%	Std. Dev.	6.21	6.41	6.89
Max Point	704.33	1.9%	COV as %	0.9	0.9	1.0

Avg. Conc. 690.688 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN	1765299 Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	100	100	psig
Injection flowmeter	30	30	sccm
Stack Temp	67.7	65.9	°F
Mean stack velocity	2458	2314	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1005	1006	mbar
Ambient humidity	35%	42%	RH
Ambient Temp	69.8	67.1	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	4, -0.9, 0.1, 5, 0.2	9, -2, -0.8, -2, 2	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/16/2012 CA 4/20/12

Notes:

CA
4/20/2012

Entries made by:	EA CA	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	Signature on file with Original 4/20/2012	Signature/date	Signature on file with Original TI-WTPSP-084 7/10/2012

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	IHLW-S1 Model	Run No.	GT-16
Date	4/20/2012	Fan Configuration	Fan B Only
Testers	XY, YFS	Fan Setting	35 Hz
Stack Dia.	11.938 in.	Stack Temp	70.8 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	1545/1705
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C Bottom

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	646	661	710	672.33	709	739	708	718.67
2	1.24	611	698	825	711.33	863	622	730	738.33
3	2.29	569	737	701	669.00	793	687	690	723.33
4	3.82	756	707	787	750.00	713	703	883	766.33
Center	5.91	575	697	737	669.67	650	699	713	687.33
5	8.00	592	855	741	729.33	645	782	740	722.33
6	9.52	695	665	678	679.33	689	656	545	630.00
7	10.57	678	838	808	774.67	746	683	770	733.00
8	11.31	814	693	687	731.33	615	710	688	671.00
Averages ---->		659.56	727.89	741.56	709.67	713.67	697.89	718.56	710.04

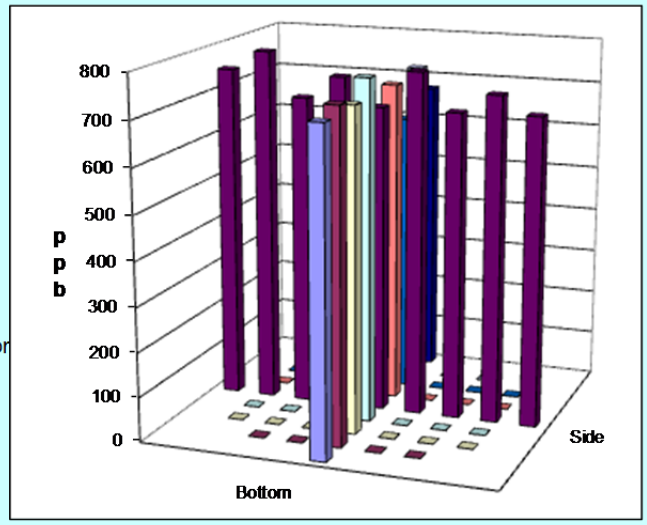
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	709.85		Mean	711.90	714.38	713.14
Min Point	630.00	-11.2%	Std. Dev.	41.59	44.00	41.15
Max Point	774.67	9.1%	COV as %	5.8	6.2	5.8

Avg. Conc. 713.771 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN	1765299 Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	125	125	psig
Injection flowmeter	30	30	sccm
Stack Temp	70.3	71.3	°F
Mean stack velocity	2068	2047	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	1007	1007	mbar
Ambient humidity	33%	33%	RH
Ambient Temp	72.5	72.5	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	4,4,0,0,-1	2,2,2,3,1	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/16/2012 XY 4/20/12

Notes: Redo of GT-9, first repeat. Injection point is C bottor
Light wind, overcast.

XY 4/20/12

Entries made by:	XY	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	Signature on file with Original 4/20/2012	Signature/date	Signature on file with Original TI-WTPSP-084 7/10/2012

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	IHLW-S1 Model	Run No.	GT-17
Date	4/23/20012	Fan Configuration	Fan B only
Testers	CA, EA, JEF	Fan Setting	37 Hz
Stack Dia.	11.938 in.	Stack Temp	77.25 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	845/ 958
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C Bottom

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	726	781	697	734.67	646	771	625	680.67
2	1.24	679	667	621	655.67	655	664	597	638.67
3	2.29	788	681	631	700.00	717	774	623	704.67
4	3.82	730	800	665	731.67	639	640	727	668.67
Center	5.91	697	666	660	674.33	743	676	669	696.00
5	8.00	703	629	661	664.33	728	684	666	692.67
6	9.52	660	724	627	670.33	699	619	693	670.33
7	10.57	661	742	663	688.67	696	673	641	670.00
8	11.31	636	683	621	646.67	676	640	625	647.00
Averages ---->		697.78	708.11	649.56	685.15	688.78	682.33	651.78	674.30

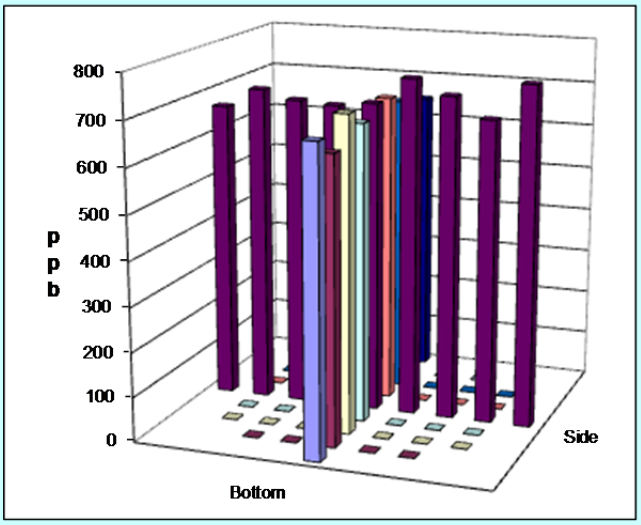
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	679.72		Mean	683.57	677.29	680.43
Min Point	638.67	-6.0%	Std. Dev.	25.88	22.37	23.47
Max Point	734.67	8.1%	COV as %	3.8	3.3	3.4

Avg. Conc. 679.042 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	125	125	psig
Injection flowmeter	30	30	sccm
Stack Temp	73	81.5	°F
Mean stack velocity	2213	2170	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	999	999	mbar
Ambient humidity	38%	39%	RH
Ambient Temp	79.7	76.1	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	2, -2, -1, -2, -0.7	3, .8, -4, 3, -3	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/23/2012 CA 4/23/12

Notes:

CA 4/23/12

Entries made by: EA, CA 4/23/2012
Signature/date

Technical Data Review performed by: Elizabeth Golovich
Signature/date Signature on file with Original
TI-WTPSP-084
7/10/2012

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	IHLW-S1 Model	Run No.	GT-18
Date	4/3/2012	Fan Configuration	Fan B only
Testers	CA, EA, JEF	Fan Setting	37 Hz
Stack Dia.	11.938 in.	Stack Temp	83 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	1000/ 1100
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C Bottom

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	607	646	638	630.33	711	715	730	718.67
2	1.24	729	723	657	703.00	613	717	722	684.00
3	2.29	682	666	686	678.00	657	630	688	658.33
4	3.82	621	675	611	635.67	724	639	692	685.00
Center	5.91	692	529	719	646.67	695	593	642	643.33
5	8.00	646	608	644	632.67	678	684	674	678.67
6	9.52	676	721	708	701.67	702	719	605	675.33
7	10.57	628	663	723	671.33	610	718	631	653.00
8	11.31	667	569	759	665.00	647	667	709	674.33
Averages ---->		660.89	644.44	682.78	662.70	670.78	675.78	677.00	674.52

All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	668.61		Mean	667.00	668.24	667.62
Min Point	630.33	-5.7%	Std. Dev.	29.47	16.53	22.96
Max Point	718.67	7.5%	COV as %	4.4	2.5	3.4

Avg. Conc. 671.563 ppb

Instruments Used:

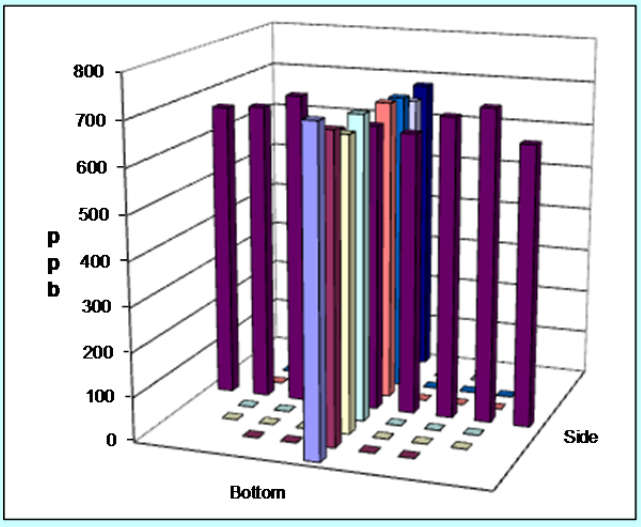
B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	125	250	psig
Injection flowmeter	30	30	sccm
Stack Temp	81.5	84.5	°F
Mean stack velocity	2170	2188	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	999	999	mbar
Ambient humidity	39%	36%	RH
Ambient Temp	76.1	77.9	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	3, 0.8, -4, 3, -3	10, 8, 6, 7, 7	ppb
No. Bk-Gd samples	5	5	n

Gas analyzer checked: 4/23/2014 CA 4/23/12

Notes: Mass flow controller set point at 30, but most of the test appeared to have 28-29sccm.

JEF 4/23/12



Entries made by: CA 4/23/2012
Signature/date

Technical Data Review performed by: Elizabeth Golovich
Signature/date Signature on file with Original TI-WTPSP-084
7/10/2012

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	IHLW-S1 Model	Run No.	GT-19
Date	4/18/2012	Fan Configuration	Fan B Only
Testers	XY, EA	Fan Setting	36 Hz
Stack Dia.	11.938 in.	Stack Temp	98.45 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	14:30/16:00
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	Center near wall

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	751	757	759	755.67	740	747	757	748.00
2	1.24	773	735	744	750.67	774	783	759	772.00
3	2.29	753	773	763	763.00	738	751	758	749.00
4	3.82	751	765	745	753.67	765	743	759	755.67
Center	5.91	775	762	770	769.00	773	769	762	768.00
5	8.00	756	765	760	760.33	755	764	746	755.00
6	9.52	753	772	759	761.33	776	765	741	760.67
7	10.57	744	755	774	757.67	742	763	758	754.33
8	11.31	761	751	769	760.33	750	758	745	751.00
Averages ---->		757.44	759.44	760.33	759.07	757.00	760.33	753.89	757.07

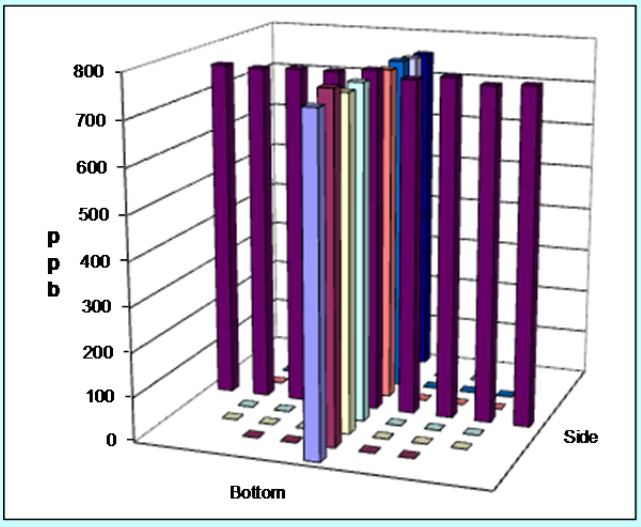
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	758.07		Mean	759.38	759.24	759.31
Min Point	748.00	-1.3%	Std. Dev.	6.08	8.18	6.92
Max Point	772.00	1.8%	COV as %	0.8	1.1	0.9

Avg. Conc. 756.771 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	375	375	psig
Injection flowmeter	30	30	sccm
Stack Temp	97.4	99.5	°F
Mean stack velocity	2129	2096	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	997	997	mbar
Ambient humidity	22%	22%	RH
Ambient Temp	92.3	90.5	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	-3,-1,-3,-1,2	3,4,-1,-1,4	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/23/2012 XY 4/23/12

Notes: Repeat of GT-8, injection at center, now is facing down stream. Hot, no wind. Checked the mass flow controller and set @ 30sccm and on mass.

XY 4/23/12

Entries made by:	XY, EA	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	Signature on file with Original 4/23/2012	Signature/date	Signature on file with Original TI-WTPSP-084 7/10/2012

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	IHLW-S1 Model	Run No.	GT-20
Date	4/23/2012	Fan Configuration	Fan B Only
Testers	XY, EA	Fan Setting	36 Hz
Stack Dia.	11.938 in.	Stack Temp	99.35 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	16:00/17:10
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	Center Far Wall

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	765	752	750	755.67	748	751	762	753.67
2	1.24	750	766	755	757.00	768	737	774	759.67
3	2.29	765	763	768	765.33	774	756	758	762.67
4	3.82	743	765	766	758.00	762	784	766	770.67
Center	5.91	750	756	755	753.67	765	760	741	755.33
5	8.00	733	747	776	752.00	776	751	773	766.67
6	9.52	776	765	784	775.00	758	772	758	762.67
7	10.57	766	752	767	761.67	780	778	764	774.00
8	11.31	747	753	768	756.00	761	762	769	764.00
Averages ---->		755.00	757.67	765.44	759.37	765.78	761.22	762.78	763.26

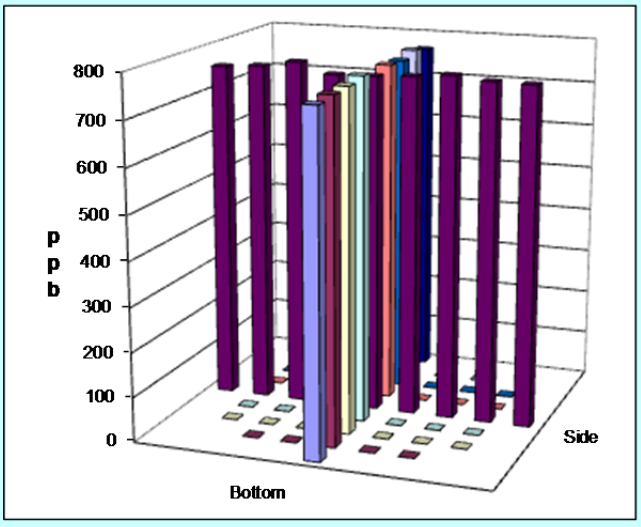
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	761.31		Mean	760.38	764.52	762.45
Min Point	752.00	-1.2%	Std. Dev.	7.88	6.42	7.23
Max Point	775.00	1.8%	COV as %	1.0	0.8	0.9

Avg. Conc. 762.167 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN	1765299	1765299 Cat2 M&TE
TSI VelociCalc	SN T95351203001		1/17/2013
Fisher Scientific	SN 90936818		12/7/2012

	Start	Finish	
Tracer tank pressure	375	375	psig
Injection flowmeter	30	30	sccm
Stack Temp	97.7	101.0	°F
Mean stack velocity	2111	2163	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	997	997	mbar
Ambient humidity	22%	20%	RH
Ambient Temp	90.5	90.5	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	3,4,-1,-1,4	6,8,2,3,8	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/23/2012 XY 4/23/12

Notes: Repeat of GT-7, injection at center far wall, bent facing downstream. Hot, no wind.

XY 4/23/12

Entries made by:	XY, EA	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	Signature on file with Original 4/23/2012	Signature/date	Signature on file with Original TI-WTPSP-084 7/10/2012

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	IHLW-S1 Model	Run No.	GT-21
Date	4/24/2012	Fan Configuration	Fan A Only
Testers	CA, JEF, XY	Fan Setting	34.5 Hz
Stack Dia.	11.938 in.	Stack Temp	75.65 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	8:31/10:02
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C Center

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	721	763	749	744.33	736	738	745	739.67
2	1.24	724	731	729	728.00	741	734	734	736.33
3	2.29	731	750	712	731.00	726	735	737	732.67
4	3.82	734	736	733	734.33	711	741	737	729.67
Center	5.91	732	753	727	737.33	726	743	743	737.33
5	8.00	746	739	735	740.00	740	740	736	738.67
6	9.52	737	741	734	737.33	745	741	746	744.00
7	10.57	752	760	746	752.67	753	745	743	747.00
8	11.31	744	740	749	744.33	740	737	730	735.67
Averages ---->		735.67	745.89	734.89	738.81	735.33	739.33	739.00	737.89

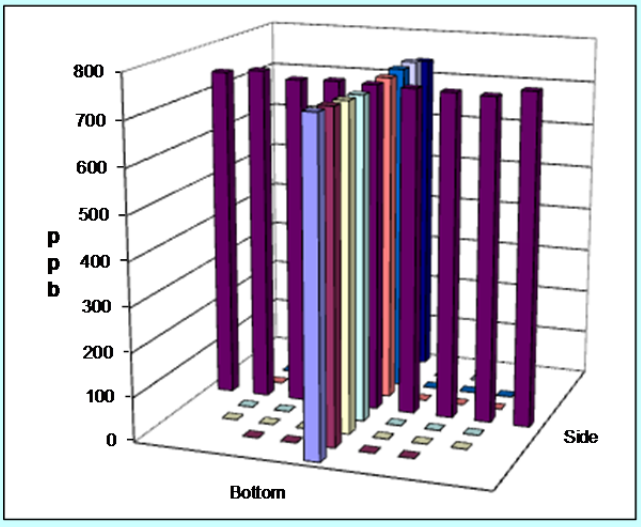
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	738.35		Mean	737.24	737.95	737.60
Min Point	728.00	-1.4%	Std. Dev.	7.94	6.04	6.79
Max Point	752.67	1.9%	COV as %	1.1	0.8	0.9

Avg. Conc. 738.479 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	125	125	psig
Injection flowmeter	25	25	sccm
Stack Temp	75.4	75.9	°F
Mean stack velocity	1614	1645	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	996	996	mbar
Ambient humidity	39%	53%	RH
Ambient Temp	75.2	71.6	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	-2, -6, -2, -5, -4	5,6,6,6,4	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/23/2012 CA 4/24/12

Notes: Light wind. Repeat GT-6.

Injection flow meter was reduced to 25 sccm.

XY 4/24/12

Entries made by:	CA, XY	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	Signature on file with Original 4/24/2012	Signature/date	Signature on file with Original TI-WTPSP-084 7/10/2012

Rev. 0

31-Jul-06

TRACER GAS TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	GT-22
Date	4/24/2012	Fan Configuration	Fan A Only
Testers	CA, XY	Fan Setting	39 Hz
Stack Dia.	11.938 in.	Stack Temp	78.5 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	10:05/11:20
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C Center

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	787	769	765	773.67	775	791	797	787.67
2	1.24	770	776	776	774.00	788	789	791	789.33
3	2.29	783	782	771	778.67	801	783	789	791.00
4	3.82	797	784	781	787.33	787	789	778	784.67
Center	5.91	774	767	780	773.67	778	805	799	794.00
5	8.00	782	768	782	777.33	783	789	784	785.33
6	9.52	788	759	790	779.00	782	778	798	786.00
7	10.57	770	774	777	773.67	787	809	787	794.33
8	11.31	777	774	773	774.67	798	815	796	803.00
Averages ---->		780.89	772.56	777.22	776.89	786.56	794.22	791.00	790.59

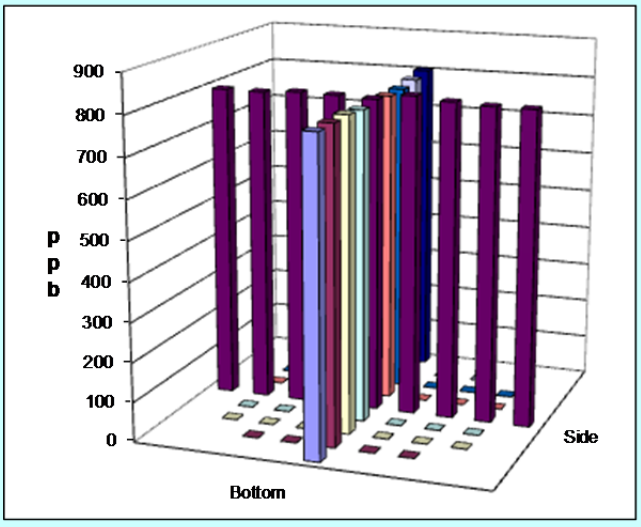
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	783.74		Mean	777.67	789.24	783.45
Min Point	773.67	-1.3%	Std. Dev.	4.86	4.05	7.38
Max Point	803.00	2.5%	COV as %	0.6	0.5	0.9

Avg. Conc. 783.729 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	250	250	psig
Injection flowmeter	30	30	sccm
Stack Temp	75.0	82.0	°F
Mean stack velocity	2011	1983	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	997	997	mbar
Ambient humidity	53%	45%	RH
Ambient Temp	70.7	75.2	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	-8,1,6,-5,-1	4,6,1,2,2	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/23/2012 CA 4/24/12

Notes: Repeat GT-2.

CA 4/24/12

Entries made by:	CA, XY	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	Signature on file with Original 4/24/2012	Signature/date	Signature on file with Original TI-WTPSP-084 7/10/2012

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	IHLW-S1 Model	Run No.	GT-23
Date	4/24/2012	Fan Configuration	Fan A Only
Testers	XY, CA	Fan Setting	10 Hz
Stack Dia.	11.938 in.	Stack Temp	81.7 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	11:30/12:58
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C Center

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	1000	903	1060	987.67	1000	925	968	964.33
2	1.24	914	990	924	942.67	958	958	908	941.33
3	2.29	1040	954	1000	998.00	960	917	989	955.33
4	3.82	937	974	1010	973.67	996	970	949	971.67
Center	5.91	932	975	977	961.33	968	834	910	904.00
5	8.00	1060	1100	900	1020.00	1030	873	890	931.00
6	9.52	959	941	884	928.00	990	875	920	928.33
7	10.57	841	900	894	878.33	855	948	925	909.33
8	11.31	977	1010	902	963.00	920	926	921	922.33
Averages ---->		962.22	971.89	950.11	961.41	964.11	914.00	931.11	936.41

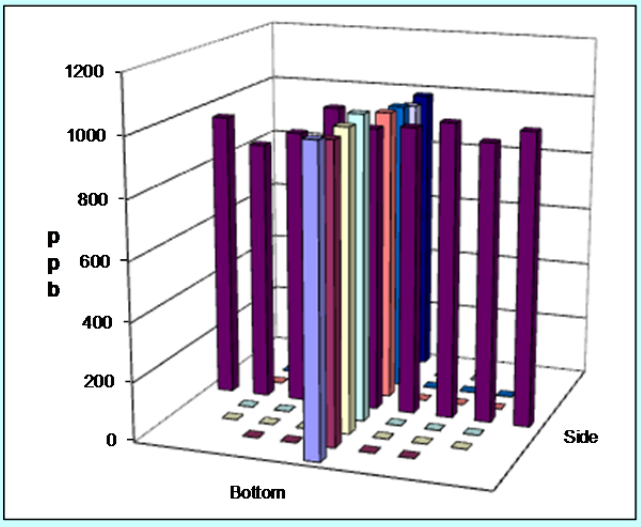
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	948.91		Mean	957.43	934.43	945.93
Min Point	878.33	-7.4%	Std. Dev.	46.87	24.07	37.73
Max Point	1020.00	7.5%	COV as %	4.9	2.6	4.0

Avg. Conc. 950.938 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	250	250	psig
Injection flowmeter	7.5	7.5	sccm
Stack Temp	79.4	84.0	°F
Mean stack velocity	409	402	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	997	997	mbar
Ambient humidity	42%	39%	RH
Ambient Temp	76.1	77.9	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	15, 15, 10, 13, 11	8,8,8,6,2	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/23/2012 CA 4/24/12

Notes: Repeat GT-3.

CA 4/24/12

Entries made by:	CA, XY	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	Signature on file with Original 4/24/2012	Signature/date	Signature on file with Original TI-WTPSP-084 7/10/2012

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	IHLW-S1 Model	Run No.	GT-24
Date	4/24/2012	Fan Configuration	Fan B Only
Testers	EA, YFS	Fan Setting	8 Hz
Stack Dia.	11.938 in.	Stack Temp	87.2 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	1410 / 1525
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C Center

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	924	971	1160	1018.33	944	1160	1120	1074.67
2	1.24	897	897	1130	974.67	1060	1110	1090	1086.67
3	2.29	931	990	1070	997.00	1000	1060	1290	1116.67
4	3.82	984	1010	1050	1014.67	1020	1020	1090	1043.33
Center	5.91	996	985	999	993.33	1090	1010	984	1028.00
5	8.00	969	1090	1020	1026.33	859	1230	1060	1049.67
6	9.52	891	975	904	923.33	988	1090	957	1011.67
7	10.57	868	993	1050	970.33	1220	911	1020	1050.33
8	11.31	1010	1080	926	1005.33	1110	1150	1390	1216.67
Averages ---->		941.11	999.00	1034.33	991.48	1032.33	1082.33	1111.22	1075.30

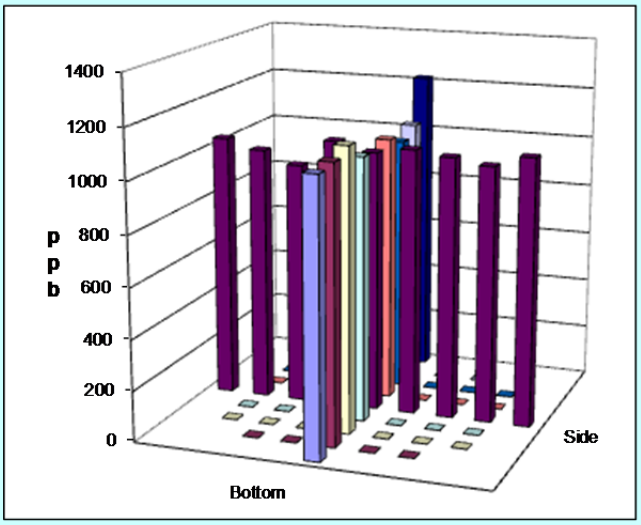
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	1033.39		Mean	985.67	1055.19	1020.43
Min Point	923.33	-10.6%	Std. Dev.	33.97	35.59	49.18
Max Point	1216.67	17.7%	COV as %	3.4	3.4	4.8

Avg. Conc. 1036.229 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	200	200	psig
Injection flowmeter	7.5	7.5	sccm
Stack Temp	87.7	86.7	°F
Mean stack velocity	381	339	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	996	995	mbar
Ambient humidity	27%	22%	RH
Ambient Temp	83.3	84.2	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	7,13,10, 10, 12	2, 7, 8, 4, 4	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/23/2012 EA 4/24/12

Notes: Breezy conditions.
Repeat of GT-4.

EA 4/24/12

Entries made by:	YFS	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	Signature on file with Original 4/24/2012	Signature/date	Signature on file with Original TI-WTPSP-084 7/10/2012

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	IHLW-S1 Model	Run No.	GT-25
Date	4/24/2012	Fan Configuration	Fan B Only
Testers	YFS, EA	Fan Setting	32 Hz
Stack Dia.	11.938 in.	Stack Temp	87.15 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	1530/1637
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	C Center

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	881	876	904	887.00	912	915	899	908.67
2	1.24	842	905	857	868.00	879	874	870	874.33
3	2.29	895	913	898	902.00	895	884	881	886.67
4	3.82	862	908	888	886.00	895	886	893	891.33
Center	5.91	882	923	916	907.00	912	908	869	896.33
5	8.00	911	895	902	902.67	883	888	882	884.33
6	9.52	880	890	907	892.33	894	866	899	886.33
7	10.57	891	870	896	885.67	895	890	904	896.33
8	11.31	898	891	893	894.00	892	886	882	886.67
Averages ---->		882.44	896.78	895.67	891.63	895.22	888.56	886.56	890.11

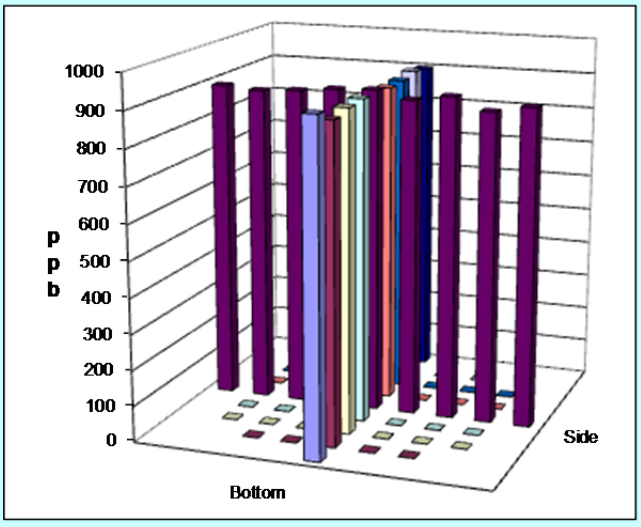
All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	890.87		Mean	891.95	887.95	889.95
Min Point	868.00	-2.6%	Std. Dev.	13.48	7.69	10.75
Max Point	908.67	2.0%	COV as %	1.5	0.9	1.2

Avg. Conc. 889.521 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	200	200	psig
Injection flowmeter	30	30	sccm
Stack Temp	86.7	87.6	°F
Mean stack velocity	1617	1616	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	995	995	mbar
Ambient humidity	22%	22%	RH
Ambient Temp	85.1	85.1	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	2,4,3,2,2	6,4,5,5,3	ppb
No. Bk-Gd samples	5	5	n



Gas analyzer checked: 4/23/2012 EA 4/24/12

Notes: Breezy conditions.

EA 4/24/12

Entries made by:	YFS	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	Signature on file with Original 4/24/2012	Signature/date	Signature on file with Original TI-WTPSP-084 7/10/2012

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	IHLW-S1 Model	Run No.	GT-26
Date	4/25/12	Fan Configuration	Fan B Only
Testers	XY, EA, CA	Fan Setting	10 Hz
Stack Dia.	11.938 in.	Stack Temp	76.65 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	10:00/11:30
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	1 Center

Order -->		1st				2nd			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	689	838	813	**780.00**	758	803	830	**797.00**
2	1.24	761	743	774	**759.33**	779	786	794	**786.33**
3	2.29	785	830	792	**802.33**	845	746	795	**795.33**
4	3.82	762	785	790	**779.00**	793	811	836	**813.33**
Center	5.91	745	819	784	**782.67**	780	796	800	**792.00**
5	8.00	776	816	796	**796.00**	765	755	841	**787.00**
6	9.52	721	724	851	**765.33**	776	786	781	**781.00**
7	10.57	742	765	807	**771.33**	794	774	808	**792.00**
8	11.31	810	776	763	**783.00**	744	796	806	**782.00**
Averages ---->		754.56	788.44	796.67	779.89	781.56	783.67	810.11	791.78

All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	785.83		Mean	779.43	792.43	785.93
Min Point	759.33	-3.4%	Std. Dev.	15.69	10.35	14.44
Max Point	813.33	3.5%	COV as %	2.0	1.3	1.8

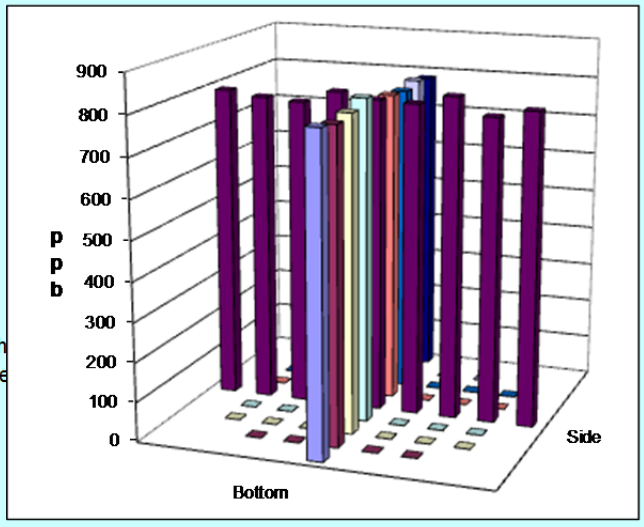
Avg. Conc. 785.646 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	125	125	psig
Injection flowmeter	7.5	7.5	sccm
Stack Temp	73.2	80.1	°F
Mean stack velocity	414	407	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	998	998	mbar
Ambient humidity	39%	28%	RH
Ambient Temp	71.6	84.2	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	4,5,4,5,4	12, 12, 9, 9, 13	ppb
No. Bk-Gd samples	5	5	n

Gas analyzer checked: 4/23/2012 4/25/12 XY



Notes: Additional 2 GT tests to cover the min. velocity of th
worst perfromance fan, B in this case. The velocity we will targe
is 392 fpm for this test. The next test will target at 831 fpm.
No wind.

XY 4/25/12

Entries made by:	XY, CA	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	Signature on file with Original 4/25/2012	Signature/date	Signature on file with Original TI-WTPSP-084 7/10/2012

Rev. 0

TRACER GAS TRAVERSE DATA FORM

31-Jul-06

Site	IHLW-S1 Model	Run No.	GT-27
Date	4/25/12	Fan Configuration	Fan B Only
Testers	XY, CA	Fan Setting	17.5 Hz
Stack Dia.	11.938 in.	Stack Temp	80.55 deg F
Stack X-Area	111.9 in.^{2}	Start/End Time	1135/1253
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	ppb SF6	Injection Point	1 Center

Order -->		2nd				1st			
Traverse-->		Side				Bottom			
Trial -->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	ppb				ppb			
1	0.50	849	928	849	875.33	836	887	830	851.00
2	1.24	868	845	891	868.00	854	836	859	849.67
3	2.29	859	849	821	843.00	838	844	851	844.33
4	3.82	902	866	882	883.33	872	857	805	844.67
Center	5.91	884	866	834	861.33	863	858	870	863.67
5	8.00	862	858	789	836.33	813	835	884	844.00
6	9.52	833	877	831	847.00	874	858	868	866.67
7	10.57	869	865	825	853.00	836	830	862	842.67
8	11.31	833	832	865	843.33	847	852	831	843.33
Averages ---->		862.11	865.11	843.00	856.74	848.11	850.78	851.11	850.00

All	ppb	Dev. from mean	*Center 2/3*	Side	Bottom	All
Mean	853.37		Mean	856.00	850.81	853.40
Min Point	836.33	-2.0%	Std. Dev.	16.15	10.09	13.21
Max Point	883.33	3.5%	COV as %	1.9	1.2	1.5

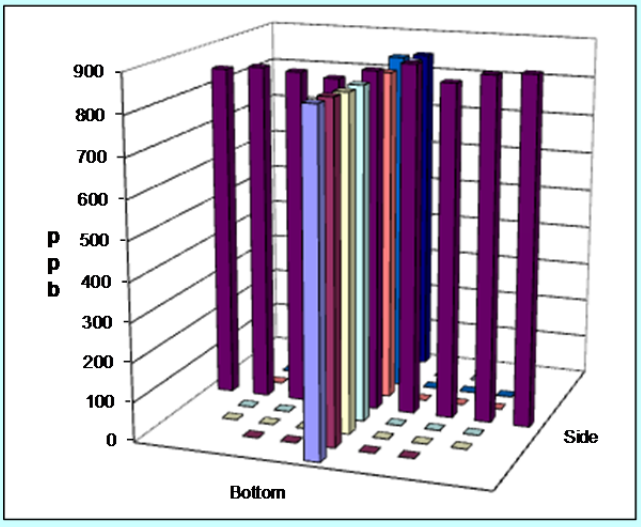
Avg. Conc. 852.229 ppb

Instruments Used:

B&K 1302 Gas Analyzer	SN 1765299	Cat2 M&TE
TSI VelociCalc	SN T95351203001	1/17/2013
Fisher Scientific	SN 90936818	12/7/2012

	Start	Finish	
Tracer tank pressure	225	225	psig
Injection flowmeter	15	15	sccm
Stack Temp	82.6	78.5	°F
Mean stack velocity	830	833	sfpm
Sampling flowmeter	5	5	lpm
Ambient pressure	997	996	mbar
Ambient humidity	29%	29%	RH
Ambient Temp	83.3	80.6	°F
B&K vapor correction	Y	Y	Y/N
Back-Gd gas	14, 12, 16, 12, 17	15, 16, 13, 13, 16	ppb
No. Bk-Gd samples	5	5	n

Gas analyzer checked: 4/23/2012 XY 4/25/12



Notes: This is the last additional GT test. The target flow will be 831 fpm.
No wind.

XY 4/25/12

Entries made by:	XY, CA	Technical Data Review performed by:	Elizabeth Golovich
Signature/date	Signature on file with Original 4/25/2012	Signature/date	Signature on file with Original TI-WTPSP-084 7/10/2012

C.5 IHLW-S1 Particle Tracer Uniformity Data Sheets

Rev. 0
3 Aug. 2006

PARTICLE TRACER TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	PT-1
Date	3/14/2012	Fan configuration	Fan A only
Tester	CA, XY, JEF	Fan Setting	42 Hz
Stack Dia.	11.938 in.	Stack Temp	49.45 deg F
Stack X-Area	111.9 in.2	Start/End Time	10:00/12:00
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	particles/ft3	Injection Point	Prt C Center
Order ---->	1st		2nd

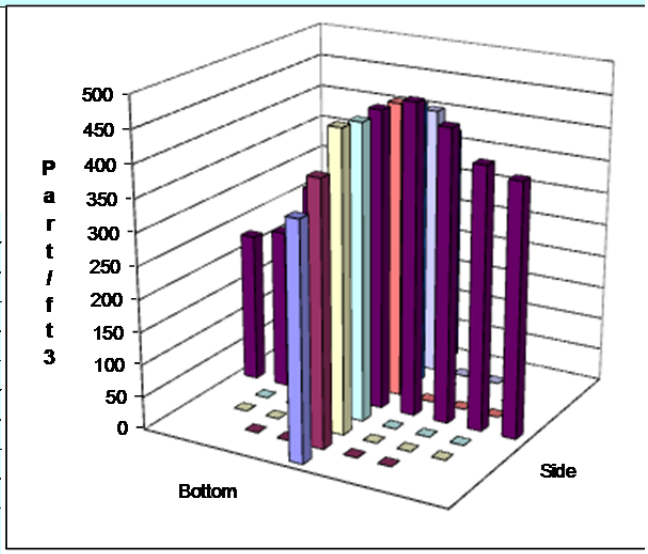
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	particles/ft3				particles/ft3			
1	0.50	442	317	400	386.3	298	346	288	310.7
2	1.24	500	312	390	400.7	329	367	344	346.7
3	2.29	561	363	415	446.3	393	406	387	395.3
4	3.82	556	428	441	475.0	408	400	363	390.3
Center	5.91	590	409	370	456.3	395	418	369	394.0
5	8.00	537	305	361	401.0	401	416	355	390.7
6	9.52	449	250	265	321.3	392	398	339	376.3
7	10.57	393	131	209	244.3	342	385	347	358.0
8	11.31	300	178	209	229.0	365	291	293	316.3
Averages ------>		480.9	299.2	340.0	373.4	369.2	380.8	342.8	364.3

All	pt/ft3	Dev. from mean	*Center 2/3*	Side	Bottom	All	Normlzd
Mean	368.8		Mean	392.1	378.8	385.5	415.41
Min Point	229.0	-37.9%	Std. Dev.	82.6	19.4	58.1	62.96
Max Point	475.0	28.8%	COV as %	21.1	5.1	15.1	15.16

Avg Conc 362 pt/ft3

	Start	Finish	
Generator Inlet Press	7.6	7.5	psig
Stack Temp	47.4	51.5	F
Mean vel.	2011	2055	sfpm
Ambient pressure	29.59	29.3	inHg
Ambient humidity	46%	37%	RH
Ambient temp	52.7	57.2	F
Back-Gd aerosol	3,2,3,2	5,3,3,0	pt/ft3
No. Bk-Gd samples	4	4	
Compressor output	175	120	psig

Instuments Used:		Cal. Due
TSI VelciCalc	T95351203001	12/17/2012
Fisher Scientific	90936818	12/7/2012
Met One OPC	1011529010	2/1/2013
Met One OPC	1011529009	1/9/2013



Notes:
Unit 1 for sample and unit 0 for reference. XY 3/14/12
Reference set at Port 1 center at bottom.

JEF 3/14/12

Oil Used: Edwards
Ref. Probe Location: Port 1, center bottom
Probe Type / Configuration:
L-shaped probe

Entries made by: CA, XY
Signature/date 3/14/2012

Technical Data Review performed by: RL Aaberg
Signature/date Signature on file with original
TI-WTPSP-085 6/15/2012

Rev. 0

3 Aug. 2006

PARTICLE TRACER TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	PT-2
Date	3/15/2012	Fan configuration	Fan B only
Tester	CA, XY	Fan Setting	36 Hz
Stack Dia.	11.938 in.	Stack Temp	62.6 deg F
Stack X-Area	111.9 in.2	Start/End Time	9:55/12:00
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	particles/ft3	Injection Point	Prt C Center
Order ——>	2nd		1st

Traverse-->	Side				Bottom			
Trial ——>	1	2	3	Mean	1	2	3	Mean
Point / Depth, in.	particles/ft3				particles/ft3			
1 / 0.50	890	1020	987	965.7	868	787	959	871.3
2 / 1.24	877	1145	957	993.0	976	948	1042	988.7
3 / 2.29	770	1135	1215	1040.0	1116	1045	1195	1118.7
4 / 3.82	992	1414	1258	1221.3	1192	1069	1206	1155.7
Center / 5.91	1085	1273	1263	1207.0	1245	1158	1317	1240.0
5 / 8.00	1081	1303	1237	1207.0	1142	1076	1290	1169.3
6 / 9.52	1108	1223	1164	1165.0	1028	1110	1213	1117.0
7 / 10.57	1016	1187	1020	1074.3	913	897	1091	967.0
8 / 11.31	992	930	871	931.0	866	794	935	865.0
Averages ——>	979.0	1181.1	1108.0	1089.4	1038.4	987.1	1138.7	1054.7

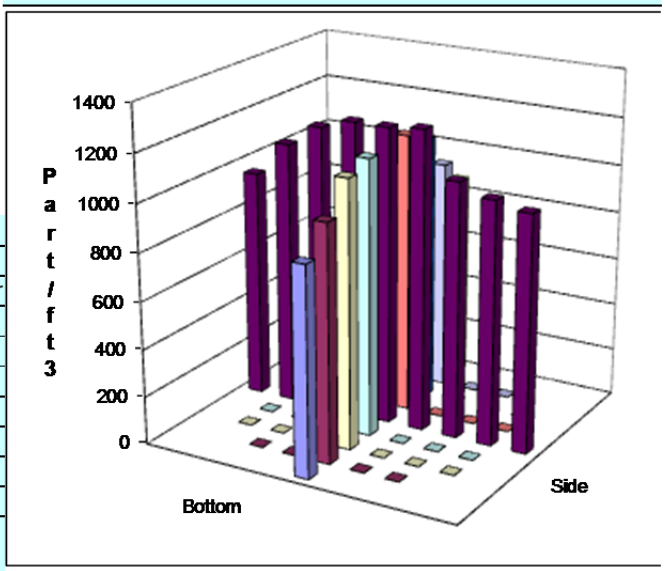
All	pt/ft3	Dev. from mean	*Center 2/3*	Side	Bottom	All	Normlzd
Mean	1072.1		Mean	1129.7	1108.0	1118.9	1134.30
Min Point	865.0	-19.3%	Std. Dev.	92.5	98.1	92.3	96.74
Max Point	1240.0	15.7%	COV as %	8.2	8.9	8.3	8.53

Avg Conc 1053 pt/ft3

	Start	Finish	
Generator Inlet Press	3.9	3.85	psig
Stack Temp	60.2	65.0	F
Mean vel.	2179	1991	sfpm
Ambient pressure	994	994	mbar
Ambient humidity	44%	41%	RH
Ambient temp	59.9	65.3	F
Back-Gd aerosol	5,3,3,3	3,3,3,5	pt/ft3
No. Bk-Gd samples	4	4	
Compressor output	105	115	psig

Instuments Used:

		Cal. Due
TSI VelciCalc	T95351203001	12/17/2012
Fisher Scientific	90936818	12/7/2012
Met One OPC	1011529010	2/1/2013
Met One OPC	1011529009	1/9/2013



Notes:

Unit 1 for sample and unit 0 for reference. XY 3/15/12

Reference set at Port 1 center at bottom.

Oil Used: Edwards

Ref. Probe Location: Port 1, center bottom

Probe Type / Configuration:

L-shaped probe

Entries made by: CA, XY

Signature/date 3/15/2012

Technical Data Review performed by: RL Aaberg

Signature/date Signature on file with original

TI-WTPSP-085 6/15/2012

Rev. 0

3 Aug. 2006

PARTICLE TRACER TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	PT-3
Date	3/16/2012	Fan configuration	FAN A ONLY
Tester	CA, EA, XY	Fan Setting	8 Hz
Stack Dia.	11.938 in.	Stack Temp	62.9 deg F
Stack X-Area	111.9 in.2	Start/End Time	11:00 /1:31
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	particles/ft3	Injection Point	Port C Center
Order ——>	1st		2nd

Traverse-->	Side				Bottom			
Trial ——>	1	2	3	Mean	1	2	3	Mean
Point / Depth, in.	particles/ft3				particles/ft3			
1 / 0.50	326	494	843	554.3	535	1292	735	854.0
2 / 1.24	308	677	529	504.7	652	603	542	599.0
3 / 2.29	311	956	1547	938.0	442	588	624	551.3
4 / 3.82	448	832	997	759.0	588	586	716	630.0
Center / 5.91	570	930	950	816.7	613	492	320	475.0
5 / 8.00	576	594	768	646.0	323	417	263	334.3
6 / 9.52	328	418	882	542.7	164	85	369	206.0
7 / 10.57	575	652	361	529.3	194	273	51	172.7
8 / 11.31	444	407	542	464.3	315	94	127	178.7
Averages ——>	431.8	662.2	824.3	639.4	425.1	492.2	416.3	444.6

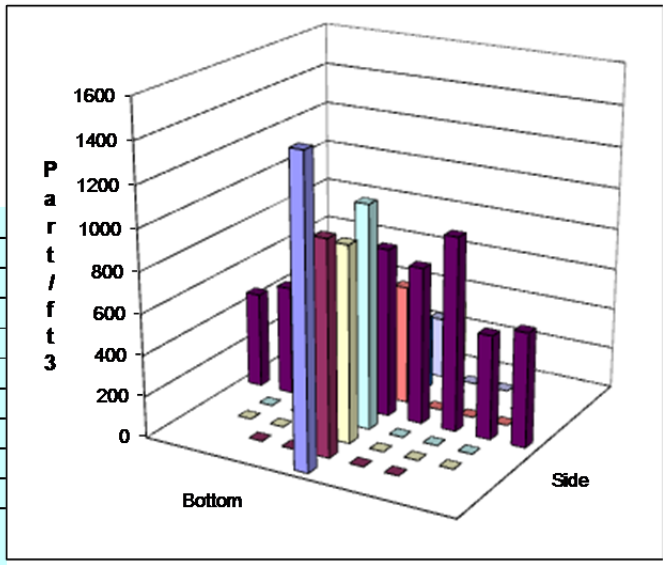
All	pt/ft3	Dev. from mean	*Center 2/3*	Side	Bottom	All	Normlzd
Mean	542.0		Mean	676.6	424.0	550.3	702.84
Min Point	172.7	-68.1%	Std. Dev.	165.8	187.4	214.6	247.61
Max Point	938.0	73.1%	COV as %	24.5	44.2	39.0	35.23

Avg Conc 529 pt/ft3

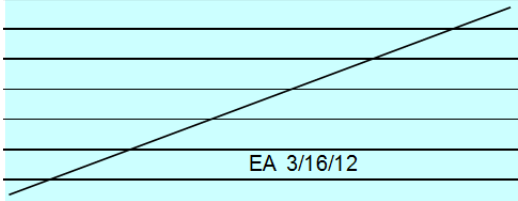
	Start	Finish	
Generator Inlet Press	0.85	0.9	psig
Stack Temp	61	64.8	F
Mean vel.	279	140	sfpm
Ambient pressure	995	995	mbar
Ambient humidity	30%	28%	RH
Ambient temp	64.4	65.3	F
Back-Gd aerosol	45, 48,24,30	30,48,39,8	pt/ft3
No. Bk-Gd samples	4	4	
Compressor output	110	110	psig

Instuments Used:

		Cal. Due
TSI VelciCalc	T95351203001	12/17/2012
Fisher Scientific	90936818	12/7/2012
Met One OPC	1011529010	2/1/2013
Met One OPC	1011529009	1/9/2013



Notes: Generator pressure is increased 1.2



Oil Used: Edwards

Ref. Probe Location: Port 1, center bottom

Probe Type / Configuration:
L-shaped probe

Entries made by: Carmen Arimescu
Signature/date 3/16/2012

Technical Data Review performed by: RL Aaberg
Signature/date Signature on file with original
TI-WTPSP-085 6/15/2012

Rev. 0

3 Aug. 2006

PARTICLE TRACER TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	PT-4
Date	3/16/2012	Fan configuration	FAN B ONLY
Tester	CA, XY	Fan Setting	9 Hz
Stack Dia.	11.938 in.	Stack Temp	68.15 deg F
Stack X-Area	111.9 in.2	Start/End Time	1:40 / 3:10
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	particles/ft3	Injection Point	Port C Center
Order ——>	2nd		1st

Traverse-->	Side				Bottom			
Trial ——>	1	2	3	Mean	1	2	3	Mean
Point / Depth, in.	particles/ft3				particles/ft3			
1 / 0.50	172.7	178.7	165.7	172.4	121.5	118.5	160.6	133.5
2 / 1.24	161.6	163.7	155.6	160.3	146.6	189.8	152.6	163.0
3 / 2.29	177.7	148.6	166.7	164.3	160.6	186.7	145.6	164.3
4 / 3.82	155.6	163.7	169.7	163.0	160.6	169.7	148.6	159.6
Center / 5.91	176.7	185.7	180.7	181.0	170.7	171.7	156.6	166.3
5 / 8.00	224.9	165.7	190.8	193.8	161.6	153.6	141.6	152.3
6 / 9.52	159.6	175.6	141.6	158.9	147.6	141.6	141.6	143.6
7 / 10.57	151.6	145.6	159.5	152.2	148.6	115.5	137.6	133.9
8 / 11.31	131.5	148.0	126.4	135.3	135.5	129.5	128.5	131.2
Averages ——>	168.0	163.9	161.9	164.6	150.4	153.0	145.9	149.7

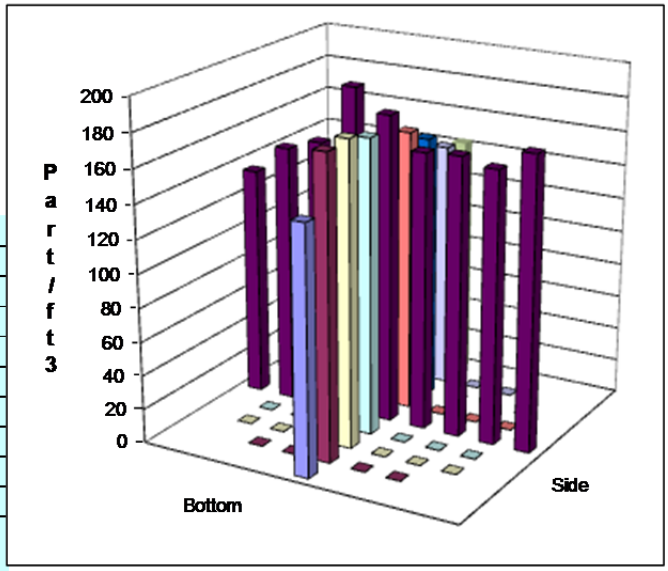
All	pt/ft3	Dev. from mean	*Center 2/3*	Side	Bottom	All	Normlzd
Mean	157.2		Mean	167.7	154.7	161.2	168.03
Min Point	131.2	-16.5%	Std. Dev.	14.5	12.1	14.5	13.33
Max Point	193.8	23.3%	COV as %	8.7	7.8	9.0	7.93

Avg Conc 155 pt/ft3

	Start	Finish	
Generator Inlet Press	0.9	0.85	psig
Stack Temp	66.7	69.6	F
Mean vel.	373	383	sfpm
Ambient pressure	995	994	mbar
Ambient humidity	27%	22%	RH
Ambient temp	69.8	76.1	F
Back-Gd aerosol	3, 3, 4, 0	1,1,1,0	pt/ft3
No. Bk-Gd samples	4	4	
Compressor output	110	110	psig

Instuments Used:

		Cal. Due
TSI VelciCalc	T95351203001	12/17/2012
Fisher Scientific	90936818	12/7/2012
Met One OPC	1011529010	2/1/2013
Met One OPC	1011529009	1/9/2013



Notes:

CA 3/16/2012

Oil Used: Edwards

Ref. Probe Location: Port 1, center bottom

Probe Type / Configuration:
L-shaped probe

Entries made by: Carmen Arimescu
Signature/date 3/16/2012

Technical Data Review performed by: RL Aaberg
Signature/date Signature on file with original
TI-WTPSP-085 6/15/2012

Rev. 0

3 Aug. 2006

PARTICLE TRACER TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	PT-5
Date	3/19/2012	Fan configuration	FAN B ONLY
Tester	CA, XY	Fan Setting	36 Hz
Stack Dia.	11.938 in.	Stack Temp	51.4 deg F
Stack X-Area	111.9 in.2	Start/End Time	9:45 / 13:00
Test Port	1	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	300 inches	Points in Center 2/3	2 to: 7
Measurement units	particles/ft3	Injection Point	Port C Center
Order --->	1st		2nd

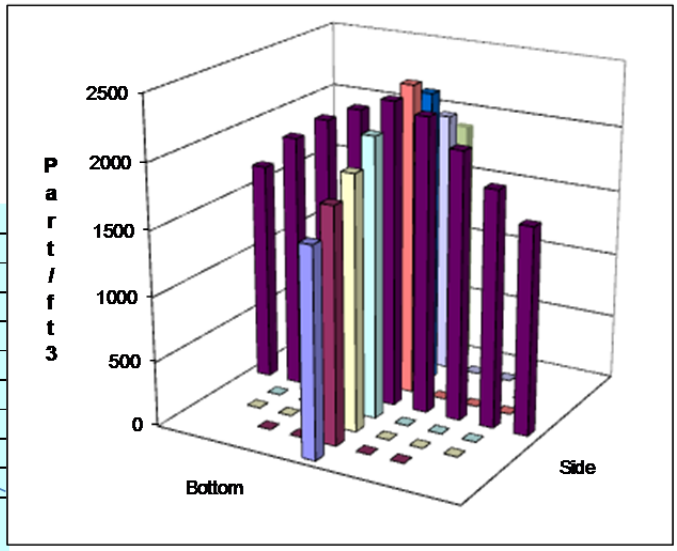
		Side				Bottom			
Traverse-->									
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	particles/ft3				particles/ft3			
1	0.50	1075	1291	1330	1232.0	1435	1692	1678	1601.7
2	1.24	1305	1405	1505	1405.0	1656	1837	1907	1800.0
3	2.29	1464	1669	1643	1592.0	1673	2071	2112	1952.0
4	3.82	1731	1806	1720	1752.3	1949	2151	2350	2150.0
Center	5.91	1729	1827	1874	1810.0	2137	2380	2495	2337.3
5	8.00	1713	1746	1733	1730.7	2321	2341	2514	2392.0
6	9.52	1550	1681	1695	1642.0	2224	2216	2351	2263.7
7	10.57	1479	1538	1495	1504.0	1974	2015	2078	2022.3
8	11.31	1387	1260	1255	1300.7	1774	1923	1908	1868.3
Averages ------>		1492.6	1580.3	1583.3	1552.1	1904.8	2069.6	2154.8	2043.0

All	pt/ft3	Dev. from mean	*Center 2/3*	Side	Bottom	All	Normlzd
Mean	1797.6		Mean	1633.7	2131.0	1882.4	2120.37
Min Point	1232.0	-31.5%	Std. Dev.	144.6	216.8	313.0	194.72
Max Point	2392.0	33.1%	COV as %	8.9	10.2	16.6	9.18

Avg Conc 1763 pt/ft3

	Start	Finish	
Generator Inlet Press	6.2	6.15	psig
Stack Temp	49.4	53.4	F
Mean vel.	2113	2095	sfpm
Ambient pressure	29.56	29.56	inHg
Ambient humidity	27%	28%	RH
Ambient temp	53.5	51.8	F
Back-Gd aerosol	0, 1, 1, 1	3, 5, 4, 2	pt/ft3
No. Bk-Gd samples	4	4	
Compressor output	155	170	psig

Instruments Used:		Cal. Due
TSI VelciCalc	T95351203001	12/17/2012
Fisher Scientific	90936818	12/7/2012
Met One OPC	1011529010	2/1/2013
Met One OPC	1011529009	1/9/2013



Notes:

CA

3/19/2012

Oil Used: Edwards

Ref. Probe Location: Port 2, center bottom

Probe Type / Configuration:

L-shaped probe

Entries made by: Carmen Arimescu

Signature/date 3/19/2012

Technical Data Review performed by: RL Aaberg

Signature/date Signature on file with original TI-WTPSP-085 6/15/2012

Rev. 0

3 Aug. 2006

PARTICLE TRACER TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	PT-6
Date	3/19/2012	Fan configuration	FAN B ONLY
Tester	CA, JAG	Fan Setting	8 Hz
Stack Dia.	11.938 in.	Stack Temp	55 deg F
Stack X-Area	111.9 in.2	Start/End Time	1:15/ 4:30
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	particles/ft3	Injection Point	Port C Center
Order --->	2nd		1st

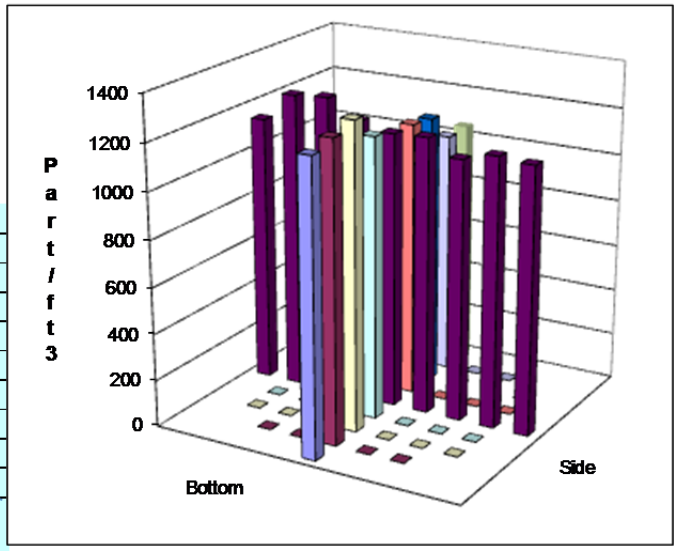
		Side				Bottom			
Traverse-->									
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	particles/ft3				particles/ft3			
1	0.50	1010	993	1102	1035.0	1075	1269	1398	1247.3
2	1.24	1034	943	1162	1046.3	1307	1271	1248	1275.3
3	2.29	995	941	1102	1012.7	1269	1333	1320	1307.3
4	3.82	1093	998	1129	1073.3	1210	1212	1185	1202.3
Center	5.91	1093	1097	1011	1067.0	1118	1143	1263	1174.7
5	8.00	1143	1146	998	1095.7	1179	1127	1217	1174.3
6	9.52	1171	1359	962	1164.0	1181	1052	1246	1159.7
7	10.57	1086	1348	1027	1153.7	1111	982	1040	1044.3
8	11.31	1019	1008	1096	1041.0	1041	1061	1048	1050.0
Averages ------>		1071.6	1092.6	1065.4	1076.5	1165.7	1161.1	1218.3	1181.7

All	pt/ft3	Dev. from mean	*Center 2/3*	Side	Bottom	All	Normlzd
Mean	1129.1		Mean	1087.5	1191.1	1139.3	1194.20
Min Point	1012.7	-10.3%	Std. Dev.	55.1	85.5	87.5	71.26
Max Point	1307.3	15.8%	COV as %	5.1	7.2	7.7	5.97

Avg Conc 1130 pt/ft3

	Start	Finish	
Generator Inlet Press	1.7	1.7	psig
Stack Temp	58	52	F
Mean vel.	311	336	sfpm
Ambient pressure	29.5	29.5	inHg
Ambient humidity	27%	27%	RH
Ambient temp	55.4	52.7	F
Back-Gd aerosol	4,3,1,1	8, 7, 9, 10	pt/ft3
No. Bk-Gd samples	4	4	
Compressor output	105	112	psig

Instruments Used:		Cal. Due
TSI VelciCalc	T95351203001	12/17/2012
Fisher Scientific	90936818	12/7/2012
Met One OPC	1011529010	2/1/2013
Met One OPC	1011529009	1/9/2013



Notes:

CA

3/19/2012

Oil Used: Edwards

Ref. Probe Location: Port 1, center bottom

Probe Type / Configuration:

L-shaped probe

Entries made by: Carmen Arimescu

Signature/date 3/19/2012

Technical Data Review performed by: RL Aaberg

Signature/date Signature on file with original TI-WTPSP-085 6/15/2012

Rev. 0

3 Aug. 2006

PARTICLE TRACER TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	PT-7
Date	3/22/2012	Fan configuration	FAN A ONLY
Tester	CA, YFS	Fan Setting	9.5 Hz
Stack Dia.	11.938 in.	Stack Temp	58.75 deg F
Stack X-Area	111.9 in.2	Start/End Time	1130/1300
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	particles/ft3	Injection Point	Port C Center
Order --->	1st		2nd

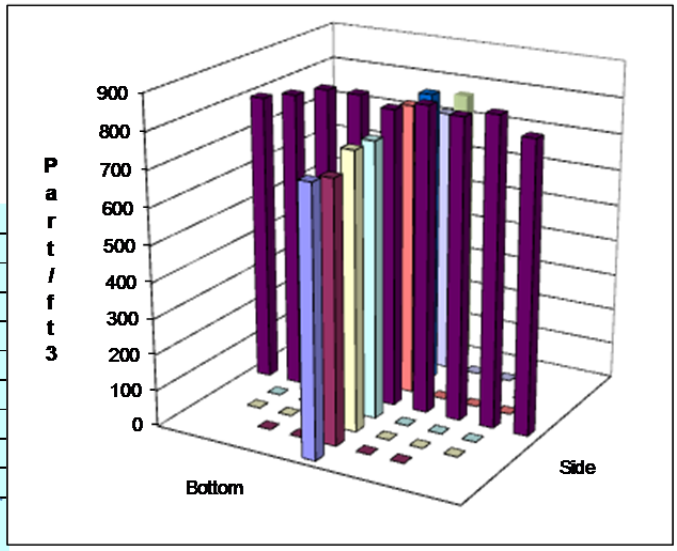
		Side				Bottom			
Traverse-->									
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	particles/ft3				particles/ft3			
1	0.50	524	543	559	542.0	686	727	794	735.7
2	1.24	557	586	577	573.3	755	626	775	718.7
3	2.29	576	535	571	560.7	752	668	870	763.3
4	3.82	632	536	546	571.3	793	680	812	761.7
Center	5.91	570	560	533	554.3	783	743	932	819.3
5	8.00	576	551	587	571.3	747	761	908	805.3
6	9.52	593	544	577	571.3	734	794	910	812.7
7	10.57	546	523	590	553.0	639	743	824	735.3
8	11.31	505	513	597	538.3	658	825	803	762.0
Averages ------>		564.3	543.4	570.8	559.5	727.4	729.7	847.6	768.2

All	pt/ft3	Dev. from mean	*Center 2/3*	Side	Bottom	All	Normlzd
Mean	663.9		Mean	565.0	773.8	669.4	804.47
Min Point	538.3	-18.9%	Std. Dev.	8.8	39.5	111.7	42.58
Max Point	819.3	23.4%	COV as %	1.6	5.1	16.7	5.29

Avg Conc 661 pt/ft3

	Start	Finish	
Generator Inlet Press	1.7	1.7	psig
Stack Temp	56.8	60.7	F
Mean vel.	408	388	sfpm
Ambient pressure	29.71	29.71	inHg
Ambient humidity	48%	35%	RH
Ambient temp	49.1	59.9	F
Back-Gd aerosol	1,1,2,2	0,0,0,2	pt/ft3
No. Bk-Gd samples	4	4	
Compressor output	110	120	psig

Instruments Used:		Cal. Due
TSI VelciCalc	T95351203001	12/17/2012
Fisher Scientific	90936818	12/7/2012
Met One OPC	1011529010	2/1/2013
Met One OPC	1011529009	1/9/2013



Notes:

CA

3/22/2012

Oil Used: Edwards

Ref. Probe Location: Port 1, center bottom

Probe Type / Configuration:

L-shaped probe

Entries made by: Carmen Arimescu

Signature/date 3/22/2012

Technical Data Review performed by: RL Aaberg

Signature/date Signature on file with original TI-WTPSP-085 6/15/2012

Rev. 0

3 Aug. 2006

PARTICLE TRACER TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	PT-8
Date	5/24/2012	Fan configuration	Fan B Only
Tester	YFS, EA	Fan Setting	14 Hz
Stack Dia.	11.938 in.	Stack Temp	#DIV/0! deg F
Stack X-Area	111.9 in.2	Start/End Time	1500 / 1745
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	particles/ft3	Injection Point	Port C Center
Order --->	1st		2nd

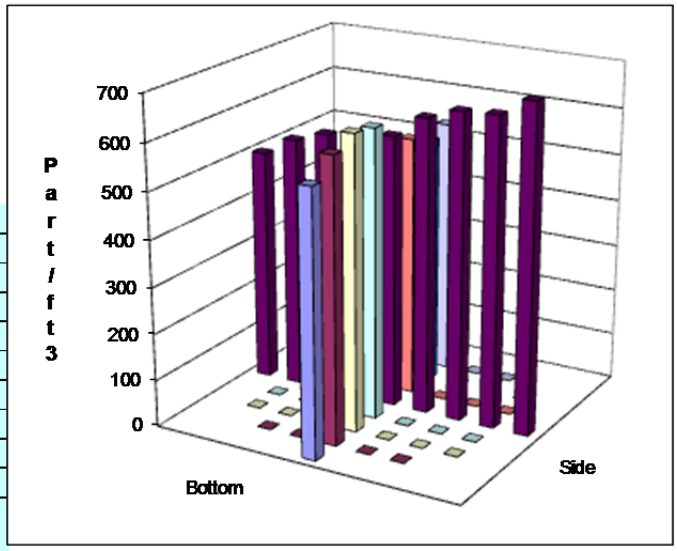
Traverse-->	Side				Bottom			
Trial --->	1	2	3	Mean	1	2	3	Mean
Point / Depth, in.	particles/ft3				particles/ft3			
1 / 0.50	1030	612	447	696.3	366	291	324	327.0
2 / 1.24	868	668	439	658.3	389	333	330	350.7
3 / 2.29	920	614	429	654.3	410	338	343	363.7
4 / 3.82	853	630	408	630.3	372	353	351	358.7
Center / 5.91	763	568	414	581.7	362	337	313	337.3
5 / 8.00	715	585	405	568.3	350	315	302	322.3
6 / 9.52	736	584	369	563.0	349	309	267	308.3
7 / 10.57	689	528	401	539.3	367	314	273	318.0
8 / 11.31	635	514	351	500.0	326	294	266	295.3
Averages ---------->	801.0	589.2	407.0	599.1	365.7	320.4	307.7	331.3

All	pt/ft3	Dev. from mean	*Center 2/3*	Side	Bottom	All	Normlzd
Mean	465.2		Mean	599.3	337.0	468.2	590.21
Min Point	295.3	-36.5%	Std. Dev.	47.7	21.5	140.7	42.11
Max Point	696.3	49.7%	COV as %	8.0	6.4	30.0	7.13

Avg Conc 466 pt/ft3

	Start	Finish	
Generator Inlet Press	1.5	3	psig
Stack Temp	N/A	N/A	F
Mean vel.	827	777	sfpm
Ambient pressure	29.38	29.35	inHg
Ambient humidity	25%	25%	RH
Ambient temp	73.5	71.6	F
Back-Gd aerosol	5, 3, 4, 5, 4, 7	5, 3, 4, 5, 4	pt/ft3
No. Bk-Gd samples	5	5	
Compressor output	31	31	psig

Instruments Used:			Cal. Due
TSI VelciCalc	T95351203001		12/17/2012
Fisher Scientific	90936818		12/7/2012
Met One OPC	1011529010	Sample	2/1/2013
Met One OPC	1011529009	Reference	1/9/2013



Notes: Stopped test Side -1 traverse. Increased inlet P to 3 psig.
Velocity measured at Side 7.

EA
5/24/2012

Oil Used: Edwards 19

Ref. Probe Location: End of stack, center

Probe Type / Configuration: L-shape

Entries made by:	Ernest Antonio	Technical Data Review performed by:	RL Aaberg
Signature/date	Signature on file with Original 5/24/2012	Signature/date	Signature on file with original TI-WTPSP-085 6/15/2012

Rev. 0

3 Aug. 2006

PARTICLE TRACER TRAVERSE DATA FORM

Site	IHLW-S1 Model	Run No.	PT-9
Date	6/1/2012	Fan configuration	Fan B Only
Tester	CA, XY	Fan Setting	14.9 Hz
Stack Dia.	11.938 in.	Stack Temp	84.8 deg F
Stack X-Area	111.9 in.2	Start/End Time	9:40/11:40
Test Port	2	Center 2/3 from	1.10 to: 10.84
Distance to disturbance	240 inches	Points in Center 2/3	2 to: 7
Measurement units	particles/ft3	Injection Point	Port C, center
Order --->	2nd		1st

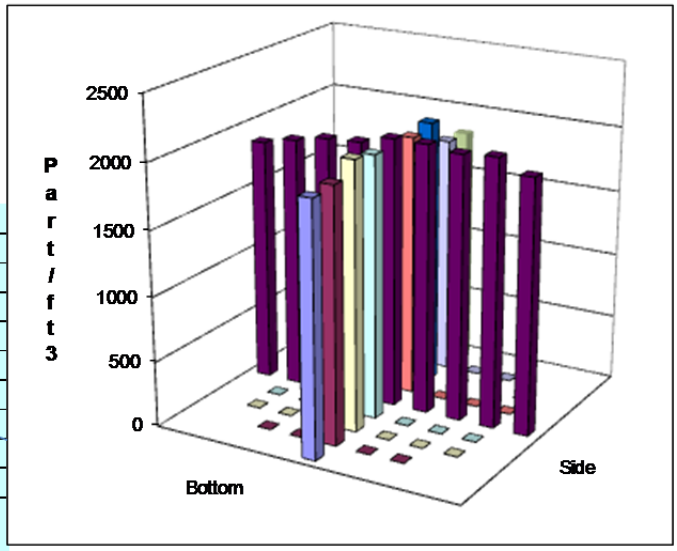
Traverse-->		Side				Bottom			
Trial --->		1	2	3	Mean	1	2	3	Mean
Point	Depth, in.	particles/ft3				particles/ft3			
1	0.50	1788	1610	1922	1773.3	2100	1936	1758	1931.3
2	1.24	1837	1822	1936	1865.0	2062	2002	1779	1947.7
3	2.29	1766	1844	1929	1846.3	2177	2110	1876	2054.3
4	3.82	1842	1879	1903	1874.7	2032	2088	1922	2014.0
Center	5.91	1734	1911	1978	1874.3	2076	2183	1921	2060.0
5	8.00	1766	1847	1830	1814.3	2032	1953	2013	1999.3
6	9.52	1678	1900	1824	1800.7	2084	1987	2049	2040.0
7	10.57	1697	1860	1701	1752.7	1880	1722	1884	1828.7
8	11.31	1650	1724	1729	1701.0	1804	1718	1934	1818.7
Averages ------>		1750.9	1821.9	1861.3	1811.4	2027.4	1966.6	1904.0	1966.0

All	pt/ft3	Dev. from mean	*Center 2/3*	Side	Bottom	All	Normlzd
Mean	1888.7		Mean	1832.6	1992.0	1912.3	2003.05
Min Point	1701.0	-9.9%	Std. Dev.	45.6	81.6	104.3	66.10
Max Point	2060.0	9.1%	COV as %	2.5	4.1	5.5	3.30

Avg Conc 1879 pt/ft3

	Start	Finish	
Generator Inlet Press	0.6	0.6	psig
Stack Temp	81.7	87.9	F
Mean vel.	880	817	sfpm
Ambient pressure	29.59	29.39	inHg
Ambient humidity	41%	27%	RH
Ambient temp	77.6	92.3	F
Back-Gd aerosol	7,7,5,4	4,2,5,5	pt/ft3
No. Bk-Gd samples	4	4	
Compressor output	30	30	psig

Instruments Used:			Cal. Due
TSI VelciCalc	T95351203001		12/17/2012
Fisher Scientific	90936818		12/7/2012
Met One OPC	1011529010	Sample	2/1/2013
Met One OPC	1011529009	Reference	1/9/2013



Notes:

XY 6/1/12

Oil Used: Edwards 19

Ref. Probe Location: End of stack, center

Probe Type / Configuration: L-shape

Entries made by:	CA, XY	Technical Data Review performed by:	RL Aaberg
Signature/date	Signature on file with Original 6/1/2012	Signature/date	Signature on file with original TI-WTPSP-085 6/15/2012

Appendix D

Flow Unit Conversions

Appendix D

Flow Unit Conversions

Flow units provided by BNI were in actual flow units. For consistency with the measurement equipment used for velocity and flow rate measurements, these were converted to standard flow units. Converting from acfm to scfm was done by simple ratio of the standard temperature (in absolute units, Rankine) to the actual temperature of the stack provided by BNI, as follows:

$$Q_{scfm} = Q_{acfm}\left(\frac{T_{std}}{T_{act}}\right)$$

The table below lists the flow and velocity values provided by BNI as well as the calculated values in standard units.

	Temperature (F)	Air Flow (acfm)	Air Flow (scfm)	Air Velocity (afpm)	Air Velocity (sfpm)
HV-S1					
Single fan—max flow	105	59,300	55,627	3,030	2,833
Single fan –norm flow	93	47,500	45,524	2,419	2,319
Single fan—min flow	59	23,700	24,202	1,207	1,233
HV-S2					
Single fan—max flow	170	63,750	53,631	3,041	2,558
Single fan –norm flow	102	51,000	48,096	2,433	2,294
Single fan—min flow	59	25,500	26,040	1,216	1,242
IHLW-S1					
Single fan—max flow	160	13,100	11,198	2,078	1,776
Single fan –norm flow	102	10,480	9,883	1,662	1,567
Single fan—min flow	59	5,240	5,351	831	849

Appendix E

Document List

Appendix E

Document List

Project Plan	PP-WTPSP-045	Air Sampling Probe Location Tests for Waste Treatment Plant HV-S1, HV-S2 and IHLW-S1 (Group 3-4) Air Exhaust Systems
Test Plan	TP-WTPSP-032 Rev 0.	Air Sampling Probe Location Tests for Waste Treatment Plant HV-S1, HV-S2 and IHLW-S1 (Group 3-4) Air Exhaust Systems
Test Instructions	TI-WTPSP-066	Measurements HV-S1 Scale Model
	TI-WTPSP-067	Calibration of Ventilation Flow Controller for HV-S1 Scale Model Stack
	TI-WTPSP-068	Velocity Uniformity Measurements of HV-S1 Scale Model
	TI-WTPSP-069	Determine Flow Angle in HV-S1 Scale Model Stack
	TI-WTPSP-070	Tests of Gas Tracer Mixing in HV-S1 Scale Model Stack
	TI-WTPSP-071	Tests of Particle Tracer Mixing in HV-S1 Scale Model Stack
	TI-WTPSP-072	Measurements HV-S2 Scale Model
	TI-WTPSP-073	Calibration of Ventilation Flow Controller for HV-S2 Scale Model Stack
	TI-WTPSP-074	Velocity Uniformity Measurements of HV-S3 Scale Model
	TI-WTPSP-075	Determine Flow Angle in HV-S2 Scale Model Stack
	TI-WTPSP-078	Tests of Gas Tracer Mixing in HV-S2 Scale Model Stack
	TI-WTPSP-079	Tests of Particle Tracer Mixing in HV-S2 Scale Model Stack
	TI-WTPSP-080	Measurements of IHLW-S1 Scale Model
	TI-WTPSP-083	Determine Flow Angle in IHLW-S1 Scale Model Stack
	TI-WTPSP-082	Velocity Uniformity Measurements of IHLW-S1 Scale Model
	TI-WTPSP-084	Tests of Gas Tracer Mixing in IHLW-S1 Scale Model Stack
	TI-WTPSP-085	Tests of Particle Tracer Mixing in IHLW-S1 Scale Model Stack
	TI-WTPSP-081	Calibration of Ventilation Controller for IHLW-S1 Scale Model Stack
Calculation Packages		
	CCP-WTPSP-1227	Calibration of Ventilation Flow Controller for IHLW-S1
	CCP-WTPSP-1228	Determine Flow Angle in IHLW-S1 Scale Model Stack
	CCP-WTPSP-1229	Determine Air Velocity Uniformity of IHLW-S1 Scale Stack Model
	CCP-WTPSP-1230	Determine Particle Tracer Uniformity of IHLW-S1 Scale Model Stack
	CCP-WTPSP-1231	Gas Tracer Mixing in the IHLW-S1 Scale Model Stack
	CCP-WTPSP-1232	Calibration of Ventilation Flow Controller for HV-S1 Scale Model
	CCP-WTPSP-1233	Determine Flow Angle in HV-S1 Scale Model Stack
	CCP-WTPSP-1234	Determine Air Velocity Uniformity of HV-S1 Scale Stack Model
	CCP-WTPSP-1235	Determine Particle Tracer Uniformity of HV-S1 Scale Model Stack
	CCP-WTPSP-1236	Gas Tracer Mixing in the HV-S1 Scale Model Stack
	CCP-WTPSP-1237	Calibration of Ventilation Flow Controller for HV-S2 Scale Model
	CCP-WTPSP-1208	Determine Flow Angle in HV-S2 Scale Model Stack

CCP-WTPSP-1209	Determine Air Velocity Uniformity of HV-S2 Scale Stack Model
CCP-WTPSP-1210	Determine Particle Tracer Uniformity of HV-S2 Scale Model Stack
CCP-WTPSP-1211	Gas Tracer Mixing in the HV-S2 Scale Model Stack

Distribution

No. of Copies

ONSITE*

4 **Bechtel National, Inc.**

FW Damerow	H4-02
JM Meyer	H4-02
MM Mwembeshi	H4-02
WTP Docs	H4-02

No. of Copies

7 **Pacific Northwest National Laboratory**

EJ Antonio	K3-54
JE Flaherty	K9-30
JA Glissmeyer	K3-54
DE Kurath	K3-52
LM Peurrung	K9-09
Information Release	K3-52
Project File	K3-52

*All distribution will be made electronically.



Pacific Northwest
NATIONAL LABORATORY

Proudly Operated by **Battelle** *Since 1965*



U.S. DEPARTMENT OF
ENERGY

902 Battelle Boulevard
P.O. Box 999
Richland, WA 99352
1-888-375-PNNL (7665)
www.pnnl.gov