AP-42 Section 11.14
Reference 7
Report Sect. –
Reference 7

ATC Project No. 014-05

PARTICULATE EMISSION TEST RESULTS
NO. 2 NORTH STACK
CHI-VIT CORPORATION
LEESBURG, ALABAMA

Prepared For

CHI-VIT CORPORATION
P.O. BOX 188
LEESBURG, AL 35983

Bruce B. Ferguson
APPROVED FOR TRANSMITTAL
MAY 1987

Prepared By

ATC, INC.
1635 Pumphrey Ave.
Auburn, AL 36830-4303

JUN 15 1987

ATC INCORPORATED

COMPLIANCE DETERMINATION SUBMITTAL FORM

COMPANY Chi-Vit Corporation DATE OF TEST 5/5/87

FACILITY NUMBER 303-0001-2003 SOURCE No. 2 Frit Unit

( ) Notification of observation of:
(✓) Test report on sampling of:

Particulate - Method 5	( )	VE (initial) - Method 9	( )
Sulfur dioxide - Method 6	( )	GAP Test (initial)	( )
Oxides of Nitrogen - Method 7	( )	SOCMI - Method 21	( )
Other ( )	( )		

This is ( ) initial compliance of ( ) an NSPS source.
(✓) retest (✓) a SIP source.
( ) a NESHAP source.
( ) a RCRA source.
( ) an air toxics source

Note any special considerations (Expiration of Permit, litigation, etc):

Allowable Emissions (with units)

Run 1	Run 2	Run 3
3.59 lbs/hr	→	→

Submitted by: Marilyn Diaz Date June 24 '87

Emissions

Run 1	Run 2	Run 3	AVG.
2.00	2.16	1.58	1.91 #/hr

Comments:

Evaluated by: [signature] Date 6/26/87

ADEM Form 175 Rev. 3/87

FACILITY Chi Vit Corp DATE OF TEST 05/05/87
FACILITY NUMBER 303 - 0001 - SOURCE TESTED No 2 Frit Unit
TESTED BY ATC

Parameter	Run	Run	Run
Units of Allowable	#/hr		
Allowable Rate	3.59		
Production Rate	—	—	—
$\overline{\Delta H}$ (0.XX in. H_2)	2.07	1.99	2.03
$\sqrt{\Delta P}$ (0.XX in. H_2)	.562	.555	.560
$\overline{t_m}$ (X°F)	101	108	107
$\overline{t_s}$ (X°F)	139	146	147
P_b (0.XX in. Hg)	29.80	—	—
P_s (0.XX in. Hg)	29.77	—	—
V_m (0.XXX ACF)	48.940	48.041	49.207
MCF (Y) (X.XXX)	1.019	—	—
$\%CO_2$	.5	—	—
$\%O_2$	20	—	—
%CO	~~.5~~	—	—
V_{1c} (0.X ml)	180	229.6	172
M_n (0.X mg)	82.8	93.3	66.6
C_p	.84	—	—
A_s (0.X ft^2)	5.46	—	—
d_n (X.XXX in.)	.309	—	—
θ (X min.)	60	—	—

STACK TEST EVALUATION FOR RETEST

CHI-VIT CORP. 303-0001 05-05-87
CONDUCTED BY ATC NO. 2 FRIT UNIT

INPUT PARAMETERS	1	2	3
DELTA H	2.070	1.990	2.030
AVE SQRT DELTA P	.567	.555	.560
METER TEMP	101.000	108.000	107.000
STACK TEMP	139.000	146.000	147.000
BAROMETRIC PRESS	29.800	29.800	29.800
STACK PRESS	29.770	29.770	29.770
VOLUME METERED	48.940	48.041	49.207
METER CORR. FACTOR	1.019	1.019	1.019
%CO2	.500	.500	.500
%O2	20.000	20.000	20.000
%N2	79.500	79.500	79.500
%CO	0.000	0.000	0.000
TOTAL VOLUME H2O	180.000	229.600	172.000
PART WT	82.300	93.300	66.600
PITOT COEF	.840	.840	.840
STACK AREA	5.460	5.460	5.460
NOZZLE DIAMETER	.3090	.3090	.3090
TIME	60.000	60.000	60.000

CALCULATED PARAMETERS	1 REPORT	2 REPORT	3 REPORT
NOZZLE AREA X 1000	.5207	.5207	.5207
VOLUME MTR STD (SDCF)	46.968	45.528	46.719
VOLUME H2O VAPOR	8.472	10.307	8.096
% MOISTURE	15.3(15)	19.2(19)	14.8(15)
MOL WT DRY	28.88	28.88	28.88
MOL WT WET	27.22	26.79	27.27
AVG STACK VEL (FPS)	35.0(35.1)	34.7(34.7)	34.8(34.8)
FLOW RATE ACTUAL (ACFM)	11500	11400	11400
FLOW RATE STD (SDCFM)	8600(8510)	8000(7970)	8400(8400)
CONCENTRATION (GR/SDCF)	.0271(.0271)	.0315(.0316)	.0219(.0220)
PART MASS RATE (#/HR)	2.00(1.9819)	2.16(2.1557)	1.58(1.5800)
% ISOKINETIC	95(96.3)	98(99.8)	96(97.2)

POUNDS PER HOUR	2.000(1.9819)	2.160(2.1557)	1.580(1.5800)

AVERAGE EMISSION RATE = 1.91 POUNDS PER HOUR
ALLOWABLE EMISSION RATE = 3.59 POUNDS PER HOUR

EVALUATED BY TSO (06/26/87)

USE OF THIS REPORT AND INFORMATION CONTAINED THEREIN

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Report No.: 014-05 Date: May 22, 1987

To: Chi-Vit Corporation
P.O. Box 188
Leesburg, AL 35983

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INTRODUCTION

SECTION 1

INTRODUCTION

ATC, Inc. (ATC) was retained by Chi-Vit Corporation to perform particulate emission testing on the No. 2 North Stack at the Leesburg, Alabama plant. The purpose of the testing was to determine compliance with emission limits set for by the Alabama Department of Environmental Management (ADEM) Air Division.

The testing took place on May 5, 1987. A team from ATC comprised of Messrs. Robert Betts and Gene Davis performed the testing. Mr. Joe Duncan was the ATC Project Manager and Dr. Bruce Ferguson was the Technical Director. Mr. Bobby Grimes of Chi-Vit collected process data and Department of Environmental Management, Air Division was present during the testing.

This report lists the results of the emission testing and gives a brief description of the manufacturing process and test procedures used. Copies of all field, laboratory and calibration data pertinent to the test are included in the appendices.

SECTION 2

RESULTS AND DISCUSSION

SECTION 2

RESULTS AND DISCUSSION

The No. 2 North stack has a mean particulate emission rate of 1.91 pounds per hour (lb/hr) which was well below the allowable limit of 3.59 lb/hr. The particulate data are summarized in Table 2.1. The allowable emission rate was calculated based on process data supplied by the plant utilizing the formula in the ADEM rules and regulations Section 4.4.1 for processes producing less than 30 ton/day.

TABLE 2.1

SUMMARY OF EMISSIONS, NO. 2 NORTH STACK

	RUN 1	RUN 2	RUN 3	MEAN	ALLOWABLE LIMIT
Date	5/5/87	5/5/87	5/5/87	-----	------
Time Began	0825	1025	1210	-----	------
Time End	0925	1130	1310	-----	------
Stack Gas					
Temperature, °F	139	147	146	144	------
Velocity, ft/sec	35	35	35	35	------
Moisture, %	15	15	19	16	------
Oxygen Concentration, %	20	20	20	20	------
Carbon Dioxide Concentration, %	0.5	0.5	0.5	0.5	------
Volumetric Flow Rate					
At Stack Conditions, x 10^3 ft^3/min	11.5	11.4	11.4	11.4	------
At Standard Conditions, x 10^3 ft^3/min	8.51	7.97	8.40	8.29	------
Particulate					
Isokinetic Sampling Rate, %	96	100	97	98	------
Concentration At STP, x 10^{-3} gr/ft^3	27	32	22	27	------
Emission Rate, lb/hr	1.98	2.16	1.58	1.91	3.59[a]
Process Weight, ton/hr	1	1	1	1	------

[a] Based on plant process weight of 1 ton/hr.

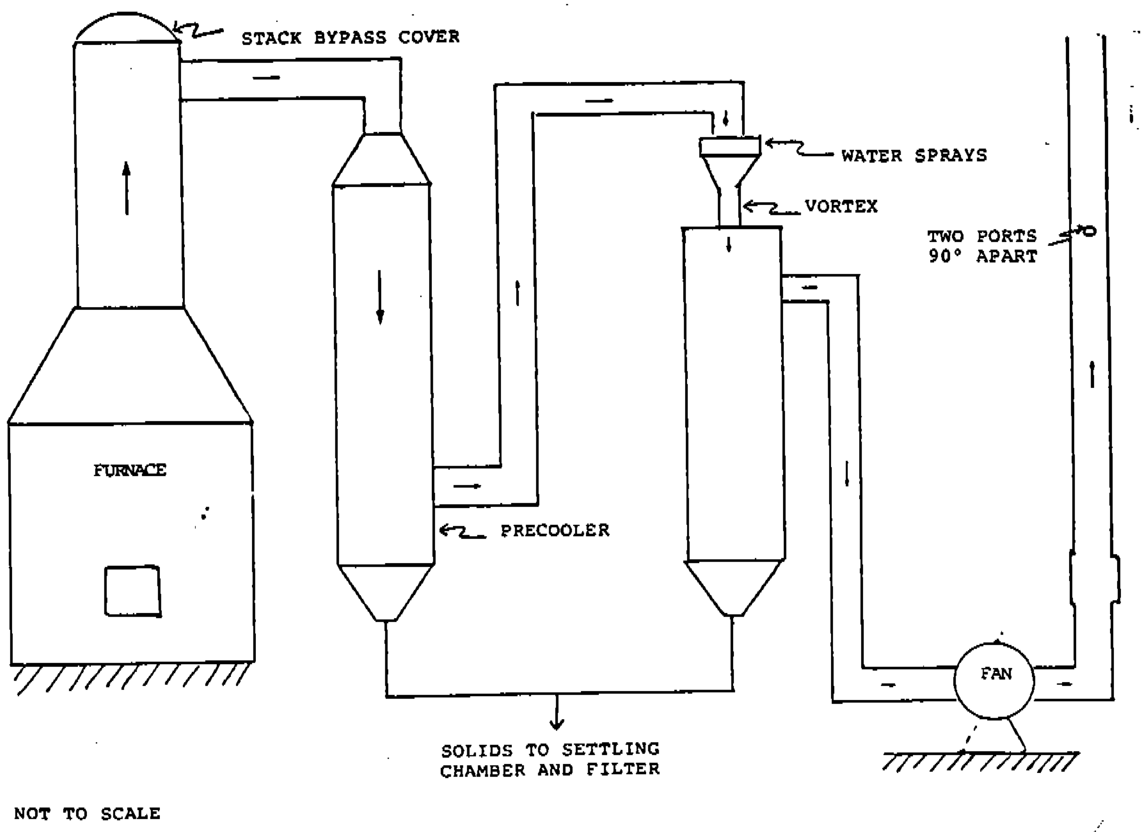
SECTION 3

PROCESS DESCRIPTION

SECTION 3

PROCESS DESCRIPTION

The Chi-Vit plant at Leesburg, Alabama produces coated glass frit for industry. The emissions for the No. 2 North stack are controlled by a Venturi wet scrubber using water with lime added as the scrubbing media. The wet scrubber has 16 spray nozzles. The scrubber is designed to control particulate emissions using only eight of the nozzles at any one time. During the testing, ten of the nozzles were operating. A schematic of the process is given in the figure below.



SCHEMATIC DRAWING OF FRIT UNIT

SECTION 4

ANALYTICAL METHODOLOGY

SECTION 4

ANALYTICAL METHODOLOGY

Testing was performed using the EPA Reference Methods below:

Parameter	EPA Reference Method
Volumetric Flow	1, 2
Gas Composition (CO_2 and O_2)	3
Moisture	4
Particulate	5

The most current revision of each method (as described in the Federal Register) was used. The following paragraphs summarize the protocol.

Stack Gas Volumetric Flow

The sampling points were selected in accordance with EPA Reference Method 1 so that a representative sample of stack gas was taken. The traverse points were located in the centers of equal area zones, the number of which was determined by the stack dimensions and the number of duct diameters upstream and downstream from the sampling points to the nearest disturbance.

The No. 2 North stack is a circular ducts 31 5/8 inches in diameter. Each sampling point is greater than 23 feet from the nearest upstream disturbance and greater than 18 feet from the nearest downstream disturbance. Twelve traverse points were used; six located through each of two ports located 90° apart.

The velocity of the gas stream was determined according to EPA Reference Method 2 by reading the instantaneous velocity head with an inclined manometer at each sampling point with a calibrated S-type pitot tube attached adjacent to the sample nozzle. The stack pressure was measured with the static side of an S-type pitot tube. A calibrated pyrometer was used to measure stack temperature at each sampling point. The stack was tested for cyclonic flow according to EPA Reference Method 2. The flow was not cyclonic.

Stack Gas Molecular Weight

The carbon dioxide and oxygen concentrations were determined using EPA Reference Method 3. An grab sample was taken for each run and analyzed with Fyrite carbon dioxide and oxygen analyzers. The molecular weight of the gas was calculated using the moisture, oxygen and carbon dioxide content and the measured stack gas temperature.

Moisture Content

The preliminary moisture content was determined by estimation. The final moisture content used for calculating the gas stream flow rate was determined by weighing the amount of condensed moisture in the impingers of the particulate sampling train as described in EPA Reference Method 4.

Particulate Concentration

The particulate emission testing was conducted using EPA Reference Method 5. The sampling points were selected in accordance with EPA Reference Method 1 as described above. An S-type pitot tube was connected adjacent to the sample nozzle so that an instantaneous head was measured at each sampling point during each test run. The stack temperature was also measured at each point.

Three runs (each of one-hour duration) were performed. The gas stream was sampled isokinetically at each sampling point by adjusting the sample flow rate to correspond to the measured velocity at each point.

The probe and nozzle were washed with water after each run to remove the adhering particulate matter. The filter was removed from the holder and stored in a petri dish until analyzed. The filter holder was then rinsed with acetone. This rinse was added to the probe rinse. The container was sealed and labeled and liquid levels marked for transport to the laboratory.

The mass of particulate matter collected was analyzed in the laboratory by evaporating the acetone in a tared beaker, adding the filter and then weighing the residue. The filter tare weight and solvent blank corrections were subtracted from the final weight to give the weight of particulate matter collected. The total weight was used to calculate the particulate concentration. All weight measurements were made on the same Mettler balance (accurate to 0.1 mg).

The mean temperature of the stack gas and the dry gas meter were used in calculating the final data. The mean isokinetic sampling rate and the stack gas velocity (volumetric flow) were calculated from the mean of the square roots of the velocity pressure measured at each traverse point during the particulate sampling. All calculations were performed using the equations given in the Reference Method and summarized in Appendix B.

APPENDIX A

PROJECT SUMMARY OF PERSONNEL RESUMES

Biographical Data

BRUCE B. FERGUSON

Principal Industrial Hygienist

Education

B.S. in Chemistry and Mathematics, 1968, Athens College, Athens, Alabama
M.A. in Physical Chemistry, 1973, Vanderbilt University, Nashville, Tennessee
Ph.D. in Physical Chemistry, 1974, Vanderbilt University, Nashville, Tennessee
Comprehensive Review of Industrial Hygiene, 1985, Rocky Mountain Center for Industrial Hygiene and Occupational Safety
Supervision of Asbestos Abatement Contracts, 1985, Georgia Institute of Technology

Professional Affiliations, Honors and Awards

Certified Industrial Hygienist, ABIH
American Chemical Society
Air Pollution Control Association
Official Association of Analytical Chemists
Technical Association of the Pulp and Paper Industry
American Petroleum Institute
Woodrow Wilson Fellow (1968)
National Science Foundation Fellow (1971-1972)
Magna Cum Laude, Athens College, Athens, Alabama (1968)

Experience Record

1972 - 1973	College Grove Smelter, College Grove, TN
1974 - 1977	PBR Electronics, Athens, AL
1977 - 1983	Harmon Engineering & Testing, Auburn, AL
1983 - Date	ATC, Inc., Auburn, AL

Qualifications for this Project

Dr. Ferguson serves as Executive Vice President and Technical Director of ATC. As a Principal Industrial Hygienist, his 14 years of experience includes a distinguished record of research and development work in air pollution and industrial hygiene monitoring methods. He has demonstrated his ability to manage multi-discipline, multi-year projects, direct technical personnel to develop and apply new innovative technology and to communicate results and findings in a clear, concise manner.

He has served as Project Manager of a $517,000, three-year NASA Contract involving particle sampling and counting in Class 100 and Class 100,000 Clean Rooms, compressed air, and commercial-grade breathing air containers used in the space program. Particulate numeration techniques included electronic methods, phase contrast microscopy (PCM), and bright field microscopy. Recently, Dr. Ferguson directed all of the asbestos microscopy work, metal analyses and solvent analyses which resulted in a commercial laboratory's obtaining its American Industrial Hygiene Association (AIHA) accreditation. Dr. Ferguson has directed numerous survey projects regarding personal exposure to asbestos, formaldehyde and other indoor air pollutants. He has served as Project Manager for over $3,000,000 worth of air monitoring projects involving asbestos, formaldehyde, arsenic, lead, sulfur, volatile organics and other toxic and hazardous compounds.

Dr. Ferguson has directed over 800 tests for hydrocarbon and sulfur species emissions from petroleum refineries, kraft pulp mills and steel mills; over 250 tests of VOC emissions; over 50 ambient monitoring projects at refineries, foundries, pharmaceutical plants, magnetic tape coating plants and high-density urban areas; over 400 tests utilizing standard EPA reference methods for particulate, NO_x, SO_2, etc. He has presented professional papers and conducted short courses on continuous emission monitoring, TRS emissions, fuel alcohol distillation and analytical chemistry.

Before forming ATC, Dr. Ferguson served as Vice President of Environmental Services at a major environmental monitoring and engineering firm. There he was responsible for all industrial hygiene and environmental laboratories, air pollution testing projects, biological and chemical environmental studies, contamination investigations, and methods development projects. He managed several R&D contracts with the EPA requiring laboratory and field validation of standard test methods such as EPA Methods 15 and 16. He managed, supervised or performed source emission tests and ambient monitoring of TRS compounds, VOC, hydrocarbon and other hazardous emissions in 40 states and Puerto Rico, covering 300 industrial sources.

Specific experience in the key areas of expertise for a manager is summarized in the following paragraphs. Experience obtained during the past eleven years has been combined by category.

Project Management experience is demonstrated by previous performance on multi-year, multi-discipline contracts with government and industry.

- As Principal Scientist for two EPA contracts (No. 68-02-3215 and No. 68-02-3405) he directed laboratory and field evaluations of EPA Reference Methods 15 and 16. Other tasks under these contracts involved evaluation of long-term process rate monitors; review and editing of QA procedures for EPA Reference Methods 13A and 13B; long-term laboratory and field evaluation of CO and H_2S CEM'S; and report review.

- As Project Manager for a 3-year NASA contract, he directed the efforts of seven full time people to monitor contamination of controlled environments, compressed gases, fuel, life support gases, source emissions, wastewater, plating solutions and rocket booster propellants. As Senior Scientist on the project, he developed a technique to trap and analyze hydrocarbons from contaminated areas in the sub ppb range.

- As a project manager for more than 300 industrial source emission projects, he demonstrated his ability to concurrently manage a variety of projects and complete each in a technically adequate manner, on time and within budget. The successful completion of this large number of projects demonstrates his ability to manage people and also to please many clients.

- As a project manager for more than 200 laboratory projects, he directed efforts for the analysis of industrial hygiene samples, wastewater samples, hazardous waste samples and a variety of environmental samples.

Technical Director experience includes field and laboratory research projects involving characterization of toxic and hazardous materials, metal dusts, organic compounds and other environmental pollutants. He has direct experience in developing and implementing analytical/sampling methods for air emissions, sea water, landfill leachate and other media. Specific project experience includes:

- Methods development research for sampling and analysis of POHC's from hazardous waste incinerators.

- Development and implementation of a plan for complex testing of hydrocarbon species at a petroleum refinery.

- Instrumentation experience with GC/ECD/FPD and capillary column; GC-MS and MS.

- Design and development of a semi-portable GC-MS system for analyzing hydrocarbon contamination in NASA's liquid oxygen and liquid nitrogen systems.

- Directed a study of land application of industrial sludges for Amoco Chemicals.

- Performed treatability studies for several metal plating plants, pesticide manufacturers, mining companies, and inorganic chemicals plants.

- Developed a method for analyzing volatile condensible hydrocarbons.

- Developed methods for micro analysis of seawater for DOE.

- As Director of Research at PBR Electronics, Dr. Ferguson developed analytical instrumentation and methods for NASA; monitored worker exposure to solvents, chlorinated hydrocarbons, and metals. He analyzed breathing air samples weekly for contamination using mass spectrometry. He was responsible for direction of research effort including computer interface projects, treatment of plating solution wastes, analysis of human hair for metals, and development of contamination monitoring techniques.

Communication skills are demonstrated by the fact that Dr. Ferguson has been an invited speaker during the past five years at numerous conferences dealing with quality assurance and performance auditing of CEMS. He has acquired a reputation based on experience in developing comprehensive test plans and analytical protocols; performing systematic site planning; performing both field and laboratory work subject to rigorous written QA/QC procedures; and preparation of state-of-the-art, easily understood reports of technical finding. Specific demonstratable skills include:

- Presentation of more than 15 technical papers at professional conferences and seminars.

- Principal speaker for a two-day seminar to the kraft pulping industry on the analysis of reduced sulfur compounds by EPA Method 16.

- Publication of 12 technical papers and articles.
- Principal author of more than 200 industrial test reports.
- Principal author/reviewer for more than 30 major government reports.
- Principal author for four (4) EPA reference methods in the Federal Register format.

Pertinent Presentations & Publications

"Surface Chemistry and Trace Analysis for Environmental Chemistry." Ph.D. Thesis, Vanderbilt University, 1974.

"DDT Levels in Milk from Indigent Blacks," American Journal of Children's Diseases, 130, 400, 1976.

"Determinations of Nicotine in Human Milk," American Journal of Children's Diseases, 130, 837, 1976.

Reece, J. W., A. R. Barbin, J. D. Sterrett and B. B. Ferguson. "Cyclonic Flow in a Venturi." The 2nd Symposium on Flow: Its Measurement and Control in Science and Industry. St. Louis, MO, March 1981. Sponsored by ASME and ISA.

Ferguson, B. B., J. W. Reece and J. D. Sterrett. "Particulate Sampling in a Cyclonic Flow." The 74th Annual Meeting of the Air Pollution Control Association. Philadelphia, PA, 1981.

Reece, J. W., J. D. Sterrett, and B. B. Ferguson. "Straightening Swirling Flows." Joint ASME/ASCE Mechanics Conference, Boulder, CO, 1981.

Lester, R. E., B. B. Ferguson and W. J. Mitchell. "Field Evaluation of H_2S and CO Continous Emission Monitors at an Oil Refinery." Continuous Emission Monitor Specialty Conference of the Air Pollution Control Association. Denver, CO, 1981.

"Role of Analytical Laboratory in Hazardous Waste Management" presented at the Second Ohio Environmental Engineering Conference, March 1982.

Ferguson, B. B. and G. R. Harmon. "Potential Methanol Recovery from Kraft Pulp Mill Waste." Water and Wastewater Equipment Manufacturers Association Conference, Houston, TX, 1982.

Elam, D. E. and B. B. Ferguson. "Quality Assurance Requirements of Total Reduced Sulfur Emission Testing." Speciality Conference on Measurement and Monitoring of Non-Criteria (Toxic) Contaminants in Air. Air Pollution Control Association, Chicago, IL, 1983

Elam, D. E. and B. B. Ferguson. "Quality Assurance Aspects of Total Reduced Sulfur Continuous Emission Monitoring Systems." Continuous Emission Monitor Speciality Conference of the Air Pollution Control Association. Baltimore, MD, 1985.

Ferguson, B. B. "TRS Continous Emission Monitoring in the Pulp and Paper Industry - One Year Later." Engineering Foundation Conference on Source Testing. Santa Barbara, CA, 1985.

Margeson, J. H., J. E. Knoll, M. R. Midgett, B. B. Ferguson, and P. J. Schworer. "A Manual Method for Measurement of Reduced Sulfur Compounds." Journal of the Air Pollution Control Association, 35(12), 1280, 1985

Biographical Data

ROBERT BETTS

Environmental Technician

Education

Enterprise State Junior College, Enterprise, AL
completed courses in computer science and programming
Opelika Technical College, Opelika, AL
completed courses in quality control methods
Short courses in Air Pollution Monitoring

Experience Record

1977 - 1979 Rawls Corporation, Enterprise, AL
1979 - 1980 Auburn Welding & Crane, Auburn, AL
1980 - 1983 Diversified Products Corporation, Opelika, AL
1983 - Date ATC, Inc., Auburn, AL

Qualifications for this Project

Mr. Betts has participated in the sampling of over 150 sources serving as Team Leader on 45 sources. Many sources sampled required (i) more than one sampling train; (ii) inlet and outlet sampling; and (iii) use of complex and non-routine sampling methods. Some highlights of Mr. Betts' field project experience include:

- A 250-hour TRS monitoring project involving performance specification testing (PST) of continuous emission monitoring system (CEMS) at a kraft pulp mill.
- Monitoring of arsenic emissions from an enamel frit manufacturing plant.
- Performed NO_x and SO_2 testing of a recovery boiler at a kraft pulp mill.
- Performed TRS, hydrocarbon, sulfur oxides monitoring at a coke oven.
- Performed permformance specification testing of CEMS at a carbon black plant.
- Performed lead emission and particulate testing at a battery plant.
- Performed ten (10) Method 15 tests at sulfur recovery units at oil refineries.
- Performed VOC testing of incinerators at a pharmaceutical plants (4 tests).
- Performed inlet-outlet testing of a baghouse at an explosive chemicals plant.
- Performed five (5) method 25 tests of VOC's at mill sites and bulk gasoline terminals.
- Performed PST of VOC control equipment at a record and magnetic tape plant.
- Performed sampling of vapor to characterize semi-volatile organic emissions from a pilot scale hazardous liquid waste evaporation unit.
- Performed several dozen PST's on dual-stream CEMS O_2, CO and TRS at a variety of sites.
- Particulate sizing and Method 5 testing at a liquid hazardous waste incinerator.
- RCRA-permit related testing of solvent incinerators for the equipment manufacturer.
- Particulate and NO_x monitoring of a waste fuel-fired boiler.
- H_2S monitoring of two scrubbers at a carbon black plant.
- Test for lead, aluminum, CO and particulate at a mineral processing plant.
- Three simultaneous Method 25 runs on inlet and outlet of catalytic oxidation system.
- Several ambient air tests using NIOSH methods, including Method 7400 for asbestos fibers.

Mr. Betts is also proficient in several techniques for metal fabrication and carpentry which has enabled him to assemble specialized field equipment for complex and one-of-a-kind monitoring assignments.

Biographical Data

JOSEPH R. DUNCAN, P.E.

Manager/Air Quality Division

Education

B.S. in Civil Engineering, 1966, University of Alabama
M.S. in Civil Engineering, 1969, West Virginia University
M.S. in Environmental Engineering, 1974, University of Tennessee

Professional Affiliations, Honors and Awards

Registered Professional Engineer (Alabama and Tennessee)
Chairman, Atmospheric Pollution Committee, Am. Soc. of Civil Engrs. (1973)
Air Pollution Control Association
  TP-3 Measurements Committee, 1978 - Present
  Chairman TP-3.2 Source Measurements, 1978 - 1980
  TE-5 Visibility Committee, 1979 - Present
  Annual Technical Program Committee, 1980 - Present
  National Technical Program Committee, 1980 - Present
Technical Program Co-Chairman 76th Annual Meeting of APCA, Atlanta, GA, 1983
Southern Section, Air Pollution Control Association, Various offices including Chairman, 1977
Alabama Society of Professional Engineers, 1973 - Present
National Science Foundation Fellow, 1968
Chi Epsilon
Sigma Xi

Experience Record

1966-1967	Metropolitan Nashville Health Dept., Nashville, TN
1967-1970	Tennessee Valley Authority, Muscle Shoals, AL
1970-1972	Knox County Department of Air Pollution Control, Knoxville, TN
1972-1975	Harmon Engineering & Testing, Auburn, AL
1975-1978	South Alabama Regional Planning Commission, Mobile, AL
1978-1983	WLD Associates, Florence, AL
1983-1987	Harmon Engineering Associates, Auburn, AL
1987-Date	ATC, Inc., Auburn, AL

Qualifications for this Project

Mr. Duncan has been involved with HVAC system evaluation for buildings, control rooms and industrial process ventilation and controls. During the past four years he has served as Vice President of Environmental Services at a major environmental and engineering firm. In this position Mr. Duncan has managed 20 HVAC-related projects that have ranged from an evaluation of the HVAC system including the measurement of the duct velocity, balancing air flows, checking the fans and determining energy efficiencies to the design of air handlers and filter systems for sensitive equipment corrosion control and the design of air handling system components that provide for the return of heated air during the winter months as makeup air. These systems have included HEPA filters and carbon filters with appropriate controls and alarms to vent the air to the atmosphere when certain criteria are exceeded.

When with the Tennessee Valley Authority, Mr. Duncan managed the Regional Air Quality Program that included an indoor air quality assessment from residential wood-burning stoves and fireplaces. He was also involved in the planning and funding for several indoor air quality studies in the TVA region. He was a member of the TVA/EPA coordinating committee and served in a review capacity for work performed by the National Commission on Air Quality.

Pertinent Presentations & Publications

"Air Quality Impact Potential From Residential Wood-Burning Stoves," for presentation at the 73rd Annual Meeting of the Air Pollution Control Association, Montreal, Canada, June 22-27, 1980. Co-authors are Kieron M. Morkin and M. Paul Schmierbach.

"Air Pollution Control and Industrial Energy Production," Ann Arbor Science Publishers, Incorporated, Ann Arbor, Michigan, June 1975. Co-editor is K.E. Noll and W.T. Davis.

"Source Measurements of Total Reduced Sulfur Compounds for Pulp and Paper Processes," for presentation at the 4th Annual Industrial Air Pollution Control Conference, Knoxville, Tennessee, March 28-29, 1974.

"Technology and Air Pollution Control," for presentation at the 14th Annual American Institute of Plant Engineers, Tampa, Florida, October 23-25, 1973.

"Industrial Air Pollution Control, " Ann Arbor Press, Ann Arbor, Michigan, June 1973. Co-editor is K.E. Noll.

"Proceedings of the Third Annual Industrial Air Pollution Control Conference, March 29-30, 1973. Co-editors are K.E. Noll, J.C. Burdick, and W.A. Drewry.

"Point Source Monitoring in the Vicinity of Industrial Operations," for presentation at the Third Annual Industrial Air Pollution Control Conference, Knoxville, Tennessee, March 29-30, 1973.

"Measurements of Liquid Droplet Emissions from Cooling Towers and Process Stacks," for presentation at the 65th Annual Meeting of the Air Pollution Control Association, Miami Beach, Florida, June 18-22, 1972. Co-authored by B.R. Fish.

"The Application of a Telementry System to Air Quality Monitoring at Large Power Plants," presented at the 9th Annual Indiana Air Pollution Control Conference, Purdue University, LaFayette, Indiana, October 1970.

"An Exercise in Source Sampling Methods," presented at the Tennessee Manufacturing Association Workshop, Nashville, Tennessee, March 1970. Co-authored with Auburn E. Owen, Jr.

"Regional Air Quality Activities - TVA," presented at the annual meeting of the Tennessee Valley Section of the AIHA, Chattanooga, Tennessee, September 1969. Co-authored with H.E. Hodges.

Mr. Duncan has over 20 years of combined experience in federal, regional and local government and environmental consulting positions. The last nine years have been devoted to environmental consulting. In these positions he has authored or been responsible for more than 400 technical reports for industry and governmental clients, covering a wide range of subjects.

PROJECT SUMMARY

CLIENT CHI-VIT ATC PROJECT NO. 014-05

DATE/TIME	ACTION TAKEN
5/4/87	
1230	ARRIVED AT CHI-VIT & TALKED TO BOBBY GRIMES; HE TOLD US WHERE TO SET UP.
1300	STARTED SETTING UP TO RUN A PRELIMINARY RUN; PRELIMINARY VELOCITY DATA SHOWED ABOUT 49 cu.ft. OF STACK GAS. BOBBY GRIMES WANTED TO GET VELOCITY DOWN TO ABOUT 35 CU. FT., SO WE RAN A TOTAL OF ABOUT 5 or 6 VELOCITY TRAVERSES AS BOBBY GRIMES CHANGED SETTINGS ON THE SMELTER.....
1515	BOBBY G. DECIDED TO CHANGE FLYWHEEL ON FAN OF SCRUBBER SO WE WAITED
1610	RAN MORE VELOCITY TRAVERSES FOR BOBBY G. & FINALLY GOT IT WHERE HE WANTED IT..... VEL = 33.1 cuft. at 43" of H_2O PRESSURE DROP AT SCRUBBER.
1730	FINISHED RUNNING ALL VELOCITY TRAVERSES HAD A TOTAL OF 8 FOR THE DAY.
1800	LEFT THE MILL - HEADED TO GASDEN TO FIND MOTEL
5/5/87	
0700	ARRIVE AT MILL. BOBBY G. ASKS TO DO 3 MORE VELOCITY TRAVERSES, SO AS TO FINE TUNE SMELTER
0800	DO PRELIMINARY WORK & SET-UP FOR RUN #1. LEAK CHECK GOOD.
0825	START RUN #1 & OBSERVER JOHN T. HUGHES WITH ADEM, ARRIVES 20 MINUTES INTO TEST #1.

TAR-10A-1/85

ATC APPLIED TECHNOLOGY CONSULTANTS

PROJECT SUMMARY

CLIENT CHI-VIT ATC PROJECT NO. Ø4-Ø5

DATE/TIME	ACTION TAKEN
Ø93Ø	FINISH RUN #1; BOBBY BETTS RECOVERS MOISTURE
	& PROBE WASH, AS I SHOW JOHN HUGHES
	CALIBRATION DATA & CALCULATE %I FOR
	HIM. ISOKINETICS LOOK GOOD.
1Ø1Ø	BEGIN RUN #2. LEAK CHECK GOOD
112Ø	FINISH RUN #2; AS BOBBY B. RECOVERS MOISTURE
	& PROBE WASH, JOHN HUGHES TELLS ME THAT
	THE EPA & ADEM CLASSIFY THE STACK WE'RE
	TESTING AS #2 NORTH STACK / #2 SMELTER.
	BOBBY GRIMES & CHI-VIT CLASSIFY IT AS
	#3 NORTH STACK & SMELTER. I [illegible] LIQUID
	PAPER OVER #3 & PUT #2 ON MY
	FIELD DATA SHEETS
121Ø	SET UP FOR RUN #3. LEAK CHECK GOOD.
[illegible]	BEGAN RUN #3
131Ø	FINISHED RUN #3 & BEGAN CLEANING UP.
	DID NOT RECOVER IMPINGERS, BECAUSE
	RAIN SET IN. [illegible]
14ØØ	ALL WORK DONE, WE LEFT MILL HEADED
	TO OPELIKA.
	TOTAL FIELD TIME — 12.5 HRS.

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ATC APPLIED TECHNOLOGY CONSULTANTS

APPENDIX B

CALCULATIONS AND ABBREVIATIONS

PARTICULATE CALCULATIONS

CLIENT CHI-VIT PROJECT NO. Ø14-Ø5

SOURCE #2 North Stack

			Run Number	1	2	3
			Date	5/5/87	5/5/87	5/5/87
			Time Began	Ø825	1Ø25	121Ø
			Time End	Ø925	112Ø	131Ø
INPUT DATA						
Sampling Time, min	(θ)	$R_{.1}$		6Ø	6Ø	6Ø
Stack Area, ft^2	(A_s)	$R_{.2}$		5.46	5.46	5.46
Barometric Pressure, in Hg	(P_b)	$R_{.3}$		29.8Ø	29.8Ø	29.8Ø
Stack Pressure, in Hg	(P_s)	$R_{.4}$		29.77	29.77	29.77
Pitot Tube Coefficient	(C_p)	$R_{.5}$		Ø.84	Ø.84	Ø.84
Meter Correction Factor	(Y)	$R_{.6}$		1.Ø19	1.Ø19	1.Ø19
Nozzle Diameter, in	(D_n)	$R_{.7}$		Ø.3Ø9	Ø.3Ø9	Ø.3Ø9
Meter Volume, ft^3	(V_m)	R_0		48.94	48.Ø4	49.2Ø
Meter Temperature, °F	(T_m)	R_1		1Ø1	1Ø8	1Ø7
Meter Orifice Pressure, in H_2O	(ΔH)	R_2		2.Ø7	1.99	2.Ø3
Volume H_2O Collected, mL	(V_{1c})	R_3		18Ø	229.6	172
CO_2 Concentration, %	(CO_2)	R_4		Ø.5	Ø.5	Ø.5
O_2 Concentration, %	(O_2)	R_5		2Ø.Ø	2Ø.Ø	2Ø.Ø
Average Sq Rt Velo Head, $\sqrt{in\ H_2O}$	$(\sqrt{\Delta P})_{ave}$	R_6		Ø.567	Ø.555	Ø.56Ø
Stack Temperature, °F	(T_s)	R_7		139	146	147
Particulate Collected, g	(M_n)	R_8		Ø.Ø828	Ø.Ø933	Ø.Ø666
CALCULATED DATA						
Standard Meter Volume, ft^3	(V_{mstd})	R_0		47.Ø	45.5	46.7
Standard Water Volume, ft^3	(V_{wstd})	R_1		8.47	1Ø.8	8.1Ø
Moisture Fraction	(BWS)	R_2		Ø.15	Ø.19	Ø.15
Mol Wt of Stack Gas	(M_s)	R_3		27.2	26.8	27.3
Average Stack Gas Velocity, ft/sec	(V_s)	R_4		35.1	34.7	34.8
Stack Gas Flow @ Stack Cond, ft^3/min	(Q_a)	R_5		$1.15\times1Ø^4$	$1.14\times1Ø^4$	$1.14\times1Ø^4$
Stack Gas Flow @ Std Cond, ft^3/min	(Q_s)	R_6		$8.51\times1Ø^3$	$7.97\times1Ø^3$	$8.4Ø\times1Ø^3$
Isokinetic Sampling Rate, %	(%I)	R_7		96.3	99.8	97.2
Particulate Conc @ Std Cond, gr/ft^3	(C_s)	R_8		Ø.Ø271	Ø.Ø316	Ø.Ø22Ø
Particulate Emission Rate, lb/hr	(PMR)	R_9		1.9819	2.1557	1.58ØØ

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ATC INCORPORATED

PARTICULATE EMISSION EQUATIONS

Standard Meter Volume, $V_{mstd} = \frac{17.64\ Y\ V_m\ P_m}{T_m}$

Standard Wet Volume, $V_{wstd} = 0.04707\ V_{\ell c}$

Moisture Content, $BWS = \frac{V_{wstd}}{(V_{wstd} + V_{mstd})}$

Molecular Weight, $M_s = [0.44\ CO_2 + 0.32\ O_2 + 0.28(100-CO_2-O_2)](1-BWS) + 18\ BWS$

Average Velocity, $V_s = 85.49\ C_p\ (\sqrt{\Delta P})_{ave} \sqrt{\frac{T_s}{P_s\ M_s}}$

$(17.64)(15,445.87)(.79)\left(\frac{30.08}{602}\right)$

Average Stack Gas Flow
@ Stack Cond, $Q_a = 60\ V_s A_s$

13,968.24

Average Stack Gas Flow
@ Std Cond, $Q_s = 17.64\ Q_a (1-BWS)\frac{P_s}{T_s}$

$V_s = 85.49(0.84)(0.40)\left(\sqrt{\frac{142+460}{(30.08)(27.\ldots)}}\right)$

% Isokinetic Sampling, $\%I = \frac{0.0945\ T_s\ V_{mstd}}{P_s\ V_s\ A_n\ \theta(1-BWS)}$

$V_s = 26.76$

(.846) $\frac{602}{839.23}$ $\sqrt{0.71}$

Particulate Concentration
@ Std Conditions, $C_s = 15.4\frac{M_n}{V_{mstd}}$

Particulate Emission Rate, $PMR = 0.00857\ C_s\ Q_s$

79.2

$(6.65)^{+}(22.17)(.79)+3.78$

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APPENDIX C

FIELD AND LABORATORY DATA

PRELIMINARY VELOCITY DATA

CLIENT Chi-Vit ATC PROJECT NO. 014-05

SOURCE #3 North Stack DATE 5-4-87

DUCT DATA

Dist from far wall to outside of port 31.625 in.

Nipple length ______ in.

Depth of duct ______ in.

Width of duct (rec) ______ in.

Area of duct 5.5 ft²

Equivalent diameter

2 x depth x width / depth + width

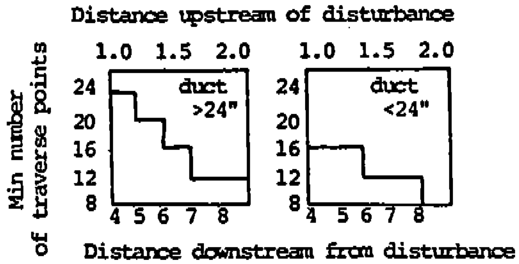
2(   )(   ) / (   ) + (   )

______

Dist from ports to nearest disturbance

	up-stream	down-stream
ft		
dia		

LOCATION OF TRAVERSE POINTS



CIRCULAR DUCTS

Traverse point number on a diameter	(Percent of stack diameter from inside wall to traverse point) 2	4	6	8	10	12
1	14.6	6.7	4.4	3.2	2.6	2.1
2	85.4	25.0	14.6	10.5	8.2	6.7
3		75.0	29.6	19.4	14.6	11.8
4		93.3	70.4	32.3	22.6	17.7
5			85.4	67.7	34.2	25.0
6			95.6	80.6	65.8	35.6
7				89.5	77.4	64.4
8				96.8	85.4	75.0
9					91.8	82.3
10					97.4	88.2
11						93.3
12						97.9

RECTANGULAR DUCTS

	2	3	4	5	6	7	8	9	10	11	12
1	25.0	16.7	12.5	10.0	8.3	7.1	6.3	5.6	5.0	4.5	4.2
2	75.0	50.0	37.5	30.0	25.0	21.4	18.8	16.7	15.0	13.6	12.5
3		83.3	62.5	50.0	41.7	35.7	31.3	27.8	25.0	22.7	20.8
4			87.5	70.0	58.3	50.0	43.8	38.9	35.0	31.8	29.2
5				90.0	75.0	64.3	56.3	50.0	45.0	40.9	37.5
6					91.7	78.6	68.8	61.1	55.0	50.0	45.8
7						92.9	81.3	72.2	65.0	59.1	54.2
8							93.8	83.3	75.0	68.2	62.5
9								94.4	85.0	77.3	70.8
10									95.0	86.4	79.2
11										95.5	87.5
12											95.8

MEASUREMENTS

Traverse Point	% of Diameter	Distance from inside wall	Distance from outside of port
1	4.4	1.4	
2	14.6	4.6	
3	29.6	9.4	
4	70.4	22.4	
5	85.4	27.0	
6	95.6	30.2	
7			
8			
9			
10			
11			
12			

SKETCH OF DUCT

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ATC APPLIED TECHNOLOGY CONSULTANTS

PRELIMINARY VELOCITY DATA

CLIENT Chi-Vit SOURCE #3 North Stack ATC PROJECT NO. ______

DATE 5/4/87 ATC PERSONNEL B. Betts / G. Davis

DUCT DIMENSION 31 5/8" CROSS SECTIONAL AREA 5.49 BAR. PRESSURE 29.81

PITOT TUBE ID # SP-1 AVG COEFFICIENT 0.84 DATE CALIBRATED ______

T_s (dry bulb) ______

T_s (wet bulb) ______

Moisture .18

P_s ______

O_2 20.0% ______

CO_2 0.5% ______

M_s 28.1

$\sqrt{\Delta P}$ ______

C_p ______

Base time ______

$V_s = 85.49\, C_p \sqrt{\Delta P} \sqrt{\frac{T_s}{M_s P_s}}$

M_s =

Q_a =

Q_s =

Stack Temp 137°F

142°F

TRAVERSE PT	$\sqrt{\Delta P}$	ΔP	ΔP	
1	.8660	.75	.75	.8660
2	.8602	.74	.74	.8602
3	.8426	.71	.72	.8485
4	.8307	.69	.60	.7746
5	.7681	.59	.54	.7348
6	.6928	.48	.45	.6708
7	.8775	.77		.7925
8	.8888	.79		
9	.8718	.76	.70	.8367
10	.8062	.65	.71	.8426
11	.7746	.60	.75	.7746
12	.6928	.48	.60	.7416
AVG:	.8143		.55	.6481
1			.42	.5916
2			.35	.7392
3	.70	.8367		
4	.74	.8602		
5	.66	.8124	.60	.7746
6	.55	.7416	.65	.8062
7	.53	.7280	.63	.7937
8	.41	.6403	.58	.7616
9		.7699	.53	.7280
10			.39	.6245
11				
12				.7481
mean				

Run #1 Run #2 Run #3 Run #4 Run 5

ATC APPLIED TECHNOLOGY CONSULTANTS

PARTICULATE DATA

CLIENT CHI-VIT ATC PROJECT NO. Ø14-Ø5
SOURCE #2 NORTH STACK/SMELTER DATE 5/5/87

RUN # 1 START TIME Ø825 END TIME Ø925
SAMPLING SITE #2 NORTH STACK CONTROL DEVICE ____
SAMPLING TYPE ____ SAMPLE CONSOLE # ATC-2 SAMPLE CASE # 1
AMBIENT TEMP 7Ø° WEATHER CLOUDY WIND SPEED/DIRECTION ____
ATC TEST PERSONNEL B. BETTS/G. DAVIS OBSERVERS JOHN HUGHES, ADEM

SKETCH OF STACK

Stack Dimensions 31 5/8 Orifice ΔH 1.759
Sample Time (min/pt) 5 Meter Corr. Factor 1.Ø19
Net Sample Time (min) 6Ø Pitot Tube # SP-1
Baro Press. (in Hg) 29.8Ø Pitot Factor Ø.84
Stack Press. (in Hg) 29.8 Nozzle ID # .3Ø9
Stack Temp DB/WB (°F) 139.25 Noz Dia Pretest (in) ____
Assumed Mois (%) ____ Noz Dia Posttest (in) ____
Pretest Leak Check Ø" @ 15" Avg Noz Dia (in) .3Ø9
Posttest Leak Check Ø" @ 15" Filter Type/Number 491
Final Gas Meter Reading 1Ø17.45Ø Silica gel # 1
Initial Gas Meter Reading 968.51Ø Δ Condensate (mL) 18Ø
Δ Meter Reading 48.94
Orsat: Method of Collection FYRITE GRAB

	RUN 1	RUN 2	RUN 3	AVG
% CO_2	Ø.5	—	—	0.5
% O_2	2Ø.0	—	—	
% CO				

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ATC APPLIED TECHNOLOGY CONSULTANTS

FIELD DATA

CLIENT CHI-VIT ATC PROJECT NO. 014-05

SOURCE #2 NORTH STACK & #2 SMELTER DATE 5/5/87 RUN # 1

PORT POINT NO.	DIST FROM WALL (IN)	CLOCK TIME	DGM READING V_m (ft^3)	ΔP (in. H_2O)	ΔH (in. H_2O)	DGM TEMP IN (°F)	DGM TEMP OUT (°F)	STACK TEMP (°F)	IMP OUT (°F)	HOT BOX TEMP (°F)	SAMPLE TRAIN VAC (inHg)
1		0825	968.510	.20	1.22	89	77	105	52	267	4
2		0830	971.511	.25	1.58	94	77	139	50	270	4
3		0835	975.533	.32	2.02	103	79	144	58	271	7
4		0840	979.395	.35	2.21	109	82	144	69	241	7
5		0845	983.641	.37	2.34	114	85	143	68	237	9
6		0850	988.251	.39	2.51	118	91	148	68	240	9
7		0855	993.201	.37	2.34	115	92	113	70	240	8
8		0900	997.921	.40	2.53	121	95	129	66	269	10
9		0905	1001.884	.45	2.90	123	97	144	70	270	13
10		0910	1007.110	.26	1.67	122	99	153	70	245	9
11		0915	1011.185	.26	1.67	122	99	154	70	245	9
12		0920	1014.310	.29	1.87	122	100	155	69	240	9
			1017.450								
AVG.		60	48.94	.32	2.07	112.6	89.4	139.15	65	252	
						101					
			√ΔP	0.567							

NOTES/REMARKS:

$\Delta H = \Delta P[(893.94)(C_p)^2(FDA)^2(\Delta H_@)(Dn)^4(\frac{T_m}{T_s})]$

80 = 6.14
90 = 6.22
100 = 6.33
110 = 6.45

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ATC APPLIED TECHNOLOGY CONSULTANTS

PARTICULATE DATA

CLIENT: CHI-VET ATC PROJECT NO. Ø14-Ø5
SOURCE: #2 NORTH STACK/SMELTER DATE: 5/5/87

RUN #: 2 START TIME: 1Ø25 END TIME: 113Ø
SAMPLING SITE: #2 NORTH STACK CONTROL DEVICE: ______
SAMPLING TYPE: ______ SAMPLE CONSOLE #: ATC-2 SAMPLE CASE #: 2
AMBIENT TEMP: 70° F WEATHER: OVERCAST WIND SPEED/DIRECTION: ______
ATC TEST PERSONNEL: B BETTS/G DAVIS OBSERVERS: John Hughes, ADEM

SKETCH OF STACK

Stack Dimensions: 31 5/8" Orifice ΔH: 1.759
Sample Time (min/pt): 5 Meter Corr. Factor: 1.Ø19
Net Sample Time (min): 6Ø Pitot Tube #: SP-1
Baro Press. (in Hg): 29.8Ø Pitot Factor: Ø.84
Stack Press. (in Hg): 29.8Ø Nozzle ID #: ______
Stack Temp DB/WB (°F): 146 Noz Dia Pretest (in): ______
Assumed Mois (%): ______ Noz Dia Posttest (in): ______
Pretest Leak Check: Ø.ØØ1" @ 15" Avg Noz Dia (in): Ø.3Ø9
Posttest Leak Check: Ø @ 15" Filter Type/Number: 492
Final Gas Meter Reading: 1Ø65.9 Silica gel #: 2
Initial Gas Meter Reading: 1Ø17.859 Δ Condensate (mL): 316 + Silicagel
Δ Meter Reading: 48.Ø4
Orsat: Method of Collection: FYRITE GRAB

232 ml
184 ml
316
229.1 TOTAL

	RUN 1	RUN 2	RUN 3	AVG
% CO_2	Ø.5	Ø.5		
% O_2	2Ø	2Ø		
% CO				

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ATC APPLIED TECHNOLOGY CONSULTANTS

FIELD DATA

CLIENT CHI-VIT ATC PROJECT NO. 014-05

SOURCE # NORTH STACK DATE 5/5/87 RUN # 2

& #2 SMELTER

PORT POINT NO.	DIST FROM WALL (IN)	CLOCK TIME	DGM READING V_m (ft^3)	ΔP (in. H_2O)	ΔH (in. H_2O)	DGM TEMP IN (°F)	DGM TEMP OUT (°F)	STACK TEMP (°F)	IMP OUT (°F)	HOT BOX TEMP (°F)	SAMPLE TRAIN VAC (inHg)
1		1025	1017.859	.31	1.92	106	88	124	57	243	5
2		1030	1023.11	.40	2.58	116	91	137	41	238	7
3		1035	1026.48	.43	2.77	120	93	151	46	233	7
4		1040	1031.39	.28	1.80	121	96	153	50	229	6
5		1045	1035.23	.25	1.61	120	97	154	52	232	5
6		1050	1039.01	.28	1.80	121	98	155	53	236	6
7		1055	1042.264	.23	1.48	116	99	126	52	239	5
8		1100	1046.00	.25	1.61	121	100	142	52	243	6
9		1105	1049.60	.28	1.80	121	101	151	54	245	7
10		1110	1053.65	.32	2.06	122	102	153	56	249	8
11		1115	1057.71	.36	2.25	123	102	154	60	248	8
12		1120	1061.91	.35	2.25	122	102	154	63	246	8
			1065.90								
AVG:			48.04	.31	1.99	119	97.4	146			
						108					
			$\sqrt{\Delta P}$	0.555							

NOTES/REMARKS:

$$\Delta H=\Delta P[(893.94)(C_p)^2(FDA)^2(\Delta H_@)(Dn)^4(\frac{T_m}{T_s})]$$

80 = 6.14
90 = 6.22
100 = 6.33
110 = 6.45

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ATC APPLIED TECHNOLOGY CONSULTANTS

PARTICULATE DATA

CLIENT CHI-VET ATC PROJECT NO. Ø14-Ø5
SOURCE #2 NORTH STACK/SMELTER DATE 5/5/87

RUN # 3 START TIME 121Ø END TIME 131Ø
SAMPLING SITE #2 NORTH STACK CONTROL DEVICE ____
SAMPLING TYPE ____ SAMPLE CONSOLE # ATC-2 SAMPLE CASE # 3
AMBIENT TEMP 7Ø°F WEATHER CLOUDY WIND SPEED/DIRECTION ____
ATC TEST PERSONNEL B.BETTS/G.DAVIS OBSERVERS JOHN HUGHES, ADEM

SKETCH OF STACK

Stack Dimensions 31 5/8" Orifice ΔH 1.759
Sample Time (min/pt) 5 Meter Corr. Factor 1.Ø19
Net Sample Time (min) 6Ø Pitot Tube # SP-1
Baro Press. (in Hg) 29.8" Pitot Factor Ø.84
Stack Press. (in Hg) 29.8" Nozzle ID # ____
Stack Temp DB/WB (°F) 146.5 Noz Dia Pretest (in) ____
Assumed Mois (%) ____ Noz Dia Posttest (in) ____
Pretest Leak Check Ø AT 15" Avg Noz Dia (in) .3Ø9
Posttest Leak Check Ø AT 15" Filter Type/Number 493
Final Gas Meter Reading 1117.3Ø8 Silica gel # 3
Initial Gas Meter Reading 1Ø68.1Ø1 Δ Condensate (mL) 172
Δ Meter Reading 49.2Ø
Orsat: Method of Collection FYRITE GRAB

	RUN 1	RUN 2	RUN 3	AVG
% CO_2	Ø.5	Ø.6	Ø.5	
% O_2	2Ø	2Ø	2Ø	
% CO				

Page 3 of ____

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ATC APPLIED TECHNOLOGY CONSULTANTS

FIELD DATA

CLIENT Chi-Vit ATC PROJECT NO. Ø14-Ø5

SOURCE #2 North Stack & #2 Smelter DATE 5/5/87 RUN # 3

PORT POINT NO.	DIST FROM WALL (IN)	CLOCK TIME	DGM READING V_m (ft^3)	ΔP (in. H_2O)	ΔH (in. H_2O)	DGM TEMP IN (°F)	DGM TEMP OUT (°F)	STACK TEMP (°F)	IMP OUT (°F)	HOT BOX TEMP (°F)	SAMPLE TRAIN VAC (inHg)
1		121Ø	1Ø68.1Ø1	.19	1.22	1Ø2	9Ø	12Ø	53	273	3
2		1215	1Ø72.27	.25	1.61	111	91	141	5Ø	245	5
3		122Ø	1Ø76.1Ø	.31	1.93	114	93	151	51	25Ø	5
4		1225	1Ø8Ø.71	.35	2.25	116	95	155	52	249	7
5		123Ø	1Ø84.2Ø	.38	2.45	117	96	155	54	257	7
6		1235	1Ø88.5	.36	2.32	118	97	155	56	261	7
7		124Ø	1Ø92.Ø39	.3Ø	1.93	116	98	122	54	257	6
8		1245	1Ø96.65	.4Ø	2.58	12Ø	99	143	54	257	8
9		125Ø	11Ø1.11	.43	2.77	121	1ØØ	152	56	259	9
1Ø		1255	11Ø5.4Ø	.28	1.8Ø	122	1Ø1	154	59	265	7
11		13ØØ	11Ø9.3	.28	1.8Ø	121	1Ø1	155	6Ø	261	8
12		13Ø5	1113.7	.28	1.8Ø	121	1Ø2	155	61	257	7
			1117.3Ø8								
AVG			49.2Ø	.31	2.Ø3	116.5	97	146.5			
						1Ø7					
			√ΔP	.56Ø							

NOTES/REMARKS:

$\Delta H = \Delta P[(893.94)(C_p)^2(FDA)^2(\Delta H_@)(Dn)^4(\frac{T_m}{T_s})]$ 8Ø = 6.14

9Ø = 6.22

K → 1ØØ = 6.33

11Ø = 6.45

Page ____ of ____

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APPLIED TECHNOLOGY CONSULTANTS

LABORATORY DATA

CLIENT CHI-VIT ATC PROJECT NO. 014-05

Condition of Sample on Arrival?	✓	✓	✓		
Liquid Levels Marked? (Y/N)	Yes	Yes	Yes		
Filter Container Sealed (Y/N)	Yes	Yes	Yes		
ATC Laboratory Number	S-1	S-2	S-3		

Laboratory Personnel Taking Custody GENE DAVIS

Date Received in Laboratory 5/6/87

Sample Identification Beaker #/Liquid Volume Run # Filter #	Initial Wt. #1 Initial Wt. #2 Initial Wt. #3 Avg. Initial Wt.	Final Wt. #1 Final Wt. #2 Final Wt. #3 Avg. Final Wt.	Δ Weight -- Filter Weight -- Blank Net Particulate Wt.
P-1/150ml Run 1 900491	104.7364 104.7350 104.7351 104.7355	105.2175 105.2160 105.2161 105.2165	0.4810 -0.3956 -0.0026 0.0828
P-10/125ml Run 2 900492	99.0241 99.0250 99.0255 99.0249	99.5170 99.5152 99.5166 99.5163	0.4914 -0.3955 -0.0026 0.0933
P-3/130ml Run 3 900493	100.5219 100.5224 100.5212 100.5218	100.9859 100.9863 100.9862 100.9861	0.4643 -0.3951 -0.0026 0.0666
Blank P-14/150 900494	103.8388 103.8406 103.8390 103.8395	104.2365 104.2373 104.2368 104.2369	0.3974 -0.3948 .0026

Analyst Betts Laboratory Supervisor [signature]

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TAR-46-1/85

ATC APPLIED TECHNOLOGY CONSULTANTS

SAMPLE RECOVERY AND INTEGRITY

CLIENT CHi-VIT ATC PROJECT NO. Ø14-Ø5

SOURCE # North Stack & #2 Smelting Tank

SAMPLE DATE 5/5/87 SAMPLE PERSONNEL Gene Davis; Bobby Betts

RECOVERY DATE 5/6/87 RECOVERY PERSONNEL G. Davis ; B. Betts

MOISTURE DATA

	RUN # 1	RUN # 2	RUN # 3
Final Volume in Impingers (mL)	364	416	360
Initial Volume in Impingers (mL)	200	✓	✓
Net Volume Increase (mL)	164	216	160
Silica Gel Number	1	2	3
Final Silica Gel Wt (g)	251.5	225.9	254.4
Initial Silica Gel Wt (g)	235.5	212.3	242.4
Δ Wt (g)	16.0	13.6	12.0
Total Moisture (mL)	180	229.6	172

IMPINGER NUMBER

Run #		1	2	3	4	5
Run #____	Final Wt					
	Initial Wt					
	Δ Wt					
Run #____	Final Wt			N/A		
	Initial Wt					
	Δ Wt					
Run #____	Final Wt					
	Initial Wt					
	Δ Wt					

SAMPLE RECOVERY

	RUN # 1	RUN # 2	RUN # 3
Filter Number	900		
Filter Cont. No/Wash Cont. No.	F-1 / PW-1	F-2 / PW-2	F-3 / PW-3
Filter Container Sealed (Y/N)	YES	✓	✓
Probe Wash Level Mark? (Y/N)	YES	✓	✓
Solvent Blank Cont. No.	BLANK	✓	✓

NOTES:

Page _____ of _____

[signature]
TEST TEAM LEADER

TAR-25-1/85

ATC APPLIED TECHNOLOGY CONSULTANTS

APPENDIX D

EQUIPMENT AND CALIBRATIONS

DRY GAS METER CALIBRATION

Date: 4201987

Console No.: ATC-2

Pbar(in. Hg): 30.100

Y std.: 1.023

Calibrated By: GENE DAVIS

Ø14-Ø5 PRECALIBRATION

Delta H	(Delta H)/13.6	Std Meter Volume Final	Std Meter Volume Initial	Std Meter Volume Delta V (Vw)	Volume Meter Final	Volume Meter Initial	Volume Meter Delta V (Vd)	T Meter Tw	T Meter In	T Meter Out	T Meter Avg. (Td)	Theta	Y1	Delta H (Calc.)
3.000	.221	278.440	264.835	13.605	928.187	913.400	14.787	72.000	127.000	112.000	119.500	15.000	1.018	1.876
2.000	.147	290.571	278.920	11.651	941.070	928.700	12.370	71.000	121.000	113.000	117.000	15.000	1.042	1.706
1.500	.110	300.842	290.984	9.858	952.046	941.401	10.645	71.000	127.000	113.000	120.000	15.000	1.031	1.778
1.000	.074	309.432	301.173	8.259	961.280	952.401	8.879	72.000	123.000	113.000	118.000	15.000	1.031	1.701
.500	.037	315.442	309.647	5.795	968.099	961.510	6.589	72.000	119.000	113.000	116.000	15.000	.973	1.734
												Average:	1.019	1.759

DRY GAS METER CALIBRATION

014-05 POST CALIBRATION

Date: 5-6-87
Console No.: ATC-2
Pbar(in. Hg): 30.080
Y std.: 1.023
Calibrated By: GENE DAVIS

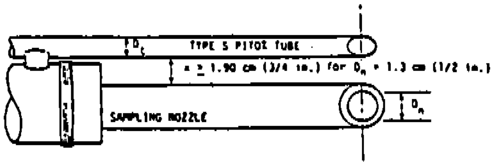
		Std Meter Volume			Volume Meter				T Meter					
Delta H	(Delta H)/13.6	Final	Initial	Delta V (Vw)	Final	Initial	Delta V (Vd)	Tw	In	Out	Avg. (Td)	Theta	Y1	Delta H (Calc.)
3.000	.221	356.597	342.616	13.981	160.736	145.938	14.798	76.000	118.000	99.000	108.500	15.316	1.018	1.917
2.000	.147	368.458	356.976	11.482	173.368	161.123	12.245	76.000	114.000	104.000	109.000	15.260	1.013	1.880
1.500	.110	378.727	368.843	9.884	184.345	173.779	10.566	75.000	121.000	106.000	113.500	15.210	1.022	1.868
1.000	.074	387.261	379.030	8.231	193.543	184.682	8.861	76.000	117.000	106.000	111.500	15.430	1.011	1.862
.500	.037	393.256	387.528	5.728	200.018	193.830	6.188	76.000	115.000	106.000	110.500	15.000	1.007	1.820
												Average:	1.014	1.869

PITOT TUBE CALIBRATION

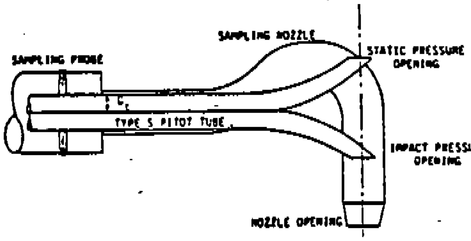
PITOT TUBE ASSEMBLY IDENTIFICATION PT-1

PITOT TUBE ASSEMBLY LEVEL? X yes ______ no

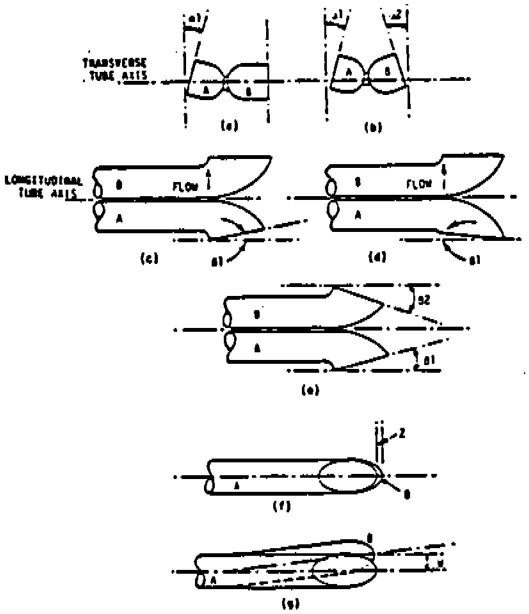
PITOT TUBE OPENINGS DAMAGED? ______ yes X no



(a) BOTTOM VIEW: SHOWING MINIMUM PITOT-NOZZLE SEPARATION.



(b) SIDE VIEW: TO PREVENT PITOT TUBE FROM INTERFERING WITH GAS FLOW STREAMLINES APPROACHING THE NOZZLE. THE IMPACT PRESSURE OPENING PLANE OF THE PITOT TUBE SHALL BE EVEN WITH OR DOWNSTREAM FROM THE NOZZLE ENTRY PLANE



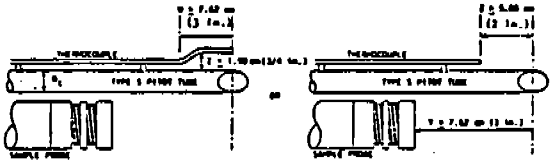


Figure 2.2 Required thermocouple and probe placement to prevent interference: D_t between 0.48 and 0.95 cm (3/16 and 3/8 in.).

α_1 = 1 ° (<10°), α_2 = 3 ° (<10°),

β_1 = 3 ° (<5°), β_2 = 2.75 ° (<5°)

γ = 1 °, θ = 1 °, A = .975 (in)

Z = A sin γ = ∅.∅17∅ (in.); <0.125

w = A sin θ = ∅.17∅ (in.); <0.031

P_A ∅.485 (in.) P_b ∅.485 (in.)

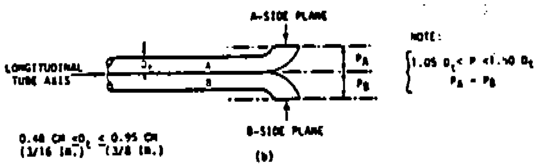
D_t = ∅.375 (in.)

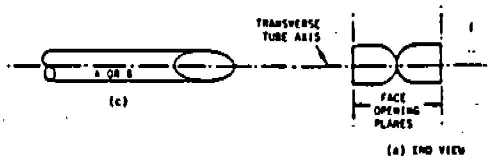
X = ______ (in.); ≥0.750

Z = ______ (in.); ≥2.0

Y = ______ (in.); ≥3.0

Comments: ______





Assign Coefficient 0.84 X yes ____ no Date 4/21/87 Checked by GENE DAVIS

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TAR-20-1/85

ATC-2

THERMOCOUPLE CALIBRATION SUMMARY

3/26/87

		ICE BATH	ROOM TEMP	STEAM	OTHER
THERMOCOUPLE LOCATION 3 ft PROBE	THERMOCOUPLE READING	35°	75°	154°	
	THERMOMETER	34°	74°	154°	
	% DIFFERENCE				
THERMOCOUPLE LOCATION HB#2 OVEN	THERMOCOUPLE READING		75°	154°	260°
	THERMOMETER		75°	154°	261°
	% DIFFERENCE				
THERMOCOUPLE LOCATION ATC-2 METER IN	THERMOCOUPLE READING		74°		
	THERMOMETER		73°		
	% DIFFERENCE				
THERMOCOUPLE LOCATION ATC-2 METER OUT	THERMOCOUPLE READING		74°		
	THERMOMETER		74°		
	% DIFFERENCE				
THERMOCOUPLE LOCATION HB#2 IMPENGER OUT	THERMOCOUPLE READING	36°	78°		
	THERMOMETER	36°	73°		
	% DIFFERENCE				
THERMOCOUPLE LOCATION	THERMOCOUPLE READING				
	THERMOMETER				
	% DIFFERENCE				
THERMOCOUPLE LOCATION	THERMOCOUPLE READING				
	THERMOMETER				
	% DIFFERENCE				
THERMOCOUPLE LOCATION	THERMOCOUPLE READING				
	THERMOMETER				
	% DIFFERENCE				

GENE DAVIS - DANNIS GREENE

APPENDIX E

PROCESS DATA

CHI-VIT CORPORATION LEESBURG, AL

OPERATOR: BOBBY GRIMES

NORTH STACK #2

UNIT: #2 FRIT UNIT

ALA PERMIT: 3-03-0001-z003

PRODUCT: A-561

PORCELAIN ENAMEL FRIT

DATE	TIME	FEED RATE	CFH GAS USEAGE	VENTURI PRES. DROP	TOTAL GAS AND AIR CFH
5-5-87	8 A.M.	1 T/H	9800	44"	107,800
	9 A.M.	1 T/H	9800	43"	107,800
	10 A.M.	1 T/H	9800	44"	107,800
	11 A,M,	1 T/H	9800	44"	107,800
	12 A,M,	1 T/H	9800	44"	107,800
	1 P.M.	1 T/H	9800	44"	107,800
	1:15 P.M.	1 T/H	9800	44"	107,800