



**AUDIT REPORT FOR
MONTEZUMA COUNTY MONITORING PROJECT
CORTEZ, COLORADO
FIRST QUARTER 2011**

Prepared by

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1.0 AUDIT SUMMARY

The Montezuma County Public Health Department is operating a Federal Reference Method (FRM) PM_{2.5} particulate sampler and ambient ozone monitoring system for the Colorado Department of Public Health and Environment (CDPHE) Air Pollution Control District (APCD). The monitoring station is located at the Montezuma County Department of Public Health Building. The monitoring program has been designed to fulfill specific regulatory requirements that relate to the APCD's Quality Assurance Project Plan (QAPP) and Standard Operating Procedures (SOPs).

The monitoring system which consists of a Thermo Scientific Model 2000 PM_{2.5} FRM sampler, a Teledyne API Model 400E ozone analyzer, a Teledyne API Model 703E ozone calibrator, a ESC Model 8832 datalogger, and a laptop computer with DataView software. The PM_{2.5} FRM is located on the roof of the County Health Building. The ozone analyzer is located in a supply closet in the facility with the air intake system located on the roof. Calibration gases are fed into the sample line near the sample inlet located on the roof. The ozone analyzer, ozone transfer standard, ESC datalogging system, and laptop computer are rack mounted and located in the supply closet. Remote communications to the datalogger and laptop computer is possible via a landline telephone modem.

Air Resources Specialists, Inc. (ARS) conducted a performance audit of the monitoring systems on March 16, 2011. Guidance from the following EPA and CDPHE documents was used to establish the audit procedures:

- 40 CFR 58, Appendix A. *Quality Assurance Requirements for SLAMS, SPMs, and PSD Air Monitoring*
- EPA *Quality Assurance Handbook for Air Pollution Measurement Systems:*
 - *Volume I. A Field Guide to Environmental Quality Assurance*
 - *Volume II. Ambient Air Quality Monitoring Program*
- EPA *Transfer Standards for Calibration of Air Monitoring Analyzers for Ozone*
- Colorado Department of Health and the Environment, Air Pollution Control District, *Quality Assurance Project Plan*
 - *QAPP Appendix D Standard Operating Procedure for the Determination of Ozone in Ambient Air*
 - *QAPP Appendix J Field Standard Operating Procedures for Operation and Maintenance of the FRM PM_{2.5} Samplers*

The monitoring site specifications, as measured by ARS' global positioning system (GPS), and parameters audited are:

-
- Elevation: 6,184 feet MSL
 - Latitude: 37° 21' 01" N
 - Longitude: 108° 35' 13" W
 - UTM 4136463 N
 - UTM 12 713732 E
-

Ambient air quality instruments audited were:

- Ozone (O₃) Analyzer
 - In-Station Calibrator
 - FRM Particulate (PM_{2.5}) Sampler
-

At the time of the audit, the ozone analyzer and FRM particulate sampler were operating within EPA and project accuracy goals. Ambient air quality audit results are summarized by parameter in Table 1-1.

Table 1-1

Summary of Ambient Air Quality Audit Results

Parameter	Instrument/Analyzer	Within Accuracy Goal
Gaseous Samplers		
O ₃	API* 400E Analyzer	Yes
O ₃	API* 703E Calibration System	Yes
Particulate Sampler		
PM _{2.5}	Thermo Scientific 2000 PM _{2.5} Sampler	Yes

*Teledyne - Air Pollution Instruments, Inc.

Details of the audit are presented in the following sections:

Section 2.0	Audit Methods
Section 3.0	Audit Equipment
Section 4.0	Audit Results
Appendix A	Audit Data Sheets
Appendix B	Audit Standards Certifications
Appendix C	ARS Quality Assurance Department

Any questions related to this audit or audit report should be addressed to:

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Air Resource Specialists, Inc.
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Fax: 970-484-3423
E-mail: dcobb@air-resource.com

2.0 AUDIT METHODS

Audit procedures, audit challenge ranges, and acceptance criteria are described below. These ranges and limits conform to the CDPHE Quality Assurance Project Plan. Audit results were verbally communicated to the site operator and the Air Resource Specialists, Inc. (ARS) Project Manager prior to departure from the site. Audit data forms are provided in Appendix A.

2.1 GASEOUS OZONE ANALYZER

Audit challenge ranges and acceptance criteria for the ambient ozone analyzer are presented in Table 2-1. Audits were conducted by using an ozone transfer standard referenced to the ARS primary standard located in the ARS standards laboratory. A zero and three (3) up scale test atmospheres were generated using the in-station calibration standard. Audit values were obtained from the on-site data acquisition system and the ARS ozone transfer standard observed values.

The percent difference between the actual concentration of the audit test gas and the concentration indicated by the analyzer was used to determine if the analyzer was operating within specified limits. Analyzers whose readings at any point differed from the test atmosphere by more than $\pm 10\%$ were considered out of tolerance, QAPP Table A7-2.

Table 2-1

Ozone Analyzer
Audit Challenge Ranges and Acceptance Criteria

Parameter	Audit Concentration Ranges (ppm)					Acceptance Criteria
	Level 1	Level 2	Level 3	Level 4	Level 5	
O ₃	0.02-0.05	0.06-0.10*	0.11-0.20*	0.21-0.30	0.31-0.90*	$\pm 10\%$ for any point

* Indicates ranges used for this project.

2.1.1 In-Station Standards Comparisons

In addition to conducting audits of the gaseous analyzers, ARS also conducted a comparison of the in-station ozone calibration standard. The in-station calibration standard consisted of an API gas dilution system which included a primary ozone standard, and zero air supply. Standards comparisons are not required in the regulatory guidelines; however, ARS has found this to be a useful evaluation tool in cases where analyzers are operating outside of project accuracy goals.

2.2 PARTICULATE SAMPLERS

The volumetric flow controlled federal reference method (FRM) PM_{2.5} particulate sampler was audited in its normal operating mode. ARS audited the sampler with a deltaCal instrument which measures flow, ambient temperature, and barometric pressure. Prior to conducting the flow audit, a system leak check was performed. A leak check of ≥ 80 mL per minute is considered out of tolerance, QAPP Table A7-7. During a leak check the Model 2000 FRM sampler will not measure flow rate therefore a change in vacuum over a 30 second period is used to identify a leak. The instrument manufacturer states in the operation manual, a leak of ≥ 80 mL per minute is equivalent to an 8.5" Hg change in vacuum over 30 seconds. This value will be used to identify if a leak is present. The observed volumetric operational flow and design flow of the sampler were compared to the audit flows measured by the ARS deltaCal. Differences between the operational sampler flow and audit flow that are greater than $\pm 4\%$ are considered out of tolerance. Differences between the designated design flow and the audit flow greater than $\pm 5\%$ are considered out of tolerance. In addition to the flow audits, the FRM's observed ambient temperature and barometric pressure sensors were also audited by comparison to the deltaCal values. A temperature difference greater than $\pm 2.0^\circ\text{C}$ and a barometric pressure difference greater than $\pm 10\text{mm Hg}$ are considered out of tolerance. Audit methods and acceptable criteria for the particulate samplers are summarized in Table 2-2.

Table 2-2

FRM PM_{2.5} Particulate Samplers
Audit Methods and Acceptance Criteria

Parameter	Audit Method	Acceptance Criteria
Leak Check	Zero flow to actual sampler flow	≤ 80 mL/min*
Actual Volumetric Sampler Flow	DeltaCal audit flow to actual sampler flow (volumetric)	$\leq \pm 4\%$
Designated Design Flow	Designated design flow to audit flow (volumetric)	$\leq \pm 5\%$
Ambient Temperature ($^\circ\text{C}$)	Audit temperature to sampler temperature	$\leq \pm 2^\circ\text{C}$
Barometric Pressure (mm Hg)	Audit barometric pressure to sampler pressure	$\leq \pm 10\text{mm Hg}$

*The manufacturer states a 80 mL/min leak is equivalent to an 8.5" HG vacuum loss in 30 seconds.

3.0 AUDIT EQUIPMENT

All audit equipment and reference standards were in current calibration and traceable to the NIST or other authoritative references. Table 3-1 lists the specific audit equipment used and certification dates. Copies of standards certifications for the equipment used in the audit are provided in Appendix C.

Table 3-1
Audit Equipment

References	Manufacturer	Model Number	Serial Number	Recertification Date
O ₃	TEI	49C	401504-581	5/17/2011
FRM Audit	BGI	deltaCal	413	9/20/2011
Digital Voltmeter	Fluke	87-III	83960053	1/10/2012

4.0 AUDIT RESULTS

Detailed Montezuma County monitoring system audit results of ozone analyzer and the standards comparison are provided in Table 4-1. Audit results for the particulate sampler are shown in Table 4-2. Audit findings and recommendations are discussed below.

4.1 AUDIT FINDINGS

Performance Audit Results

- The ozone analyzer was operating within project accuracy goals. However, there was more difference than normal. Following the audit, the issue was traced to line loss in the ozone output gas sample line to the roof. A temporary fix was implemented by bypassing the output gas line.

System Audit Results

- Leak check not performed as sample was operating; leak check was performed by site operator.

Table 4-1
 Summary of Audit Findings
 Continuous Ozone Analyzer
 Montezuma County
 Cortez, CO
 March 16, 2011

Parameter	Manufacturer	Instrument Serial No.	Designated Audit Value	DAS Observed	Accuracy Goal (±) *	Percent Difference (± 10%)	Within Accuracy Goal
Ozone - Parts Per Million							
Analyzer	API	1750	0.000	0.000	0.000	NA	N/A
			0.403	0.400	0.040	-0.7	Y
			0.192	0.189	0.019	-1.6	Y
			0.076	0.069	0.008	-9.2	Y
Slope = 1.010746		Correlation = 0.999962					
Intercept = -0.006737		Mean % = -2.88					
Ozone - Parts Per Million							
Transfer Standard	API	145	0.000	0.000	0.000	0.0	N/A
			0.403	0.402	0.0403	0.4	Y
			0.192	0.200	0.0192	0.2	Y
			0.076	0.081	0.0076	0.1	Y
Slope = 0.968371		Correlation = 0.999957					
Intercept = 0.015271		Mean % = 2.62					
* Continuous analyzer accuracy goals are +/- 10.0% of observed. Accuracy goals were taken from the CDPHE Quality Assurance Project Plan Table A7-2.							

Table 4-2
 Summary of Audit Findings
 FRM Sampler
 Montezuma County
 Cortez, CO
 March 16, 2011

Parameter	Manufacturer	Instrument Serial No.	Designated Audit Value	DAS Observed	Accuracy Goal (±)	Difference	Within Accuracy Goal
FRM PM_{2.5}	TEI	200FB208870804					
Lk Ck External			-15.5	-14.5	15.0	1.0	Y
Lk Ck Internal			-19.5	-17.8	8.5	1.7	Y
Flow (Volumetric)			16.5	16.7	5.0	1.2	Y
Flow (Design)			16.7	16.7	4.0	0.0	Y
Ambient Temperature			8.2	8.6	2.0	0.4	Y
Filter Temperature			8.3	8.5	2.0	0.2	Y
Ambient Pressure			608.0	608	10.0	0.0	Y
* PM 2.5 measurement quality objectives were taken from the CDPHE Quality Assurance Project Plan Table A7-7							
*Leak check accuracy goals are based on 80 ml/min which corresponds to < 8.5" Hg change in 30 seconds, according to the manufacturer.							

APPENDIX A

Audit Data Sheets

OZONE AUDIT

Date: **3/16/2011** Network: Montezuma County Site: Cortez Auditor: **D. Cobb**

Site Analyzer Mfg: API Model: 400E S/N: 1750 Last Certification Date: **2/8/2011**

Site Reference Mfg: API Model: 703E S/N: 145 Last Certification Date: **2/8/2011**

Audit O3 Mfg: **TECO** Model: **49c** S/N: **401504-581** Recalibration Date: **5/17/2011**

Frequency A: **109138** Frequency B: **83717** A Flow: **0.621** B Flow: **0.617**

Zero Air Mfg: In-Station Model: N/A S/N: N/A Maintenance Due Date: N/A

AUDIT REFERENCE		STATION ANALYZER			STATION REFERENCE		
Audit Point	Input Conc. (ppm)	DAS Reading	Recorder Reading	%Difference Ref.vs.Analyzer	DAS Reading	Recorder Reading	%Difference Ref.vs.SiteRef.
Zero	0.000	0.000	N/A	NA	0.000	N/A	NA
1	0.403	0.400	N/A	-0.7	0.402	N/A	-0.2
2	0.192	0.189	N/A	-1.6	0.200	N/A	4.2
3	0.076	0.069	N/A	-9.2	0.081	N/A	6.6
4							

STATION REFERENCE CHECK					
Station Reference			Station Analyzer		
Cal. Point	Display Reading	Recorder Reading	DAS Reading	Recorder Reading	% Difference Ref. vs Analyzer
1	N/A	N/A	N/A	N/A	N/A
2	N/A	N/A	N/A	N/A	N/A
3	N/A	N/A	N/A	N/A	N/A

LINEAR REGRESSION			
Station Analyzer		Station Reference	
Slope	1.010746	Slope	0.968371
Intercept	-0.006737	Intercept	0.015271
Correlation	0.999962	Correlation	0.999957
Average % Difference	-2.9	Average % Difference	2.6

REMARKS:

Signature: *D. Cobb*

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FRM PM_{2.5} Monitor Audit

Date: 3/16/2011 Network: Montezuma County Site: Cortez, Colorado Auditor: D. Cobb

Manufacturer: TEI Model: 2000 FRM S/N: 200FB208870804

Audit Standards			
Flow Standard	Model BGI Delta Cal	S/N 413	Cal. Date 9/10/2010
Temperature Std.	Model BGI Delta Cal	S/N 413	Cal. Date 9/10/2010
BP Standard	Model BGI Delta Cal	S/N 413	Cal. Date 9/10/2010

Leak Check*			
	Start Vacuum	End Vacuum	Difference
Lk Ck Ext. (<15.0")	-	-	
Lk Ck Int. (<8.5")	-	-	

Flow Audit lpm			
	Reference/Std	FRM Observed	Difference
Flow (Volumetric)	16.5	16.7	1.2
Flow (Design)	16.7	16.7	0.0

Temperature °C			
	Reference/Std	FRM Observed	Difference
Ambient Temperature	8.2	8.6	0.4
Filter Temperature	8.3	8.5	0.2

Barometric Pressure mmHg			
	Reference/Std	FRM Observed	Difference
Ambient Pressure	608	608	0

APPENDIX B

Audit Standards Certifications

LAB O₃ CALIBRATION FORM

Date 2/17/2011 Client ARS Tech. Martin H Valvur

DVM Manufacturer Fluke Model 179

Last Certification Date New Serial Number 93300646

Z Air Make ARS Model Lab

Serial Number N/A Last Maintenance Date 02/18/09

PRIMARY	
Last Cal. Date	6/17/2010
Manufacturer	TECO
Model	49C PS
Serial Number	75759-380
BKG / CO EFF	0.0 / 1.020
A Frequency	86144
B Frequency	88281
Flow	.661 / .547
Cell Temp / BP	29.9 / 635.0
Inst. Offset (ppm)	0

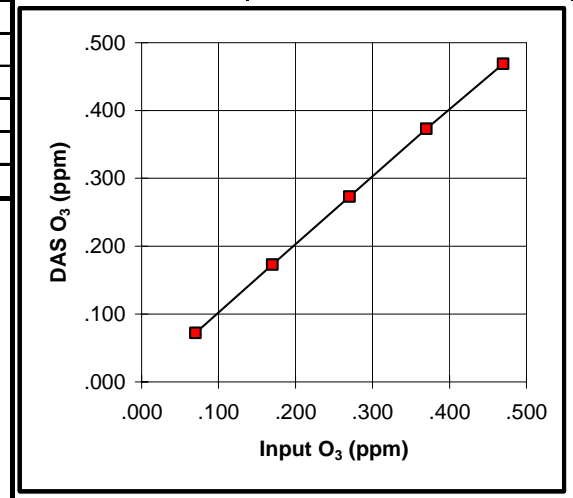
Instrument to be Calibrated	
Last Cal. Date	12/2/2010
Manufacturer	TECO
Model	49C
Serial Number	401504-581
BKG / CO EFF	0.0 / 1.020
A Frequency	108671
B Frequency	84120
Flow	.637 / .633
Cell Temp / BP	32.1 / 619.2
Inst. Offset (ppm)	.000

Input Conc. (ppm)	Display Reading (ppm)	Output Voltage VDC	DAS O ₃ (ppm)	Error in ppm	Error Delta Percent
.000	.000	.000	.000	.000	NA
.470	.470	.460	.469	-.001	-00.2 %
.370	.370	.365	.373	.003	00.8%
.270	.270	.262	.273	.003	01.1%
.170	.170	.168	.173	.003	01.8%
.070	.069	.069	.072	.002	02.9%
.000	.000	.000	.003	.000	NA

SLOPE	0.999067
INTERCEPT	0.001877
CORRELATION	0.999953
AVERAGE DELTA%	01.3 %

Remarks

Signature *Martin H Valvur*



COPY

BGI INCORPORATED 58 GUINAN STREET WALTHAM, MA 02451
NIST Traceable Calibration Facility, ISO 9001:2008 Registered

deltaCal

CERTIFICATE OF CALIBRATION - NIST TRACEABILITY

(Refer to instruction manual for further details of calibration)

deltaCal Serial Number: 000413

DATE 20-SEPT-10

Calibration Operator: BRIAN DEVOE

Critical Venturi Flow Meter: Max Uncertainty = 0.346%

Serial Number: 1 *CEESI NVLAP NIST Data File 01BGI002*

Serial Number: 2 *CEESI NVLAP NIST Data File 01BGI003*

Serial Number: 4 *CEESI NVLAP NIST Data File 02BGI004*

Room Temperature : Uncertainty = 0.071% Room Temperature: 20.6 C

Brand: *Ertco* Serial Number: 9216

NIST Traceability No. 516837

deltaCal:

Ambient Temperature (set): 20.6 C

Aux (filter) Temperature (set): 20.6 C

Barometric Pressure and Absolute Pressure

Vaisala Model PTB330(50-1100) Digital Accuracy: 0.019%

S/N C4310002

NIST Traceable (Princo Primary Standard Model 453 S/N W12537) Certificate No. P-7485

deltaCal:

Barometric Pressure (set): 760 mm of Hg

Results of Venturi Calibration

Flow Rate (Q) vs. Pressure Drop (ΔP).

Where: Q=Lpm, ΔP = Cm of H₂O

$Q = 4.17396 \Delta P^{0.52383}$

Overall Uncertainty: 0.35%

Date Placed In Service _____

(To be filled in by operator upon receipt)

Recommended Recalibration Date _____

(12 months from date placed in service)

Revised: June 2009



MICRO PRECISION CALIBRATION
 21331 ADAMSON DRIVE
 GRASS VALLEY CA 95949
 (530) 268-1860

Certificate of Calibration

Date: 1/10/2011

Certificate #: 1212793

Customer:

AIR RESOURCE SPECIALIST, INC
 1901 SHARP POINT DR, STE E
 FORT COLLINS, CO, 80525

Purchase Order: A24439
 Work Order: 103016

MPC Control #: AX8941
 Asset ID: N/A
 Gage Type: MULTIMETER
 Manufacturer: FLUKE
 Model Number: 87III
 Size: N/A
 Temp./RH: 72 °F / 30 %

Serial Number: 83960053
 Department: N/A
 Performed By: ROBERT MEANS
 Received Condition: IN TOLERANCE
 Returned Condition: IN TOLERANCE
 Cal Date: January 10, 2011
 Cal. Interval: 12 MONTHS
 Cal. Due Date: January 10, 2012

Found conditions meet or exceed manufacturer specifications.

*Calibration Notes:

Standards Used To Calibrate Equipment

I.D.	Description	Model	Serial	Manufacturer	Cal. Due Date	Traceability #
AM9934	CALIBRATOR	5500A	6260010	FLUKE	2/19/2011	888094

Procedures Used In This Event:

Procedure Name	Description
83,85,87,1000V,FLUKE	MULTIMETERS (FLUKE)

Calibrating Technician:

Robert E Means

ROBERT MEANS

QC Approval:

Brian Gold

BRIAN GOLD

Unless Otherwise Noted, Uncertainty Estimated at ≥ 4 to 1. Uncertainties have been estimated at a 95 percent confidence level ($k=2$). Services rendered comply with ISO 17025:2005, ISO 9001:2008, ANSINC SL Z540-1, MPC Quality Manual, MPC CSD and with customer purchase order instructions.

Calibration cycles and resulting due dates were submitted/approved by the customer. Any number of factors may cause an instrument to drift out of tolerance before the next scheduled calibration. Recalibration cycles should be based on frequency of use, environmental conditions and customer's established systematic accuracy. The information on this report, pertains only to the instrument identified.

All standards are traceable to the National Institute of Standards and Technology (NIST). Services rendered include proper manufacturer's service instructions and are warranted for no less than thirty (30) days. This report may not be reproduced in part or in whole without the prior written approval of the issuing MPC lab.

APPENDIX C

ARS Quality Assurance Department

ARS' quality assurance department is operated independently to provide at least two (2) levels of management between quality assurance functions and project management functions of the company. This allows the quality assurance department to provide objective, independent assessments of project activities both within and outside the company. A flow chart showing ARS' corporate structure is provided as Figure C-1. Quality assurance procedures related to field performance and systems audits of air quality monitoring programs are fully compliant with EPA guidance and, where appropriate, state agency specific requirements. ARS' audit standards are independently maintained and traceable to National Institute of Standards and Technology (NIST) or other recognized standards.

The ARS auditor for this project was Mr. Donald Cobb who reports directly to Quality Assurance Department Manager Ms. Gloria Mercer. Mr. Cobb's responsibility within ARS is to provide independent field performance and systems audits of air quality and meteorological monitoring programs. He is not involved in the installation or operation of air quality monitoring programs for ARS' clients. A copy of Mr. Cobb's résumé is also provided.

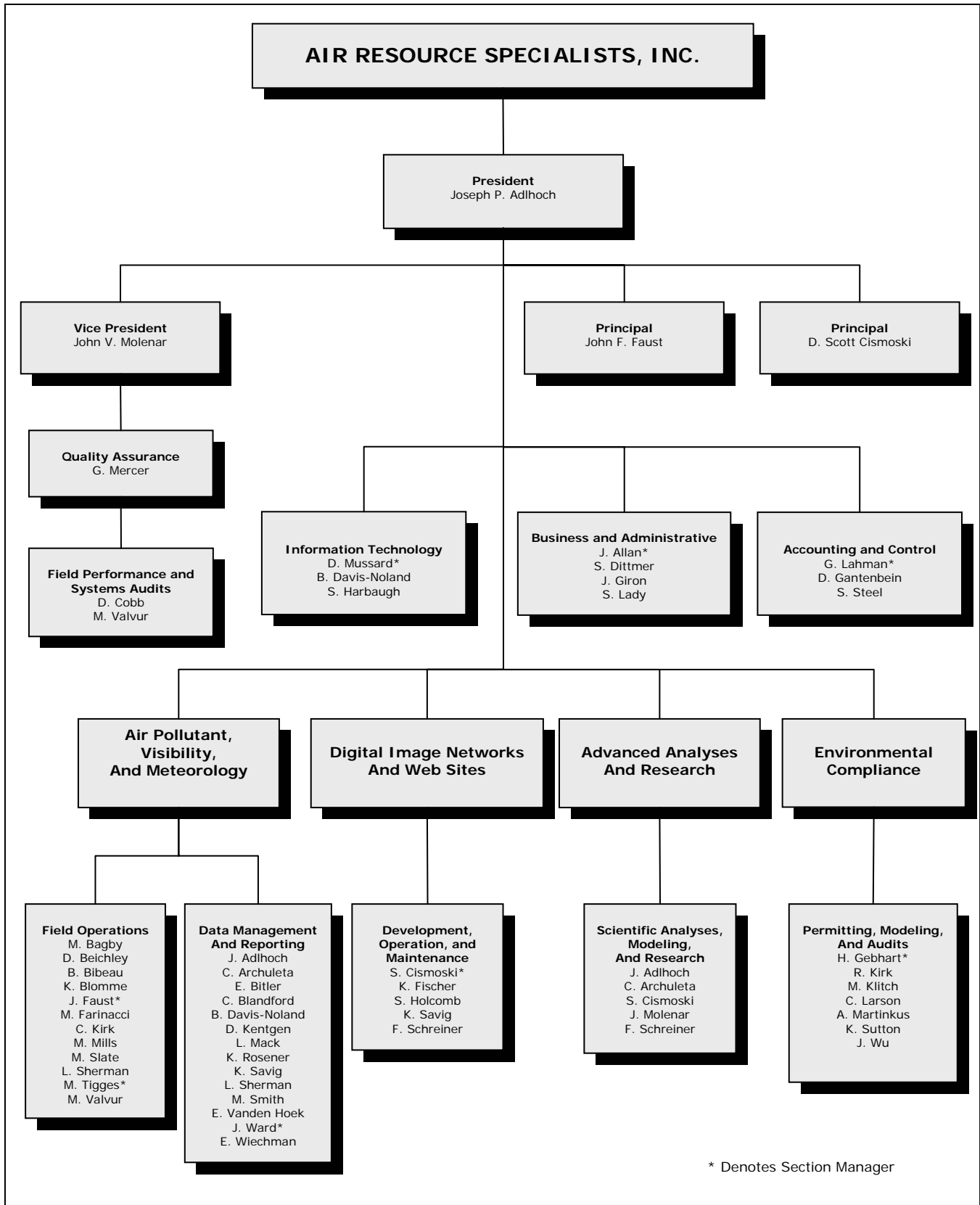


Figure C-1. Corporate Structure, Air Resource Specialists, Inc.

DONALD R. COBB
Air Quality and Meteorology Auditor

Résumé

Summary of Qualifications

Mr. Cobb has over 30 years' experience managing technical aspects of ambient air quality and meteorological monitoring programs, including performing instrument installation, servicing, data analysis, instrument audit, and reporting. He is proficient with operating principles of a variety of ambient air quality and meteorology monitoring instrumentation.

Professional Experience

- Performs field performance and systems audits of federal, state, municipality, tribal, and private industry ambient air quality and meteorological monitoring programs.
- Oversees day-to-day operations and schedules audits.
- Maintains and calibrates ambient air quality and meteorological audit instrumentation and standards.
- Ensures traceability and maintains documentation of all audit standards.
- Prepares and maintains audit field documentation forms and spreadsheets.
- Researches and applies changes in EPA monitoring guidance to audit procedures.
- Analyzes audit data and writes audit reports.
- Prepares proposals and manages audit programs.

Work History

2002-Present Air Quality and Meteorological Auditor, Air Resource Specialists, Inc.,
Fort Collins, CO
1994-2002 Project Manager, Air Resource Specialists, Inc., Fort Collins, CO
1988-1994 Project Manager, ENSR Consulting & Engineering, Fort Collins, CO
1985-1988 Project Manager, Electronic Techniques, Inc., Fort Collins, CO
1978-1985 Research Associate, Colorado State University, Fort Collins, CO
1967-1977 Project Manager, ENSR Consulting & Engineering, Fort Collins, CO
1962-1967 Research Associate, Colorado State University, Fort Collins, CO

Educational Background

Coursework in computer programming and accounting, Colorado State University