

## 5.0 ANNOTATED BIBLIOGRAPHY

This bibliography lists each of the documents used to develop the guidance materials presented in Chapters 2 through 4 and Appendix B of this document. The entries are listed in alphabetical order and are formatted as they are in each section reference list. Additional documents are listed that provide useful information on the subjects discussed in this document. In addition to the bibliographical information presented, keywords and phrases are provided for each of the listed documents. The complete list of keywords used is provided in Table 5.1.

TABLE 5.1 LIST OF KEYWORDS

Adsorber	Incinerator, catalytic
Afterburner, direct flame	Incinerator, thermal
Afterburner, catalytic	Level measurement
Baghouse	Monitoring frequency
Calibration methods	Monitoring parameters
Centrifugal collector	Operation and maintenance (O&M)
Conductivity measurement	pH measurement
Continuous emission monitoring system (CEMS)	Predictive emission monitoring system (PEMS)
Continuous opacity monitoring system (COMS)	Pressure gauge
Control device, other	Pressure transducer
Data acquisition system (DAS)	Pressure measurement, other devices
Electrical energy measurement	Resistance temperature detector (RTD)
Electrostatic precipitator (ESP)	State/local agency monitoring and permit guidelines
Electrostatic precipitator, wet (WESP)	Temperature measurement
Fabric filter	Temperature measurement device, other
Flare	Thermocouple
Flow measurement	Vapor recovery system
Flow meter, gas	Venturi scrubber
Flow meter, liquid	Wet scrubber, gaseous
Flow meter, mass	Wet scrubber, PM
Gravity collector	Work practice

*Air Pollution Engineering Manual*, Buonicore and Davis, Eds., Air and Waste Management Association, Van Nostrand Reinhold, New York, NY, 1992.

**Summary:** This document is a fundamental and practical source of information on air pollution control. It includes chapters on control technologies used for gaseous pollutants (i.e., absorption, adsorption, condensation, and incineration), particulates (i.e., cyclones and inertial separators, wet scrubbers, electrostatic precipitators, and fabric filters), fugitive emissions, and control of odors. For each control technology, the manual includes a description of the equipment, design and performance equations, recommended operation and maintenance procedures, and suggestions for maintaining and improving the equipment performance. The manual also includes chapters on specific industries, including combustion sources, waste incineration sources, evaporative loss sources, surface coating, graphic arts, chemical process industry, food and agriculture industry, metallurgical industry, mineral products industry, pharmaceutical industry, petroleum industry, wood processing industry, treatment and land disposal, and groundwater and soil treatment processes. These chapters include a process description, a characterization of the air emissions, and a discussion of the techniques used to control these emissions.

**Keywords:** Adsorber; afterburner, catalytic; afterburner, direct flame; baghouse; centrifugal collector; control ; electrostatic precipitator, wet (WESP); electrostatic precipitator (ESP); fabric filter; flare; incinerator, catalytic; incinerator, thermal; operation and maintenance (O&M); pressure measurement, other devices; temperature measurement; venturi scrubber; wet scrubber, gaseous; wet scrubber, PM.

**CAM Guidance Document chapter/section:** Appendix B

Allocca, J. and A. Stewart, *Transducers: Theory and Application*, Reston Publishing Company, Reston, VA, 1984.

**Summary:** This book contains complete and detailed information on pressure, temperature, and flow transducers. It includes chapters on background information, strain gage transducers, LVDT's, capacitive transducers, piezoelectric transducers, potentiometric transducers, RTD's, thermocouples, thermistors, photo tubes, photomultiplier tubes, photoconductive cells, photovoltaic cells, lasers, fiberoptics, environmental and biomedical transducers, position sensing transducers, transducer interfacing systems, and smoke detectors. The authors use a considerable number of comparisons of instrument types, drawings, and some mathematical information. The book was used for a comparison of electrical pressure measurement devices, for information on QA/QC procedures for pressure transducers, and for general information on pressure transducers.

**Keywords:** Pressure guage; pressure transducer; pressure measurement, other devices; control devices, temperature measurement; resistance temperature detector (RTD); thermocouple; temperature measurement ; electrical energy measurement; flow measurement; flow meter, gas; flow meter, liquid; flow meter, mass.

**CAM Guidance Document chapter/section:** 4.3

*Alternative Control Technology Document - Organic Waste Process Vents*, EPA-450/3-91-007, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, December, 1990.

**Summary:** This EPA document contains information to address VOC emissions from process vents on waste management units that are exempted from the Resource Conservation and Recovery Act (RCRA) process vent standards. The technologies regulated by the RCRA process vent standards are the most common ones used with exempted process vents, and the non-regulated units are a significant contributor to total air emissions from waste management unit process vents. The document includes technical information for State and local agencies to use in emission-reduction

planning. The information in this document will allow planners to identify process vent emission sources, identify available control options, and evaluate VOC reduction and control costs. The emission control techniques discussed include vapor recovery control techniques, such as adsorption and absorption, and combustion control devices, such as flares and thermal incinerators.

**Keywords:** Adsorber; flare; incinerator, catalytic; incinerator, thermal; vapor recovery system; control .

**CAM Guidance Document chapter/section:** Appendix B

Anderson, R.L., et al., Decalibration of Sheathed Thermocouples, *Temperature: Its Measurement and Control*, American Institute of Physics, New York, NY, 1992.

**Summary:** This document summarizes the results of tests conducted on 24 combinations of thermocouples and sheaths material types at temperatures up to 1200°C. Conclusions are that thermocouples maintain calibration better if sheath material is similar in composition to thermocouple alloys. Using similar sheath and thermocouple materials provides significantly longer performance for thermocouples subjected to temperatures greater than 600°C, and is essential for thermocouples subjected to temperatures greater than 1000°C.

**Keywords:** Temperature measurement; thermocouple.

**CAM Guidance Document chapter/section:** 4.2

*APTI Course SI:412, Baghouse Plan Review, Student Guidebook*, EPA 450/2-82-005, U. S.

Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, April 1982.

**Summary:** This document is the student manual designed to familiarize technical personnel with the steps for evaluating a fabric filter used to control particulate emissions. Used with a slide/tape program and a final exam, this is a course of study for persons responsible for reviewing plans for installations of baghouses. The document covers the following areas: fabric filtration operations and baghouse components, fabric filter material, bag cleaning, baghouse design, baghouse operation and maintenance, industrial applications, and a review exercise. This manual contains straightforward descriptions and clear, well-drawn diagrams.

**Keywords:** Baghouse; fabric filter.

**CAM Guidance Document chapter/section:** Appendix B

*APTI Course 413, Control of Particulate Emissions, Student Manual*, EPA 450/2-80-066, U. S.

Environmental Protection Agency, Research Triangle Park, NC, October 1981.

**Summary:** This Student Manual is to be used in conducting APTI Course 413 “Control of Particulate Emissions” in conjunction with the Instructor’s Guide (EPA 450/2-80-066) and the Student Workbook (EPA 450/2-80-067). This manual supplements the course lecture material, presenting detailed discussions on particulate emission control equipment. The major topics include: Basic Gas Properties, Particle Dynamics, Particle Sizing, Settling Chambers, Cyclones, Electrostatic Precipitators, Fabric Filters, and Wet Collectors. This manual will assist the reader in evaluating plans for particulate emission control systems and in conducting plan reviews.

**Keywords:** Electrostatic precipitator, wet (WESP); fabric filter.

**CAM Guidance Document chapter/section:** Appendix B

ASTM Designation E 220, “Standard Method for Calibration of Thermocouples by Comparison Techniques,” American Society for Testing and Materials, Philadelphia, PA.

**Summary:** This document describes a protocol for calibrating thermocouples by comparing the reading from the subject thermocouple to the reading for a more accurate thermometer, which is

maintained at the same temperature. The procedure involves measuring the electromotive force of the thermocouple being calibrated at selected calibration points. The number and selection of calibration points depend on the type of thermocouple, the temperature range to which it is subjected, and the accuracy required.

**Keywords:** Calibration methods; temperature measurement; thermocouple.

**CAM Guidance Document chapter/section:** 4.2

Barron, W.R., "The Principles of Infrared Thermometry", *Sensors*, 9(12), December 1992.

**Summary:** This article is an in-depth discussion of infrared thermometry including design elements, single- and dual-wavelength thermometry, and reasons for the value of understanding the theory.

**Keywords:** Temperature measurement; temperature measurement .

**CAM Guidance Document chapter/section:** 4.2

Benedict, R.P., *Fundamentals of Temperature, Pressure, and Flow Measurements*, John Wiley and Sons, New York, NY, 1977

**Summary:** This document provides detailed information on the history, principles of operation, and calibration methods for a wide variety of temperature, pressure, and flow measurement devices.

**Keywords:** Calibration methods; flow measurement; flow meter, gas; flow meter, liquid; flow meter, mass; pressure guage; pressure transducer; pressure measurement, other devices; resistance temperature detector; temperature measurement; thermocouple; temperature measurement .

**CAM Guidance Document chapter/section:** 4.2, 4.3

Brunner, C. R., *Incineration Systems*, Government Institutes, Rockville, MD, 1982.

**Summary:** This book focuses on incineration system design. It includes a discussion of regulations applicable to incineration, analytical methods for systems design, and the various types of incinerators currently in use.

**Keywords:** Incinerator, catalytic; incinerator, thermal.

**CAM Guidance Document chapter/section:** Appendix B

Calvert, S., and H. M. Englund, Eds., *Handbook of Air Pollution Technology*, John Wiley and Sons, New York, NY, 1984.

**Summary:** This handbook includes chapters on control technologies used for gaseous pollutants (i.e., absorption, adsorption, condensation, chemical reaction, and combustion) and particulates (i.e., scrubbers, filters, electrostatic precipitators, and mechanical collectors). For each control technology, the manual includes a description of the operating principles, applications, design, equipment, and potential problems. The handbook also includes chapters on specific industries (including typical emissions and control techniques used to control these emissions), sampling and analysis, and air pollution standards and regulations.

**Keywords:** Adsorber; afterburner, direct flame; afterburner, catalytic; baghouse; centrifugal collector; continuous emission monitoring system; electrostatic precipitator (ESP); electrostatic precipitator, wet (WESP); fabric filter; flare; gravity collector; incinerator, catalytic; incinerator, thermal; wet scrubber, gaseous; wet scrubber, PM.

**CAM Guidance Document chapter/section:** Appendix B

*Combustion Emissions Technical Resource Document (CTRED)*, USEPA Solid Waste and Emergency Response (5305), EPA 530-R-94-014, May 1994.

**Summary:** To be completed.

**Keywords:** To be completed.

**CAM Guidance Document chapter/section:** Appendix B

Considine, D. M., Ed., *Van Nostrand's Scientific Encyclopedia*, 5th edition, Van Nostrand Reinhold.

**Summary:** This document lists the advantages and disadvantages of many of the flow meters described in this chapter. This document also lists the measurement accuracy and applicable pipe diameters of many of the flow meters described in this chapter.

**Keywords:** Flow measurement; flow meter, gas; flow meter, liquid; flow meter, mass.

**CAM Guidance Document chapter/section:** 4.4

DeCarlo, J. P., *Fundamentals of Flow Measurement*, Chapters 2, 6, 8, and 9, Instrument Society of America, Research Triangle Park, NC.

**Summary:** This document describes the classification of flow meters and contains information on principles of operation, orifice plates, turbine flow meters, vortex flow meters, magnetic flow meters, ultrasonic flow meters, thermal flow meters, and mass flow meters.

**Keywords:** Flow measurement; flow meter, gas; flow meter, liquid; flow meter, mass.

**CAM Guidance Document chapter/section:** 4.4

*Draft Alternative Control Technology Document -- PM-10 Emissions from the Wood Products Industry: Particleboard, Oriented Strandboard, and Waferboard Manufacturing*, U.S. Environmental Protection Agency, September 1992.

**Summary:** This document discusses particulate control techniques for dryers, boilers, hot presses, and sanders in particleboard, OSB, and waferboard manufacturing. Control of fugitive emissions from storage piles is also discussed. Control technologies examined include wet ESP's, electrified filter beds (EFB's), fabric filters, dry ESP's, wet scrubbers, and multiclones. Environmental impacts and cost analyses for the various control options for each emission point are presented.

**Keywords:** baghouse; centrifugal collector; electrostatic precipitator, wet (WESP); electrostatic precipitator (ESP); fabric filter; venturi scrubber; wet scrubber, PM

**CAM Guidance Document chapter/section:** Appendix B

*Engineering Handbook for Hazardous Waste Incineration*, Office of Research and Development, U. S. Environmental Protection Agency, Cincinnati, OH, November, 1980.

**Summary:** To be completed.

**Keywords:** To be completed.

**CAM Guidance Document chapter/section:** 4.3

Everest, C.E., "Noninvasive Surface Temperature Measurement with Medical Infrared Thermometer," *Sensors*, 2(2), February, 1995.

**Summary:** This article contains a discussion of a small, hand-held, noncontact, infrared thermometer, which will make precision surface measurements at low temperatures.

**Keywords:** Temperature measurement; temperature measurement .

**CAM Guidance Document chapter/section:** 4.2

Galster, Helmuth, *pH Measurement*, VHC Press, New York, NY, 1991.

**Summary:** This book presents an overview of pH measurement stations and how to select and install the proper station for different types of streams. It also includes information on electrode selection, operation and maintenance of the pH measurement system, and calibration procedures.

**Keywords:** Calibration methods; operation and maintenance (O&M); pH measurement.

**CAM Guidance Document chapter/section:** 4.5

*Generic Permit Conditions Pertaining to Monitoring*, Georgia State Pollution Control Agency GDNR.

**Summary:** These generic permit conditions were developed by the Georgia Industrial Source Monitoring Program for use in Synthetic Minor operating permits with the aim of producing a consistent, stable, enforceable, speedy permit application and issuance process. The document outlines permit conditions to be used on all permits, when performance testing is to be required, and when performance test methods must be included in the permit. It also discusses notification reporting, and recordkeeping. Specific permit conditions pertaining to parameter monitoring and recordkeeping are listed for several control methods and source classifications. Control methods include absorbers, incinerators, enclosures, condensers, baghouses, and flares. Source categories include fuel burning equipment and stone crushing operations. The monitoring requirements given in this document are not to replace any applicable NSPS, NESHAP, or SIP monitoring requirement to which the source may be subject.

**Keywords:** State/local agency monitoring and permit guidelines; monitoring parameters.

**CAM Guidance Document chapter/section:** Appendix B

Glick, S., "Infrared Temperature Measurement Errors," *Sensors*, 5(4), April, 1988.

**Summary:** The discussion in this article includes temperature errors due to object emissivity, transmission losses, background interference; and some solutions.

**Keyword:** Temperature measurement.

**CAM Guidance Document chapter/section:** 4.2

Grieb, B., Temperature Measurement in Process Control, *Advances in Instrumentation and Control, Proceedings of the Annual Meeting of the Instrument Society of America, Volume 47*, Instrument Society of America, Research Triangle Park, NC, 1992.

**Summary:** The article provides a comprehensive overview of thermocouples and RTD's, including (in Appendix A of the paper) a comparison of the advantages and disadvantages of each. It also includes detailed illustrations of sensor components.

**Keywords:** Temperature measurement; thermocouple; resistance temperature detector (RTD).

**CAM Guidance Document chapter/section:** 4.2

Harland, P. Ed., *Pressure Gauge Handbook*, Marcel Dekker, Inc., New York, NY.

**Summary:** This document provides an overview of the fundamentals of pressure measurement and pressure gauges. The components, operation, maintenance, and calibration of various types of pressure gauges are described. The document also provides general information on pressure transducers.

**Keywords:** Pressure gauge; pressure transducer; calibration methods; operation and maintenance (O&M).

**CAM Guidance Document chapter/section:** 4.3

Hashemian, H. M., and K. M. Peterson, Accuracy of Industrial Temperature Measurement, *Advances in Instrumentation and Control, Proceedings of the Annual Meeting of the Instrument Society of America, Volume 43*, Instrument Society of America, Research Triangle Park, NC, 1988.

**Summary:** The article presents a good overview of the use and applicability of thermocouples and RTD's for temperature measurement in industry; compares thermocouples and RTD's with respect to applicability, performance, and costs; and makes recommendations on calibrating at industrial installations.

**Keywords:** Temperature measurement; thermocouple; resistance temperature detector (RTD).  
**CAM Guidance Document chapter/section:** 4.2

Hashemian, H. M., and K. M. Peterson, *Achievable Accuracy and Stability of Industrial RTD's, Temperature: Its Measurement and Control*, American Institute of Physics, New York, NY, 1992.  
**Summary:** This document presents results of tests on 47 RTD's to determine the effects of aging at temperatures in the range of 0° to 300°C. Tests were conducted for thermal aging, vibration aging, high temperature application, and thermal cycling. The conclusion was that RTD's generally keep calibration to within  $\pm 0.2^\circ\text{C}$  for at least 2 years over the temperature range of 0° to 300°C.  
**Keywords:** Temperature measurement; resistance temperature detector (RTD).  
**CAM Guidance Document chapter/section:** 4.2

Hesketh, H. E., and K. C. Schiffner, *Wet Scrubbers, A Practical Handbook*, Lewis Publishers, Inc., Chelsea, MI, 1986.  
**Summary:** This book discusses wet scrubber types, applications, design, and maintenance and control issues. Calculations for vapor-liquid equilibrium, pressure drop, velocity, and other parameters are also discussed, and example calculations are given. The relationships of pressure drop, particle size, and particle concentration in the incoming gas stream to control efficiency are examined.  
**Keywords:** venturi scrubber; wet scrubber, gaseous; wet scrubber, PM  
**CAM Guidance Document chapter/section:** Appendix B

Jennings, M. S., et al., *Catalytic Incineration for Control of Volatile Organic Compound Emissions*, Noyes Publications, Park Ridge, NJ, 1985.  
**Summary:** This book describes and evaluates the use of catalytic incinerators for the control of industrial VOC emissions. It includes a description of how catalytic incineration is applied to the control of industrial VOC emissions and assesses the overall performance, applicability, and costs as compared to alternate VOC control technologies. It also describes the results of case studies, which gathered actual performance data through a field testing program on existing operating industrial catalytic incinerators. The types of sources that typically use catalytic incinerators are also described in the book.  
**Keywords:** Incinerator, catalytic; operation and maintenance (O&M).  
**CAM Guidance Document chapter/section:** Appendix B

Johnson, F. L., "Detecting and Preventing RTD Drift," *Sensors*, 12(5):64-66, 78, May, 1995.  
**Summary:** This article contains a discussion of RTD drift and procedures for preventing drift.  
**Keywords:** Calibration methods; resistance temperature detector; temperature measurement; thermocouple.  
**CAM Guidance Document chapter/section:** 4.2

Laird, F., "Infrared Temperature Measurement and Imaging," *Sensors*, 11(8), August, 1994 .  
**Summary:** This article is an overview of IR temperature measurement with detailed explanations of emissivity, IR imaging systems, and applications.  
**Keywords:** Temperature measurement; temperature measurement device.  
**CAM Guidance Document chapter/section:** 4.2

Le, D. H. and S. Loth, "Ensuring Strain Gauge Pressure Transducer Stability," *Sensors*, 5(7), July, 1988

**Summary:** This article is an in-depth discussion of instability in pressure transducers, which ‘can invalidate pressure accuracy by contributing an unknown error component to the measurement. Attention to design, testing, and calibration can optimize instrument stability.’

**Keywords:** Calibration methods, pressure transducer.

**CAM Guidance Document chapter/section:** 4.3

Linder, Peter, Ralph Torrington, and David Williams, *Analysis Using Glass Electrodes*, Open University Press, Milton Keynes, England, 1984.

**Summary:** This book presents background information on pH measurements using glass electrodes. The book includes a presentation on the pH scale and what it means, and a discussion of operation and maintenance of pH measurement systems.

**Keywords:** Calibration methods; operation and maintenance; pH measurement.

**CAM Guidance Document chapter/section:** 4.5

Lonergan, S., “Specifying Transducers for an Industrial Environment,” Engineered Systems, Business News Publishing Company, August, 1994.

**Summary:** This article discusses stresses, including vibration, electronic noise, corrosion, and temperature fluctuations, that degrade accuracy and cause failure in pressure transducers. Solutions that lie in transducer designs, strain gage technology, and capacitive sensing are explored.

**Keywords:** Pressure transducer.

**CAM Guidance Document chapter/section:** 4.3

Maguire, John, Ed., *Handbook of Industrial Water Conditioning*, Betz Laboratories, Trevose, PA, 1980.

**Summary:** This reference provides background information on conductivity measurements, including how to measure the conductivity of a water stream and how conductivity measurements are used in assessing water quality and determining solids content.

**Keywords:** Conductivity measurement.

**CAM Guidance Document chapter/section:** 4.5

*Model 444RL, Temperature Transmitter Owner's Manual*, Rosemount, Inc., Eden Prairie, MN, Product literature.

**Summary:** This product manual contains a discussion of temperature transmitter design and calibration. It also includes wiring, block, parts, and circuit diagrams.

**Keywords:** Calibration methods; resistance temperature detector; temperature measurement; thermocouple.

**CAM Guidance Document chapter/section:** 4.2

North Carolina Department of Environment, Health, and Natural Resources, Division of Air Quality, *Final Testing, Monitoring, Reporting, and Recordkeeping (TMRR) Approach*.

**Summary:** This document consists of a series of 6 examples to assist NCDEM permit writers in writing permit conditions regarding TMRR. The examples are as follows:

- PM from boiler controlled with packed bed scrubber
- PM from boiler controlled with multiclone
- SO<sub>2</sub> from generic coal combustion sources
- VE from boiler with multiclone
- VOC from miscellaneous sources



Examples are short (half page each) and most are for work practices rather than parameter monitoring. No additional guidance is provided, and the only control device parameter monitoring presented is for monitoring pressure drop and liquid flow rate for packed bed scrubbers.

**Keywords:** Monitoring parameters; State/local agency monitoring and permit guidelines; wet-scrubber, PM; work practice.

**CAM Guidance Document chapter/section:** Not referenced.

Ohio EPA, Ohio EPA Engineering Guide No. 65, Ohio EPA, Division of Air Pollution Control.

**Summary:** This document, which is in question-and-answer format, was written to assist State permit and Title V applicants, as well as agency permit reviewers regarding the types of sources that should develop a monitoring, recordkeeping, and reporting (MRR) program to ensure continuous compliance; also provides guidance on what constitutes a reasonable and adequate program. The types of emissions units for which an MRR program should be established are described in tables by pollutant. The tables also reference the *Ohio State Air Resource System (STARS)* library of terms and conditions and list the types of limitations sources may be subject to, such as operating or production caps, that require an MRR program. The document provides guidance on how to determine if a source that is not listed in the tables must develop an MRR program. Examples also are presented.

**Keywords:** State/local agency monitoring and permit guidelines; monitoring frequency; monitoring parameters.

**CAM Guidance Document chapter/section:** Not referenced.

Ohio EPA, *The "STARS" Library of Terms and Conditions for Permits to Install, Title V Permits, and State Permits to Operate*, Version 3.0, Ohio EPA, Division of Air Pollution Control, November 1996.

**Summary:** "STARS" stands for State Air Resources System. This document is a compilation of common terms and conditions which are used by the Division of Air Pollution Control (DAPC) in preparing permits to install, Title V permits, and State permits to operate. The first section contains general terms and conditions which are required for Title V permits and State permits to operate. The second section contains common terms and conditions for emission units which will be used in the permits. Monitoring, recordkeeping, and reporting requirements are given for specific emission sources, as well as requirements for CEMS certification and required parameter monitoring for control devices. Compliance methods and testing requirements are also discussed, as are ambient air quality and visible particulate emission standards.

**Keywords:** State/local agency monitoring and permit guidelines; monitoring parameters; monitoring frequency; operation and maintenance (O&M); adsorber; baghouse; continuous emission monitoring system (CEMS); continuous opacity monitoring system (COMS); control; fabric filter; flare; incinerator, thermal; incinerator, catalytic; venturi scrubber; wet scrubber, gaseous; wet scrubber, PM.

**CAM Guidance Document chapter/section:** Not referenced.

Ohio EPA's *Operating and Maintenance (O&M) Guidelines for Air Pollution Control Equipment*, for Ohio EPA, Columbus, OH, by Environmental Quality Management, Inc., Cincinnati, OH, February 1993.

**Summary:** This document presents discussions of operation and maintenance (O&M) procedures for air pollution control equipment commonly used in Ohio. Proper O&M minimizes pollutant emissions, reduces equipment malfunction, ensures equipment reliability, and aids in continued compliance with air pollution regulations and Ohio's permit requirements. The document focuses on eight types of air pollution control equipment: mechanical collectors; fabric filters, including dry scrubbers; electrostatic precipitators, both wet and dry; carbon adsorbers; incinerators, thermal and catalytic;

flares; wet scrubbers; and condensers. There is a general description for each equipment type. Also wherever appropriate, there are guidelines for monitoring; inspection, operation, and maintenance procedures; example inspection forms; discussions and tables of major problems or malfunctions; and overviews of operator training and spare parts needs.

**Keywords:** Adsorber; baghouse; electrostatic precipitator (ESP); electrostatic precipitator, wet (WESP); fabric filter; flare; incinerator, catalytic; incinerator, thermal; vapor recovery system; venturi scrubber; wet scrubber, gaseous; wet scrubber, PM; control .

**CAM Guidance Document chapter/section:** Appendix B

*Omega Complete Temperature Measurement Handbook and Encyclopedia, Vol. 29.* Omega Engineering, Inc., Stamford, CT, 1995.

**Summary:** This book gives information on temperature sensing devices and their associated instrumentation manufactured by Omega Engineering, Inc. Data acquisition systems and calibration equipment are also discussed. The book also includes a technical reference section that includes information on thermistors, RTD's, monolithic temperature sensors, thermocouples, and standard wire errors.

**Keywords:** temperature measurement; thermocouple; resistance temperature detector (RTD); temperature measurement .

**CAM Guidance Document chapter/section:** 4.2

*Operation and Maintenance Manual for Fabric Filters,* U. S. Environmental Protection Agency, EPA/625/1-86/020, June 1986.

**Summary:** This manual focuses on the operation and maintenance (O&M) of typical fabric filters. The manual includes a discussion of the basic theory and design of fabric filters. It also presents the purpose, goals, and role of performance monitoring as a major element in an O&M program (including key performance indicators and their measurement) and covers instrumentation, data acquisition, and record keeping methods useful in optimizing fabric filter system performance. The use of performance monitoring in evaluating the control system performance and discovering and correcting causes of poor performance is also discussed. The manual also presents guidelines for general O&M practices and procedures for use in improving and sustaining fabric filter performance and reliability, and it provides step-by-step procedures and techniques for conducting inspections of the systems and their components.

**Keywords:** Baghouse; fabric filter; monitoring parameters; operation and maintenance (O&M).

**CAM Guidance Document chapter/section:** Appendix B

*Operation and Maintenance Manual for Electrostatic Precipitators,* U. S. Environmental Protection Agency, EPA/625/1-85/017, Office of Research and Development, Research Triangle Park, NC, September 1985.

**Summary:** This manual discusses the operation and maintenance (O&M) of typical electrostatic precipitators (ESP's). The manual includes a discussion of the basic theory and principles of electrostatic precipitation; performance monitoring as a major element in an O&M program and the use of performance monitoring in evaluating the control system performance and discovering and correcting causes of poor performance; guidelines for general O&M practices, including proper startup/shutdown procedures, normal operating practices, and schedules for inspection of equipment and for performing preventive maintenance; and common problems encountered in ESP control systems.

**Keywords:** Electrostatic precipitator (ESP); monitoring frequency; monitoring parameters; operation and maintenance (O&M).

**CAM Guidance Document chapter/section:** Appendix B

Oregon Department of Environmental Quality, Air Quality Division, *Compliance Monitoring Guidance Document–Discussion Draft*, May 11, 1994.

**Summary:** This document proposes guidance for Title V and Title VII compliance monitoring. A step-by-step compliance monitoring development process is described. The document includes five tables that provide guidance on appropriate compliance monitoring. These tables include lists of monitoring required by Oregon Administrative Rules, monitoring guidance for the most commonly encountered industries in Oregon, compliance monitoring guidance for PM and gaseous emissions, and recommendations for determining compliance with visible emissions limits.

**Keywords:** State/local agency monitoring and permit guidelines.

**CAM Guidance Document chapter/section:** Not referenced.

Organic Chemical Manufacturing, Volume 4: Combustion Control Devices, EPA-450/3/80/027

**Summary:** To be completed.

**Keywords:** To be completed.

**CAM Guidance Document chapter/section:** Appendix B

Peacock, G. R., Radiation Thermometry: Temperature Measurement Without Contact, *Advances in Instrumentation and Control, Proceedings of the Annual Meeting of the Instrument Society of America, Volume 46*, Instrument Society of America, Research Triangle Park, NC, 1991.

**Summary:** This document provides good overview of infrared (IR) thermometers, describes recent developments in the technology, and presents summary of advantages and disadvantages of IR thermometry.

**Keywords:** Temperature measurement; temperature measurement .

**CAM Guidance Document chapter/section:** 4.2

Perry, R. H. and C. H. Chilton, Eds., *Chemical Engineers' Handbook*, Fifth and Sixth Editions, McGraw-Hill Book Company, New York, N.Y., 1973

**Summary:** This document contains detailed information on venturi tubes, flow nozzles, and orifice plate flow meters. Specifically, this document describes the location of the pressure taps for an orifice plate and describes flow loss due to the pressure drop across these three types of flow meters. The document includes background information on chemical engineering arranged in 25 areas including heat-transfer equipment, gas absorption, liquid-gas systems, and process control. 135 authors contributed to this readable text. This is a good, basic reference.

**Keywords:** Adsorber; baghouse; centrifugal collector; conductivity measurement; control; electrical energy measurement; fabric filter; flow measurement; flow meter, gas; flow meter, liquid; flow meter, mass; gravity collector; incinerator, thermal; level measurement; operation and maintenance (O&M); pH measurement; pressure gauge; pressure measurement, other devices; pressure transducer; resistance temperature detector (RTD); temperature measurement; temperature measurement ; thermocouple; vapor recovery system; venturi scrubber; wet scrubber, gaseous; wet scrubber, PM.

**CAM Guidance Document chapter/section:** 4.2, 4.3, 4.4

Product literature, Badger Meter, Inc., Industrial Products Division, Milwaukee, WI.

**Summary:** This product literature contains application specific information (e.g., applicable pipe diameters and measurement accuracy) for orifice plates, venturi tubes, flow nozzles, ultrasonic flow meters, and turbine flow meters.

**Keywords:** Flow measurement; flow meter, gas; flow meter, liquid; flow meter, mass.

**CAM Guidance Document chapter/section:** 4.4

Product literature, Catalogue No. 60, Flow-Lin Corporation, Arlington, TX.

**Summary:** This product literature presents application specific design specifications and measurement accuracy of a flow nozzle flow meter.

**Keywords:** Flow measurement; flow meter, gas; flow meter, liquid.

**CAM Guidance Document chapter/section:** 4.4

Product literature, Catalogue No. 70, Flow-Lin Corporation, Arlington, TX.

**Summary:** This product literature presents application specific design specifications and measurement accuracy of a venturi tube flow meter.

**Keywords:** Flow measurement; flow meter, gas; flow meter, liquid.

**CAM Guidance Document chapter/section:** 4.4

Product literature, Form VT-106.1, Universal Flow Monitors, Inc., Hazel Park, MI, 1995.

**Summary:** This product literature presents application specific design specifications and measurement accuracy of a vortex flow meter.

**Keywords:** Flow measurement; flow meter, gas; flow meter, liquid.

**CAM Guidance Document chapter/section:** 4.4

Product information, Kurz Instruments, Inc., Monterey, CA.

**Summary:** This product information presents application specific design specifications, measurement accuracy, and calibration of thermal flow meters.

**Keywords:** Flow measurement; flow meter, gas.

**CAM Guidance Document chapter/section:** 4.4

Product information, McCrometer, Helmet, CA.

**Summary:** This product information contains the line drawing of a helical gear flowmeter used in Figure 4.4-8.

**Keywords:** Flow measurement; flow meter, liquid.

**CAM Guidance Document chapter/section:** 4.4

Product literature, Micro Motion, Boulder, CO.

**Summary:** This product literature presents a description of the principle of operation, specific applications for this device, measurement accuracy, and specification for a mass flow meter.

**Keywords:** Flow measurement; flow meter, gas; flow meter, liquid; flow meter, mass.

**CAM Guidance Document chapter/section:** 4.4

*Protocol for Determining the Daily Volatile Organic Compound Emission Rate of Automobile and Light-Duty Truck Topcoat Operations*, EPA-450/3-88-018, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, December, 1988.

**Summary:** This document, the EPA/Auto Protocol, is an important, useful tool that was developed jointly by EPA and the auto industry to provide EPA Regions, States, local permitting agencies, and the industry with a sound method for determining the compliance status of assembly plant painting operations. The document has been used to demonstrate compliance with RACT, NSPS, and LAER emission limits for topcoat and spray primer/surfacer coating lines. The following are significant elements of the Auto Protocol: recordkeeping requirements, procedures and example forms for the compliance determination; various directions, discussion “notes”, and coating line layouts that can be

used in the compliance determination; daily VOC emission rate calculations, and other example calculations supporting the compliance determination; and bake oven control device destruction efficiency and control credit procedures. Many of these elements are applicable to other coating operations as well.

**Keywords:** State/local agency monitoring and permit guidelines.

**CAM Guidance Document chapter/section:** Appendix B

Roberson, J. A., and C. T. Crowe, *Engineering Fluid Mechanics*, Houghton Mifflin Company, Boston, MA, 1975.

**Summary:** This reference was used for background information on pressure sensors and for drawings of a manometer and a rotameter.

**Keywords:** Flow measurement; flow meter, gas; flow meter, liquid.

**CAM Guidance Document chapter/section:** 4.3, 4.4

Rosenberg, Robert J. , “Temperature Measurement on the job site using RTD's and Thermocouples,” *ISA Transactions, Volume 33*, Instrument Society of America, Research Triangle Park, NC, 1994.

**Summary:** This article discusses the factors that affect calibration of RTD's and thermocouples on the job site, including electric “noise” from nearby motors and electrical equipment, radio frequency interference, and ground loops; an presents recommendations on how to minimize these decalibrating factors.

**Keywords:** Temperature measurement; thermocouple; resistance temperature detector (RTD).

**CAM Guidance Document chapter/section:** 4.2

Spitzer, D. W., *Industrial Flow Measurement*, Instrument Society of America, Research Triangle Park, NC.

**Summary:** Chapters 6, 7, 10-15, 18-22, and 24 of this document provide a good description of flow meter maintenance, calibration, and spare parts. Also, this document provides a good principle of operation description of most of the flow meters discussed in this chapter.

**Keywords:** Flow measurement; flow meter, gas; flow meter, liquid; flow meter, mass.

**CAM Guidance Document chapter/section:** 4.4

Staley, J., “Platinum Thin Films in RTDs and Hot Film Anemometers ,” *Sensors*, 12(9):60-67, September, 1995.

**Summary:** This article contains a discussion of platinum thin films in RTD's and anemometers, self heating, and the ways packaging and support structures affect behavior.

**Keywords:** Resistance temperature detector; temperature measurement; temperature measurement ; thermocouple.

**CAM Guidance Document chapter/section:** 4.2

Tandeske, D., *Pressure Sensors*, Selection and Application, Marcel Dekker, Inc., New York, NY

**Summary:** This book features a comprehensive overview of pressure sensors. It includes background basics; classifications; descriptions; drawings; and mathematical explanations of Boyle's law, the pressure-temperature law, the combined gas law, and types of flow. There is also background information on mechanical dial pressure gauges. The book was used primarily for information and drawings of pressure transducers (in this document, pressure measurement devices that convert pressure to electrical signals). Pressure transducers described by Tandeske include strain gage sensors, LVDT's, capacitance transducers, piezoresistive transducers. He also discusses QA/QC issues and sensor specifications.

**Keywords:** Calibration methods; pressure gauge; pressure transducer; pressure measurement, other devices.

**CAM Guidance Document chapter/section:** 4.3

*The Flow and Level Handbook*, Omega Engineering, Inc., Stamford, CT, 1995.

**Summary:** This book contains a great variety of flow and level measurement equipment with specifications, a glossary, and background information.

**Keywords:** Calibration methods; conductivity measurement; level measurement; monitoring parameters; pressure device; control ; pH measurement; pressure gauge; data acquisition system; flow measurement; flow meter, gas; flow meter, liquid; flow meter, mass; temperature measurement; thermocouple; temperature measurement .

**CAM Guidance Document chapter/section:** Not referenced.

*The pH and Conductivity Handbook*, Omega Engineering, Inc., Stamford, CT, 1995.

**Summary:** This handbook presents an overview of pH and conductivity measurement techniques. The handbook has sections on selecting the proper pH measurement equipment for a sample stream, proper operation and maintenance of the pH measurement system, and calibration procedures. The handbook also includes information on conductivity measurement systems and a catalog of pH and conductivity measurement systems sold by the company.

**Keywords:** Calibration methods; conductivity measurement; operation and maintenance (O&M); pH measurement.

**CAM Guidance Document chapter/section:** 4.5

*Temperature Measurement and Calibration of Type K Thermocouples in High Temperature Stacks*, D. Bivins, EMTIC, GD-024.

**Summary:** This document provides guidelines on the use and limitations of Type K thermocouples in high temperature stationary source stacks. Calibration methods are identified and recommended calibration frequencies are specified. The document also provides information on thermocouple drift.

**Keywords:** Calibration methods; temperature measurement; thermocouple.

**CAM Guidance Document chapter/section:** 4.2

*Temperature Sensors Products Catalog*, 1995, Pyromation Inc., Fort Wayne, IN.

**Summary:** This group of loose pages contains specifications and some drawings of thermocouples, RTDs, and related instruments and devices.

**Keywords:** Resistance temperature detector (RTD); thermocouple; temperature measurement ; temperature measurement.

**CAM Guidance Document chapter/section:** 4.2

U. S. Environmental Protection Agency, *Control Techniques for Particulate Emissions from Stationary Sources--Volume 1*, EPA-450/3-81-005a, September 1982.

**Summary:** This document presents technical information on particulate emissions and control techniques, including mechanical collectors, electrostatic precipitators, fabric filters, wet scrubbers, and incinerators. Discussions include the operating principles, control effectiveness, and maintenance requirements for these control techniques.

**Keywords:** Electrostatic precipitator (ESP); fabric filter; gravity collector; incinerator, catalytic; incinerator, thermal; operation and maintenance (O&M); wet scrubber, PM.

**CAM Guidance Document chapter/section:** Appendix B

Virginia State Advisory Board on Air Pollution, Sub-Committee Report on Compliance Assurance Monitoring (CAM), October 16, 1995.

**Summary:** This report largely describes a general methodology for determining the most appropriate method of monitoring an emissions unit based on the required monitoring, significance of the unit, current monitoring practices, and cost of various monitoring options. According to the methodology, the significance of an emissions unit is determined by rating the emissions unit according to four criteria and calculating the numeric average of the four ratings. The rating criteria are: type of applicable requirement, percent of potential-to-emit (PTE) for the emissions unit to the PTE for the facility as a whole, percent of PTE to major cutoff, and compliance margin. Appendix A of this document provides a fairly extensive list of monitoring options for a variety of generic emissions units and control devices.

**Keywords:** State/local agency monitoring and permit guidelines; monitoring parameters; adsorber; baghouse; electrostatic precipitator (ESP); fabric filter; flare; incinerator, catalytic; incinerator, thermal; wet scrubber, gaseous; wet scrubber, PM; control

**CAM Guidance Document chapter/section:** 2.5

Wang, T.P., A. Wells, and D. Bediones, "Accuracy and Repeatability of Temperature Measurement by RTDs," *Advances in Instrumentation and Control*, Proceedings of the Annual Meeting of the Instrument Society of America, Volume 44, Instrument Society of America, Research Triangle Park, NC, 1989

**Summary:** Tested 19 RTD's at moderate temperatures (200°C). Initial accuracy of all within ASTM Grade B specification; all but 3 within Grade A specs. Cycled all RTD's to 200°C. As a group, tended to stabilize after 3 calibration cycles.

- Recommended stabilizing at highest likely service temperature before putting into service.
- No significant differences in calibration as function of form (thin film or wire wound) platinum purity, 4-wire RTD's seemed to perform better than 3-wire in some cases.

**Keywords:** Calibration methods; resistance temperature detector (RTD), temperature measurement.

**CAM Guidance Document chapter/section:** 4.2

*Wisconsin Air Permit Compliance Demonstration Guidance*, Wisconsin Department of Natural Resources, 1994

**Summary:** This document is intended as a supplement to the Wisconsin Air Pollution Permit Application Instruction Booklet. It consists of 15 pages of text and copies of the Wisconsin Air Pollution Permit Application forms, which include Compliance Demonstration forms. The introduction to the document states that the permit program includes the following five components related to compliance: compliance demonstration, compliance status with applicable requirements, compliance plan, compliance certification, and a monitoring data reporting schedule. These components are related to specific application forms. The document outlines the types of monitoring that may be used to demonstrate compliance, including monitoring of control system parameters.

**Keywords:** State/local agency monitoring and permit guidelines.

**CAM Guidance Document chapter/section:** Appendix B

*1994 Product Catalogue*, Dwyer Instruments, Inc., Chicago, IL, 1993, Product literature.

**Summary:** This document contains descriptions and drawings of a variety of pressure gauges, flow meters, and level switches. It was used specifically for its description of manometers.

**Keywords:** Flow measurement; level measurement; pressure gauge; pressure measurement, other devices; control .

**CAM Guidance Document chapter/section:** 4.3