

*Institute of Environmental Sciences and Technology*

IEST-RP-CC014.2

Contamination Control Division  
Recommended Practice 014.2

# Calibration and Characterization of Optical Airborne Particle Counters



1827 Walden Office Square, Suite 400 |  
Schaumburg, IL 60173 USA  
Phone: (847) 981-0100 • Fax: (847) 981-4130  
E-mail: [information@iest.org](mailto:information@iest.org) • Web: [www.iest.org](http://www.iest.org)

---

This Recommended Practice is published by the Institute of Environmental Sciences and Technology to advance the technical and engineering sciences. Use of this document is entirely voluntary, and determination of its applicability and suitability for any particular use is solely the responsibility of the user. Use of this Recommended Practice does not imply any warranty or endorsement by IEST.

This Recommended Practice was prepared by and is under the jurisdiction of Working Group C-4 of the IEST Contamination Control Division.

Copyright © 2010 by the Institute of Environmental Sciences and Technology

Second printing, July 2017

ISBN 978-0-9841330-3-1

**PROPOSAL FOR IMPROVEMENT:** The Working Groups of the Institute of Environmental Sciences and Technology are continually working on improvements to their Recommended Practices and Reference Documents. Suggestions from users of these documents are welcome. If you have a suggestion regarding this document, please use the online Proposal for Improvement form found on the IEST website at [www.iest.org](http://www.iest.org).

Institute of Environmental Sciences and Technology  
1821 Warden Office Square, Suite 400 |  
Schaumburg, IL 60173 USA  
Phone: (847) 981-0100 • Fax: (847) 981-4130  
E-mail: [information@iest.org](mailto:information@iest.org) • Web: [www.iest.org](http://www.iest.org)

---

# Calibration and Characterization of Optical Airborne Particle Counters

## IEST-RP-CC014.2

### CONTENTS

#### SECTION

1	SCOPE AND LIMITATIONS.....	5
2	REFERENCES .....	5
3	TERMS AND DEFINITIONS.....	6
4	BACKGROUND AND PURPOSE.....	7
5	REQUIREMENTS .....	7
6	CALIBRATION OF INLET FLOW RATE.....	8
7	PARTICLE SIZE CALIBRATION.....	9
8	FALSE COUNT .....	11
9	COUNTING EFFICIENCY— METHOD 1 .....	12
10	COUNTING EFFICIENCY— METHOD 2 .....	15
11	RESPONSE RATE.....	16
12	CONCENTRATION (COINCIDENCE) LIMIT .....	17
13	RESOLUTION.....	18

#### FIGURE

FIGURE 1	—NON-MONOTONIC REGION OF AN OPC CALIBRATION CURVE.....	9
FIGURE 2	—DETERMINATION OF MEDIAN VOLTAGE USING A PHA DISTRIBUTION.....	10
FIGURE 3	—CONNECTIONS FOR COUNTING EFFICIENCY DETERMINATION—METHOD 1.....	13
FIGURE 4	—CONNECTIONS FOR COUNTING EFFICIENCY DETERMINATION—METHOD 2.....	16
FIGURE 5	—PULSE DISTRIBUTION METHOD A.....	18
FIGURE 6	—PULSE DISTRIBUTION METHOD B.....	19
FIGURE E	—STANDARD DEVIATION DIAGRAM.....	29
FIGURE B2	—EFFECT OF DIFFERENTIAL NONLINEARITY.....	30
FIGURE C1	—ERLENMEYER FLASK MIXING CHAMBER.....	33
FIGURE D1	—OPC FLOW CALIBRATION PLOT.....	35
FIGURE D2	—COINCIDENCE LOSS.....	37

---

## TABLE

1—OBSERVED COUNT AND 95% UCL. ....	11
D1—CALIBRATION MEASUREMENTS.....	34
D2—PARTICLE SIZE SELECTION.....	35
D3—COUNTING EFFICIENCY DETERMINATION.....	36
D4—PARTICLE SIZE SELECTION.....	36
D5—COUNTING EFFICIENCY DETERMINATION.....	37
D6—DETERMINATION OF CONCENTRATION LIMIT.....	37

## APPENDIX

A—FORMS.....	21
B—PHILOSOPHY.....	28
C—SPECIFIC IMPLEMENTATIONS OF TEST APPARATUS.....	31
D—EXAMPLES.....	34
E—BIBLIOGRAPHY.....	38

# Calibration and Characterization of Optical Airborne Particle Counters

## IEST-RP-CC014.2

### 1 SCOPE AND LIMITATIONS

#### 1.1 Scope

This Recommended Practice (RP) covers procedures for calibrating and characterizing the performance of optical particle counters (OPCs) that detect and measure the size of single particles in air and other gases. These procedures are intended for use by OPC manufacturers, specialized test houses, and OPC users who maintain calibration and testing facilities to determine the sizing and counting accuracy of these instruments.

#### 1.2 Limitations

The procedures for characterization and calibration described in this document use monodisperse particles. The response of actual contamination particles, typically with refractive indices different from the monodisperse particles used for calibration, will differ slightly from the results obtained from the procedures in this document. Also, the differences will vary for particle counters with different optical designs.

This RP does not discuss calibration of condensation nucleus counters (CNCs). The document assumes CNCs used as reference counters have 100% counting efficiency in the range of interest for OPCs.

**NOTE.** This RP does not purport to address all of the safety issues that may arise from its use. The user is responsible for assessing potential safety issues associated with a given method at its point of use. Before using the methods described herein, the user should consider all general laboratory safety precautions. In particular, the user should identify and implement suitable health and safety measures and comply with all applicable regulations.

### 2 REFERENCES

The following documents are incorporated into this RP to the extent specified herein. Users should apply the most recent edition of the references.

#### 2.1 Reference Documents

*IEST-RP-CC011.2: A Glossary of Terms and Definitions Related to Contamination Control*

*IEST-RP-CC013: Calibration Procedures and Guidelines for Select Equipment Used in Testing Cleanrooms and Other Controlled Environments*

*ISO 21501-4: Determination of particle size distribution—Single particle light-interaction methods—Part 4: Light-scattering airborne particle counter for clean spaces*

#### 2.2 Sources and Addresses

##### **IEST**

Institute of Environmental Sciences and Technology  
1827 Walden Office Square, Suite 400 |  
Schaumburg, IL 60173 USA  
Phone: 847-981-0100  
Fax: 847-981-4130  
[www.iest.org](http://www.iest.org)

##### **ISO**

International Organization for Standardization  
1, ch. de la Voie-Creuse, Case postale 56  
CH-1211 Geneva 20, Switzerland  
Phone: +41 22 749 01 11  
Fax: +41 22 733 34 30  
[www.iso.ch](http://www.iso.ch)