

Institute of Environmental Sciences and Technology

IEST-RP-CC042.1

Contamination Control Division
Recommended Practice 042.1

**Sizing and Counting of
Submicrometer Liquid-borne
Particles Using Optical
Discrete-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 • Web: 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 042 of the IEST Contamination Control Division.

Copyright © 2011 by the Institute of Environmental Sciences and Technology

Second printing, June 2017

ISBN 978-0-915414-09-3 (Electronic Edition)

ISBN 978-0-915414-47-5 (Print Edition)

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.

Institute of Environmental Sciences and Technology
1827 Walden Office Square, Suite 400
Schaumburg, IL 60173, USA
Phone: (847) 981-0100 • Fax: (847) 981-4130
E-mail: information@iest.org • Web: www.iest.org

COPYING IS ILLEGAL

Sizing and Counting of Submicrometer Liquid-borne Particles Using Optical Discrete-particle Counters

IEST-RP-CC042.1

CONTENTS

SECTION

1	SCOPE AND LIMITATIONS.....	7
2	REFERENCES	7
3	TERMS AND DEFINITIONS.....	8
4	BACKGROUND AND PURPOSE	9
5	LIQUID-BORNE PARTICLE MEASUREMENT—CHALLENGES AND RECOMMENDED PRACTICES	9

FIGURE

1	SCHEMATICS OF THE OPTICAL SYSTEM OF A LIQUID-BORNE PARTICLE COUNTER BASED ON LIGHT SCATTERING	10
2	TYPICAL POWER LAW DISTRIBUTIONS FOUND IN MANY LPC APPLICATIONS.....	13
3	STATISTICS OF PSL STANDARDS	14
4	50/50 SPLIT CALIBRATION OF AN LPC	14
5	50/50 SPLIT CALIBRATION OF AN LPC (ALL CHANNELS CALIBRATED THE SAME WAY)	14
6	COUNTING EFFICIENCY OF REAL-WORLD PARTICLES.....	15
7	PARTICLE SIZE DISTRIBUTION AT DIFFERENT CONCENTRATION LEVELS—EFFECT OF COINCIDENCE ERROR	16
8	A TYPICAL PULSE HEIGHT DISTRIBUTION FOR A SPECTROMETER.....	17
9	EFFECT OF EXCESSIVE BUBBLES ON THE SIZE DISTRIBUTION OF PARTICLES	18
10	SCATTERED LIGHT INTENSITY BY A PARTICLE (0.2 μm AT 633 nm WAVELENGTH) AS A FUNCTION OF REFRACTIVE INDEX CONTRAST.....	20
11	EXCESSIVE BASELINE NOISE EFFECT	22
12	PROPER INSTALLATION OF AN LPC TO MONITOR A PARTS-CLEANING ULTRASONIC BATH...	23
13	PROBABILITY DENSITY FUNCTION FOR 10-MIN SAMPLE TIME	26
14	PROBABILITY DENSITY FUNCTION FOR 30-MIN SAMPLE TIME	27

TABLE

1	ADVANTAGES AND DISADVANTAGES OF BATCH SAMPLING INSTRUMENT TYPES.....	11
2	DATA FORMAT FOR AN LPC ILLUSTRATING DIFFERENTIAL AND CUMULATIVE COUNTS	12
3	INDEX CONTRAST OF CERTAIN PARTICLE-FLUID COMBINATIONS	21
4	SENSOR-TO-SENSOR COUNT CORRELATION (AT CONCENTRATION LEVELS WITH LOW COINCIDENCE ERRORS).....	24
5	STANDARD DEVIATIONS OF LOW-CONCENTRATION SCENARIOS BASED ON POISSON DISTRIBUTION	25
6	PROBABILITY THAT A SAMPLE WILL CONTAIN A GIVEN NUMBER OF PARTICLES	26
7	CUMULATIVE PROBABILITIES OF AN ALARM BEING FALSE AS A FUNCTION OF AVERAGE PARTICLES PER SAMPLE	28

APPENDIX

A	EXAMPLE: EVALUATING THE LIKELY NUMBER OF FALSE ALARMS PER DAY FOR A GIVEN SAMPLE TIME.....	29
B	BIBLIOGRAPHY.....	30

Sizing and Counting of Submicrometer Liquid-borne Particles Using Optical Discrete-particle Counters

IEST-RP-CC042.1

1 SCOPE AND LIMITATIONS

1.1 Scope

This Recommended Practice (RP) addresses the sizing and counting of submicrometer liquid-borne particles using optical discrete-particle counters with a focus on applications in the semiconductor, flat-panel display, and data storage industries. Topics covered include the following:

- Overview of light-scattering technology
- Liquid particle counter (LPC) instrument types
- Data interpretation
- Coincidence level or maximum concentration limit
- Particle-size detection limit
- Bubble issue
- Refractive index effect
- Flow rate
- Calibration verification
- Instrument noise and false counts
- Practice of minimizing sensor contamination
- Sensor correlation
- Particle counting statistics

1.2 Limitations

This RP does not address the measurement and identification of living organisms, e.g., bacteria.

This RP does not address the measurement of extremely high particle concentrations, e.g., chemical-mechanical polishing (CMP) slurry.

This RP does not address the calibration of LPCs.

2 REFERENCES

The cited editions of the following documents are incorporated into this Recommended Practice to the extent specified herein. Users are encouraged to investigate the possibility of applying the most recent editions of the references.

2.1 Reference Documents

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

ISO 21501-2:2007 Determination of particle size distribution—Single particle light interaction methods—Part 2: Light scattering liquid-borne particle counter

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

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