Institute of Environmental Sciences and Technology

IEST-STD-CC1246E

Contamination Control Division
Standard 1246E

Product Cleanliness Levels – Applications, Requirements, and Determination

Arlington Place One
2340 S. Arlington Heights Road, Suite 620
Arlington Heights, IL 60005-4510
Phone: (847) 981-0100 • Fax: (847) 981-4130
E-mail: information@iest.org • Web: www.iest.org

This Standard 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 Standard was prepared by and is under the jurisdiction of Working Group 901 of the IEST Contamination Control Division.

First printing, February 2013

ISBN 978-1-937280-08-6

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
Arlington Place One
2340 S. Arlington Heights Road, Suite 620
Arlington Heights, IL 60005-4510
Phone: (847) 981-0100 • Fax: (847) 981-4130
E-mail: information@iest.org • Web: www.iest.org

Product Cleanliness Levels – Applications, Requirements, and Determination

IEST-STD-CC1246E

CONTENTS

HISTORICAL BACKGROUND....4

SECTION

1 SCOPE AND LIMITATIONS 5
2 REFERENCES AND APPLICABLE DOCUMENTS....5
3 TERMS AND DEFINITIONS 6
4 BACKGROUND AND PURPOSE 7
5 CLEANLINESS REQUIREMENTS....7
6 MEASUREMENT OF CLEANLINESS.... 11
7 STATISTICAL ANALYSIS AND REPORTING OF DATA.... 12
8 PROTECTION.... 14
9 INSPECTION 14
10 BIBLIOGRAPHY 14
11 ADDITIONAL RESOURCES 14

FIGURE

1 PARTICLE SIZE DISTRIBUTION ON A LOG–LOG^2 SCALE....8
2 FORMAT AND EXAMPLE FOR SPECIFYING PRODUCT CLEANLINESS LEVELS 10

TABLE

1 PARTICULATE CLEANLINESS LEVELS....8
2 NONVOLATILE RESIDUE CLEANLINESS LEVELS....9
3 SAMPLING AND MEASUREMENT TECHNIQUES FOR SURFACES, LIQUIDS, AND GASES.. 11
4 STUDENT'S t FACTOR FOR 95% CONFIDENCE LIMIT 13
A1 PARTICLE FALLOUT CLEANLINESS LEVELS 15
A2 PARTICLE FALLOUT CLEANLINESS LEVEL PLUS INITIAL PARTICLE CLEANLINESS LEVEL.... 15
B1 CALCULATING PARTICLE PERCENT AREA COVERAGE 16
D1 VISIBLY CLEAN CRITERIA.... 19

ANNEX

A PARTICLE FALLOUT SPECIFICATION 15
B PERCENT AREA COVERAGE OF PARTICLES 16
C OTHER PARTICLE COUNT SPECIFICATIONS 18
D VISIBLY CLEAN 19

HISTORICAL BACKGROUND

The establishment of contamination control practices became a necessity with the advent of World War II and the ensuing mechanical wartime innovations. Two of the wartime inventions requiring high levels of cleanliness were the Norden bombsight and the first navigational gyroscopes. Particles in the range of 20 to 50 µm would cause the bombsight and the gyroscope to malfunction. Further degrees of refinement in equipment created the need for greater control of product cleanliness and ambient conditions. In 1956 the US government acquired an inertial guidance system containing two floating gyros. The suspension system was highly dependent on contaminant-free fluid. It was observed that contamination one-half the size of cigarette smoke particles could compromise the system, indicating the degree of cleanliness control necessary in the development of that system.

Major improvements in the area of industrial contamination control and air filtration occurred during the late 1950s and early 1960s. The development of improved techniques occurred as a result of manufacturing advances and the introduction of extremely sophisticated electronic, electromechanical, electro-optical, and hydraulic equipment. These devices required major improvements in cleanliness levels because the presence of microscopic particles could result in the malfunction of a device, an entire system, or even the mission.

With the technological advancements that have followed, requirements for higher degrees of cleanliness have forced contamination control efforts to keep pace through new developments and applications. The greatest impetus for stricter requirements for contamination control has come from the microelectronics industry. The advent of solid-state electronics and integrated circuits made it possible to produce chips containing hundreds of thousands of discrete devices, each consisting of multiple component parts with specific functions, totaling perhaps millions of such components per chip. Without the innovations in contamination control, the advances in low-cost computers, communications, and a myriad of other uses of microelectronics would not have been possible.

The development of cleanliness standards for critical components was the direct result of satisfying the need for common terminology and standardization. In 1962 a military standard was created to establish guidelines and requirements for the specification of cleanliness levels essential to product reliability and quality. This document, known as MIL-STD-1246, has been updated periodically in order to keep current with technological advances. Its history is summarized as follows:

MIL-STD-1246 (MI)	19 December 1962
MIL-STD-1246A	18 August 1967
MIL-STD-1246B	4 September 1987
MIL-STD-1246C	11 April 1994
IEST-STD-CC1246D	January 2002

The 1246C version was prepared for the US Army Missile Command by the Contamination Control Division of the Institute of Environmental Sciences and Technology (IEST).

In 1997, the U.S. Army commissioned IEST to revise and adapt this military standard as an industry standard. Its usefulness today extends far beyond military applications. This document is the resulting industry standard.

Institute of Environmental Sciences and Technology
Contamination Control Division
Standard 1246E

Product Cleanliness Levels – Applications, Requirements, and Determination

IEST-STD-CC1246E

1 SCOPE AND LIMITATIONS

1.1 Scope

This standard provides methods for specifying and determining product cleanliness levels for contamination-critical products. The emphasis is on contaminants that can impact product performance.

1.2 Use

The requirements set forth in this standard are not required for all products but are intended for use in procurement and design contracts for those items where contamination control limits for parts, components, or fluids are necessary to ensure reliability and performance.

1.3 Safety

This standard does not purport to address the safety problems that may be associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

1.4 Contamination Control Program

This standard no longer provides information concerning the creation of a contamination control program. Refer to ASTM E1548, Standard Practice for Preparation of Aerospace Contamination Control Plans, for this information.

2 REFERENCES AND APPLICABLE DOCUMENTS

The following documents are incorporated into this Standard to the extent specified herein. Unless otherwise specified, the latest revision shall apply. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. No content in this document, however, supersedes applicable laws and regulations unless specific exemption has been obtained.

2.1 American Society for Testing and Materials (ASTM)

E1216: Standard Practice for Sampling for Particulate Contamination by Tape Lift

E1234: Standard Practice for Handling, Transporting, and Installing Nonvolatile Residue (NVR) Sample Plates Used in Environmentally Controlled Areas for Spacecraft

E1235: Standard Test Method for Gravimetric Determination of Nonvolatile Residue (NVR) in Environmentally Controlled Areas for Spacecraft

E1548: Standard Practice for Preparation of Aerospace Contamination Control Plans

F25: Standard Test Method for Sizing and Counting Airborne Particulate Contamination in Cleanrooms and Other Dust-Controlled Areas