

# GLOSSARY OF CLEANROOM TERMS



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# OK Available Materials and Services

## Cleanroom Training Manuals

### ◆ **Cleanrooms, the Basics**

Solid basic overview of the critical fundamentals of cleanrooms for the neophyte as well as a solid refresher with lots of new info for the veteran. Applicable to all those who plan, design, build, startup, operate, or pay for cleanrooms.

- History of the cleanroom
- Micro concepts and ionic contamination
- HEPA filters, what they can and can't do for you
- Federal Standard 209E and ISO14644
- Basic cleanroom concepts, tools of understanding
- The mathematics of cleanrooms, a good foundation
- HVAC and other system considerations
- IES RP-012, Cleanroom Design Considerations
- Clean Construction Protocol, costs and benefits
- Certification, when, why, & how
- TSC and Isolation Technology, rational planning
- Rational of Clean Construction Protocol
- What and How of Clean Construction Protocol
- Developing a typical Clean Construction Protocol
- Support for the cleanroom, the overlooked factor
- Cleanroom Gowning and Protocol
- Cleaning the Cleanroom
- Workstations & micro-environments
- Retrofits, an economical alternative
- Energy conservation, where the big bucks are
- Stop spending so much, the economic issues

### ◆ **Cleanrooms, the Numbers**

Cuts directly to the core of good cleanroom design and operation. Covers basic mathematics of cleanroom theory and operation including examples of computer analysis spreadsheets and other design aids!

- Areas & volumes; importance of right choice
- Air flows
- Air change rates
- HEPA filtration, what it can and can't do
- Exhaust & flow diagrams
- Air return basics
- Cleanroom pressurization & air balance of room
- Sizing returns and pressure deltas

- Raised floors
- System concerns
- Economics of proper mathematical analysis
- Cleanroom Planner and Pre-Planner

### ◆ **Cleanrooms, the Protocol**

The most outstanding course on Clean Construction Protocol available. Reflects experience of over a dozen recent major projects. Absolute must for anyone involved in planning, design, construction, startup or use of a cleanroom. Topics include:

- What and why of CCP
- Economics of CCP
- Micro concepts
- HEPA filtration, what it can and can't do
- Certification, and beyond
- Developing a good CCP mindset
- Normal versus clean construction
- Monitoring with particle counters
- Designing, scheduling, and procuring for CCP
- Developing a good CCP
- Detailed study of sample protocol

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## Online Training Modules

### **How it works:**

- **Study the Manual** of reading material supplied with each package.
- **Run the OnLine Training Module** on your own computer and study the content at your leisure. The module can be read by any program that recognizes PDF format files but we highly recommend [Adobe Acrobat Reader](#) which is free and easily downloadable from the internet, You can step through the module a slide at a time, with each slide accompanied by detailed comments for your edification.
- **Complete the Test** supplied and email it to us. We will grade it and send you a notice of completion.
- **Receive a Certificate of Completion** when you have successfully completed and passed the Final Test. If you should happen to not pass the test, the test will be returned to you with comments so you can restudy and resubmit a new test when you are ready.

## What you receive with each package:

- **A Home Study Manual** package of required reading material in PDF format.
- **An OnLine Training Module** in PDF format. Each module consists of a Slide Show type presentation with detailed related information.
- **A Final Test** which you submit when you have finished studying the material at your leisure in the comfort of your own home or office.
- **A Certificate of Completion** when you have successfully completed the test.

## What Courses are offered:

◆ **Cleanrooms, the Basics** - An introduction to Cleanrooms including History, Micro Concepts and other basic cleanroom information vital to those who want or need to learn about cleanrooms.

◆ **Cleanroom Gowning and Protocol** - All you need to know about how to dress for and behave in a cleanroom environment.

◆ **Basic Cleanroom Cleaning** - Provides you with all the information and specific details that you need to be able to successfully clean non-aseptic cleanrooms.

◆ **Cleanroom Standards and Certification** - Covers Federal Standard 209 and ISO 14466 along with all the rationale for Cleanroom Certification including details on recommended Cleanroom Testing.

◆ **Clean Construction Protocol** - The rationale and reasoning behind Clean Construction Protocol along with details on how to develop your own Clean Construction Protocol and a sample Protocol for you to follow.

◆ **Cleanrooms, the Numbers** - Consists of information on basic cleanroom concepts, airflow velocities and change rates, pressurization, air return requirements, HEPA filters and other basic cleanroom design concepts.

◆ **Cleanrooms, the Cleaning Package** - a special package recommended for those with little or no cleanroom experience. Excellent package

for use with employees who will be cleaning your cleanroom. Package consists of the Cleanrooms, the Basics; Cleanroom Gowning and Protocol; and Basic Cleanroom Cleaning courses.

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## Tech Packages

### Special Federal Standard 209E Package

Includes:

- "Review of Federal Standard 209E for the Layman", a sixteen page synopsis of the provisions of the new FED STD 209E.
- 209E Summary Sheet, a double-sided sheet laminated in plastic gives you a quick reference to all of the major details of the new 209E Federal Certification Specification. A must for anyone dealing with cleanroom issues.
- Federal Standard 209E, the full official Federal Standard 209E. This is included in your package free of charge

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## Pricing

### Cleanroom Training Modules:

Cleanrooms, the Basics, h'copy	\$59.95 ea*
Cleanrooms, the Basics, PDF	\$39.95 ea*
Cleanrooms, the Protocol, h'copy	\$39.95ea*
Cleanrooms, the Protocol, PDF	\$29.95 ea*
Cleanrooms, the Numbers, h'copy	\$39.95 ea*
Cleanrooms, the Numbers, PDF	\$29.95 ea*

### Cleanroom Tech Packages:

Federal Standard 209E Package \$19.95 ea\*

### Cleanroom OnLine Training Modules

<b>Cleanrooms, the Basics</b>	<b>\$49.95</b>
<b>Cleanroom Gowning and Protocol</b>	<b>\$49.95</b>
<b>Basic Cleanroom Cleaning</b>	<b>\$49.95</b>
<b>Cleanroom Standards and Cert</b>	<b>\$49.95</b>
<b>Clean Construction Protocol</b>	<b>\$49.95</b>
<b>Cleanrooms, the Cleaning Package</b>	<b>\$79.95</b>

Cleanroom OnLine Training Module prices are per person.

\*Add \$10.50 per order postage and handling for books, 2.00 for Federal Standard 209E package, N/C for PDF Cleanroom Manuals or OnLine Training modules which are emailed: \$3.00 for PDF Cleanroom Manuals or OnLine Training modules which are mailed on CD:

- Specification and proposal review
- Design reviews
- Clean Construction Protocol
- Certification
- Support local contractors, designers, etc.
- Augmentation of your staff with Professional Expertise

## **Consulting Services Available**

### ◆ Cleanroom Design Review

- New and retrofit designs.
- Review design concepts
- Review conceptual design
- Advise on performance and manufacturability issues.

### ◆ Cleanroom Specifications

- Review your specification
- Provide custom specifications
- Performance specifications
- Detail specifications

### ◆ Cleanroom Certification Consultation

- Evaluate certification needs
- Recommend procedures
- Provide specifications
- Review specifications and proposals
- Interpret results
- Act as owner's representative

### ◆ Cleanroom Audits

- Analysis of existing cleanrooms
- Performance improvements Upgrade potential

### ◆ Cleanroom Problem Analysis

- Existing cleanroom performance problem analysis and recommendations
- New construction problem analysis
- TSC Analysis

### ◆ Cleanroom Project Owner's Representative

- Represent owner's project interests
- Planning
- Design Concepts

Orders for books, other materials, information on additional courses and services or comments may be sent to the author at the address below.

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## A GLOSSARY OF CLEANROOM TERMS

**ABSOLUTE FILTER:** An absolutely erroneous and obsolete term used to describe a HEPA filter. When HEPA filters were first introduced to the market, one firm utilized the trade name "ABSOLUTE", which later became, incorrectly, a generic term for HEPA filters.

**ABSORPTION:** A process whereby a material extracts one or more substances present in an atmosphere or mixture of gases or liquids accompanied by the material's physical and/or chemical changes.

**ACCEPTANCE TEST:** A test made upon completion of fabrication, receipt, installation, or modification of a component unit or system to verify that it meets the requirements specified.

**ACCURACY:** The extent to which the value of a quantity indicated by an instrument under test agrees with an accepted value of the quantity.

**ADSORPTION:** The action, associated with the surface adherence, of a material in extracting one or more substances present in an atmosphere or mixture of gases and liquids, unaccompanied by physical or chemical change in the material.

**AEROSOL:** A gaseous suspension of solid or liquid particles about 100  $\mu\text{m}$  or smaller in size.

**AEROSOL GENERATOR:** A device for generating an aerosol.

**AEROSOL PHOTOMETER:** A light scattering airborne particle mass concentration indicator. Instruments of this type having a threshold sensitivity of no more than  $10^{-3}$  microgram per liter for 0.3 micrometer diameter DOP particles and capable of measuring concentrations over a range of  $10^5$  times the threshold sensitivity are suitable for scan testing.

**AGGLOMERATION:** A process of contact and adhesion whereby particles form clusters of increasing size.

**AIR, RECIRCULATED:** Return air passed through the conditioner before being again supplied to the conditioned space.

**AIR, RETURN:** Air returned from conditioned or refrigerated space.

**AIR CHANGE RATE:** The number of times the total air volume of a defined space is replaced per unit of time. Typically calculated by dividing the amount of air delivered per hour by the total volume in cubic feet to give air changes per hour.

**AIR CHANGES:** A method of expressing the amount of air leakage into or out of a building or room in terms of the number of building volumes or room volumes exchanged.

**AIR-GENERATED AEROSOL:** The aerosol that results when the pneumatic force of a high-velocity stream of air (using a Laskin-type atomizer) breaks up a liquid into droplets. The liquid, used at room temperature, is dioctyl phthalate (DOP) or a specified alternative. When generated with a Laskin nozzle, the resulting DOP aerosol has a count mean diameter (CMD) of approximately 0.3  $\mu\text{m}$ , a geometric standard deviation (GSD) of approximately 1.5, and a mass mean diameter (MMD) of approximately 0.7  $\mu\text{m}$ .

**AIR SHOWER:** A relatively small, isolated "chamber" normally located at the main entrance of a cleanroom. Designed allegedly to remove gross particulate from personnel and garments by air jets.

## A GLOSSARY OF CLEANROOM TERMS

**AIR SUPPLY:** That air delivered to the conditioned space and used for ventilation, heating, cooling, humidification, or dehumidification.

**AIRBORNE PARTICLES:** Particles suspended in air. (see AEROSOL)

**AIRBORNE PARTICULATE CLEANLINESS CLASS:** The level of cleanliness specified by the maximum allowable number of particles per cubic meter of air (per cubic foot of air), shown for the class in Table I of FED-STD-209E, as determined by the statistical methods of FED-STD-209E, Section 5.4. The name of the class in SI units is taken from the logarithm (base 100 of the maximum allowable number of particles, 0.5  $\mu\text{m}$  and larger, per cubic meter. The name of the class in English (U.S. customary) units is taken from the maximum allowable number of particles, 0.5  $\mu\text{m}$  and larger, per cubic foot.

**AIRBORNE PARTICULATE CLEANLINESS LEVELS:** The number of particles equal to or larger than a given size per unit volume of air.

**AIRBORNE PARTICULATES:** Airborne particulates are discrete particles having measurable physical boundaries in all directions and of such size and mass as to remain suspended in air long enough to be sampled and measured (usually 100 micrometers or less except for lint fibers). Particulates are distinguished from particles which may have the connotation of atomic or sub-atomic matter.

**AIRLOCK:** A small chamber with dual doors designed to maintain pressure and prevent horizontal air currents during entry or exit from a cleanroom or between two sections of a clean facility of different pressures. Use of interlocked doors is recommended. Should be used any time pressure differentials are greater than 0.0001 in. WG.

**AMBIENT CONDITION:** Normal conditions, such as pressure, temperature, humidity, etc. which are considered normal for a given location.

**AMMONIUM HYDROXIDE:** Used for cleaning glass and vinyl flooring in cleanrooms as a dilute solution in DI water (approximately one-half to one percent concentration).

**ANAEROBIC:** Living or active in the absence of oxygen; as in *anaerobic* bacteria.

**ANEMOMETER:** An instrument for measuring air velocities.

**ANEMOMETER, HOT WIRE:** See THERMOANEMOMETER

**ANEMOMETER, VANE TYPE:** An instrument for measuring air velocities which mechanically converts the momentum of the air by rotation or deflection.

**ANGSTROM:** Unit of length (equal to  $1 \times 10^{-10}$  meters) used when measuring wavelength of light.

**ANISOKINETIC SAMPLING:** The condition of sampling in which the mean velocity of the flowing air stream differs from the mean velocity of the air entering the inlet of the sampling probe. Because of particle inertia, anisokinetic sampling can cause the concentration of particles in the sample to differ from the concentration of particles in the air being sampled.

**ANTISTATIC:** The ability of a product to neutralize, or avoid generating static electric charges.

**AREA:** Defined space setting off portion of a larger space. Generally used to designate a portion of a building at a given

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level of protection or contamination control, as set off from adjoining portions of different contamination levels. Used somewhat interchangeably with space or zone.

**AS-BUILT CLEANROOM:** See Cleanroom, As-Built.

**AS FOUND DATA:** Data comparing the response of an instrument to known standards as determined without adjustment after the instrument is made operational.

**ASPIRATOR:** Any apparatus such as a squeeze bulb, fan, pump, or venture, that produces a movement of a fluid by suction.

**AT-REST CLEANROOM:** See Cleanroom, At-Rest.

**ATMOSPHERE:** A unit of pressure equal to one standard atmosphere (equal to 14.696 psi equal to 29.92 in HG equal to 101.325 kPa equal to 406.82 inches Water Gage).

**BAFFLE:** A non-perforated member oriented substantially perpendicular to the direction of air flow, connected to a wall or divider of the cell, and having the purpose of preventing wall effect and/or channeling.

**BAGOUT:** A replaceable system of transferring material into or out of a glovebox or similar container using a long bag which can be sealed and cut in sections to prevent breaching the integrity of the container.

**BCD (Bulk Chemical Distribution):** Refers to an automatic system designed to supply a fab area with chemicals.

**BLOWDOWN:** A critical point in the construction of cleanrooms when recirculating handlers are turned on and a final cleaning prior to the Hepa Filters being unbagged is complete.

**BOOTIES, CLEANROOM:** Cleanroom booties are garments which are fabricated from low particulate materials and which are designed to be worn over conventional footwear. Booties are distinctive from shoe covers because they have boot-like tops which are fastened in the upper calf part of the leg. Cleanroom booties may be constructed of low particulate fabric materials or of synthetic materials such as Tyvek. The sole of the booties should be fabricated from a strong material (such a plastic) which will not easily deteriorate during use.

**BROWNIAN MOVEMENT:** The random movement of molecules which is increased as energy levels are increased (heat added) and decreased as energy levels are decreased (heat removed). See DIFFUSION.

**BUCKETS, CLEANROOM:** Mop buckets, constructed of stainless steel or plastic with a split compartment, one for clean and one for dirty water used in cleanroom operations.

**BUILDING ENVELOPE:** The elements of a building which enclose conditioned spaces through which energy may be transferred to or from the exterior.

**BYPASS:** The diversion (or facilities for diversion) of air around an air cleaning unit or component. The inadvertent leakage or diversion of air around an internal component of the air cleaning unit or component, resulting in the release of uncleaned air.

**CALIBRATED EQUIPMENT:** Test equipment that has been calibrated in accordance with the equipment manufacturer's recommendations or accepted industry practices.

**CALIBRATION:** Comparison of a measurement standard or instrument of unknown accuracy with another standard or instrument of known

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accuracy to detect, correlate, report, or eliminate by adjustment, any variation in the accuracy of the unknown standard or instrument.

**CANDLE:** A measure of intensity of a light source. The international candle is based on the light emitted by a black body heated to a specific temperature.

**CAPS, CLEANROOM:** Cleanroom caps are garments which are fabricated from low particulate materials and which are designed to be worn on the head to contain the hair, in the same fashion as a hairnet. Their use is appropriate for lower levels of contamination control.

**CASSETTE:** A holder for wafers or wafer frames.

**CERTIFICATE OF COMPLIANCE (CONFORMANCE):** A written statement, signed by a qualified party, attesting that the items or services are in accordance with specified requirements, and accompanied by additional information to substantiate the statement.

**CERTIFICATION, CLEANROOM, NOUN:** Statement by a testing agency that a cleanroom has been tested in accordance with the latest version of FED-STD-209 and IES-RP-CC006 or other document and that the cleanliness class or other specified requirements have been achieved.

**CERTIFICATION, CLEANROOM, verb:** A series of tests and adjustments designed to both confirm that the cleanroom or clean facility meets the designed performance specifications and to enable the system to perform at maximum capability, very frequently at a level much higher than specified if proper adjustments and repairs are effected. Critical tests include in-place filter scan, velocity, pressurization, visible vapor, and induction leak testing. Temperature, humidity, lighting, etc. are frequently included.

**CERTIFICATION AGENCY:** A company providing on-site, field certification services for profit or gain.

**CHALLENGE CONCENTRATION:** The concentration of an aerosol or gas of known characteristics used to expose a filter, adsorber, or other air cleaning device, under specified conditions, for the purpose of testing. The test aerosol or gas is the challenge aerosol or challenge gas, respectively

**CHEMICAL COMPATIBILITY:** The interaction of a material with a chemical substance with which it has come into contact. A minimum interaction is desirable.

**CHEMICAL DEGRADATION:** Changes in material when in contact with chemicals. Undesirable forms of degradation are swelling, loss of tensile strength, deformation, and loss of abrasion resistance.

**CHIMNEY EFFECT:** A phenomenon consisting of a vertical movement of a localized mass of air or other gases due to temperature differences.

**CLASS (Airborne Particulate):** Cleanliness Class as defined by Federal Standard 209.

**CLEAN:** A term without meaning unless level is specified in terms of contamination per unit area, volume, etc.

**CLEAN-AIR DEVICE:** A clean bench, clean work station, downflow module, or other equipment designed to control particulate air

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cleanliness in a localized working area and incorporating, as a minimum, a HEPA filter and a blower.

**CLEAN-AIR DEVICE, LAMINAR FLOW:** A clean bench, clean work station, wall or ceiling hung module, or other device (except a cleanroom) which incorporates a HEPA filter(s) and motor-blower (s) for the purpose of supplying laminar flow clean air to controlled work space.

**CLEAN-AIR SYSTEM:** An air cleaning system designed to maintain a defined level of air cleanliness usually in terms of a permissible number of particles in a given size range per unit volume, within an enclosed working area.

**CLEAN AREA:** A defined space within which the airborne particulate level is controlled to a specified limits. Those areas designated and maintained for the purpose of gowning, equipment cleaning, etc. for people or material about to enter the "cleanroom". May be temporary in nature.

**CLEAN CONSTRUCTION AREA:** All areas controlled by specific clean construction protocol rules. A defined space in which contamination is minimized for the purpose of avoiding entrapment of particles in what will become a permanent cleanroom or a recirculation plenum.

**CLEAN ENVIRONMENT:** All space falling inside the cleanrooms, clean zones, and clean area.

**CLEAN GARMENTS:** New, unused disposable garments, or reusable garments that have not been used since they were cleaned by a cleaner who specializes in cleaning of cleanroom garments. All clean garments must be packaged or otherwise stored to protect them from exposure to the environment.

**CLEAN ISLAND:** A type of locally controlled environment in which contamination control is achieved by providing cleanliness levels which exceed those of the surrounding area.

**CLEAN ROOM:** A room in which the particulate levels are reduced through means of extra-ordinary cleaning and disciplinary methods, but without the use of HEPA filtered air.

**CLEAN WORK STATIONS:** Small stand-alone clean devices utilizing HEPA filtration to create a clean laminar flow micro environment.

**CLEAN ZONE:** A defined space in which the concentration of airborne particles are controlled to specified limits according to the same limitations and definitions as Cleanroom.

**CLEANLINESS LEVEL:** An established maximum allowable level of contaminants based on size, composition, quantity, properties, etc. for a given area or volume.

**CLEANABILITY:** The ultimate limit of cleanliness obtainable for a material by a cleaning process.

**CLEANROOM:** A room in which the concentration of airborne particles is controlled and which contains one or more clean zones.

**CLEANROOM CLASS, CONTROLLED:** Cleanroom class, when designated as "Class XXX", (i. e. class 1000, class 1, etc.) refers to a class strictly defined by Federal Standard 209E. Class counts should typically be expected to be at least one order of magnitude lower than the class designated, i. e. counts should usually fall below 10 if class 100 is designated. In no circumstance shall the counts exceed the class designated.

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**CLEANROOM CLASS, TYPICAL:** An unofficial cleanroom class, when designated as "Typical Class XXX", refers to the level of particle counts which one should typically see under normal circumstances. Particle counts in areas defined as typical classes will vary considerably and occasionally exceed the noted class, especially when contamination generating activity is in progress. This term is usually used to designate uncontrolled, but relatively clean areas such as return air service chases.

**CLEANROOM (FACILITY) - AS-BUILT:** A cleanroom (facility) that is complete and ready for operation, with all services connected and functional, but without production equipment or personnel within the facility.

**CLEANROOM (FACILITY) - AT-REST:** A cleanroom (facility) that is complete and has the production equipment installed and operating, but without personnel within the facility.

**CLEANROOM (FACILITY) - OPERATIONAL:** A cleanroom (facility) in normal operation with all services functioning and with production equipment and personnel present and performing their normal work functions in the facility.

**CLEANROOM - CONVENTIONAL:** A cleanroom in which the airflow is random, typically applied to Class 1000 and less clean cleanrooms. A term invented to differentiate laminar flow cleanrooms from non-laminar flow cleanrooms when laminar flow cleanrooms were developed.

**CLEANROOM - HORIZONTAL FLOW:** A cleanroom in which the clean air, supplied through a wall bank of HEPA filters, travels horizontally and exits through an opposite wall.

**CLEANROOM - LAMINAR AIRFLOW:** A cleanroom in which the filtered air makes a single pass through the work area in a parallel flow pattern with a minimum of turbulent flow areas. Laminar airflow rooms have a minimum of 80% of the ceiling (vertical flow) or one wall (horizontal flow) producing a uniform and parallel HEPA filtered airflow.

**CLEANROOM - MIXED FLOW:** A hybrid cleanroom consisting of a combination of laminar airflow cleanroom and turbulent flow cleanroom.

**CLEANROOM - TURBULENT FLOW:** A cleanroom in which the air enters the room in a non-uniform velocity or turbulent flow. Such rooms exhibit a non-uniform or random airflow pattern throughout the enclosure.

**CLEANROOM - VERTICAL FLOW:** A cleanroom in which the clean air, supplied through a ceiling bank of HEPA filters, travels vertically and exits through the floor or low sidewall returns.

**CLEANROOM TUNNEL:** A particular type of cleanroom design utilizing a series of laminar flow modules or ceiling units and walls to form clean areas, or tunnels, typically from 10' to 12' wide (14 feet maximum for sidewall return) and of varying lengths. Typically used in a series of tunnels connected to a central corridor in an E or back to back E shape with an air return service bay between the tunnels.

**CLEANROOM TESTING AGENCY:** An organization that employs appropriately skilled technicians employing specified instrumentation and methods in a specified manner to determine cleanroom cleanliness class. The skill and experience level of

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the testing agency should be specified by the user or contracting agency.

**COLLECTOR:** A device for removing and retaining contaminants from air or other gases. Usually this term is applied to cleaning devices in exhaust systems.

**CONDENSATION NUCLEI:** Small particles, normally within the size range from 0.001 to 0.1  $\mu\text{m}$  radius, upon which water vapor condenses in the atmosphere.

**CONDENSATION NUCLEUS COUNTER:** An instrument for counting small airborne particles, approximately 0.01 micrometer and larger, by optically detecting droplets formed by condensation of a vapor upon the small particles.

**CONTAINED SPACE:** A building, building space, room, cell, glove box, or other enclosed volume in which the air supply and exhaust are controlled.

**CONTAMINANT:** Any unwanted substance present in or on a material.

**CONTAMINATION, PRIMARY:** Contamination which directly affects a product or process.

**CONTAMINATION, SECONDARY:** That contamination which either adversely affects a tool, material, or environment in a manner which reduces the capability of that tool, material, or environment to properly interface with the primary product or process or which enters the tool and environment and is later transmitted to the primary product or process.

**CONTAMINATION CONTROL:** Organized action to reduce the degree or the level of contaminants to a minimum that will not constitute a hazard or degrade a function.

**CONTROLLED ENVIRONMENT FACILITY:** A specified working area that has the primary objective of controlling one or more physical, chemical, or biological variables.

**CONTROLLED WORK AREA:** A specified work area in which access, operations, and environment are controlled.

**CONTROLLED WORK STATION:** An individual work bench or similar enclosure used to minimize the effects of the human operator and undesirable influences on items requiring a controlled environment. A controlled micro environment.

**COVERALLS, CLEANROOM:** Cleanroom coveralls are garments, frequently referred to as "bunny suits", which are designed to be worn over conventional clothing. Cleanroom coveralls may be constructed of low particulate fabric materials or of synthetic materials such as Tyvek. They should be capable of fastening arm, leg, and neck openings in a manner tight enough to prevent escape of contaminants.

**CROSS FLOW CLEANROOM:** See Cleanroom, Horizontal.

**DAMPER:** An operable device used to control pressure or flow by varying the air path area.

**DEBRIS:** Macro contamination such as scrap, boxes, unused pipe, etc.

**DECOMPOSITION:** The reduction of a material to more elemental forms, for example, the decomposition of plastic with the resultant release of DOP plasticizer, etc.

**DECONTAMINATION:** The removal of contamination from air, other gases, surfaces, or liquids.

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**DECONTAMINATION FACTOR:** The ratio of the concentration of a contaminant in the uncleaned (untreated) air to its concentration in the clean (treated) air.

**DESORPTION:** The process of freeing from a sorbed state.

**DIE:** Generic unit referring to an individual integrated circuit both on a wafer and after wafer separation.

**DIFFUSION:** A major mechanism whereby HEPA filters trap particles which are small enough to be influenced by Brownian movement of molecules and act in a similar manner. See Brownian Movement and Langmuir's Principle.

**DIFFUSION, MOLECULAR:** A process of spontaneous intermixing of different substances, attributable to molecular motion and tending to produce uniformity of concentration.

**DISCRETE-PARTICLE COUNTER (DPC):** A particle-counting instrument that utilizes light-scattering or other suitable principle to count and size discrete particles in air, and that displays or records the results. The discrete-particle counter is also known as a single-particle counter or simply as a particle counter.

**DISPERSION:** The most general term for a system consisting of particulate matter suspended in air or other gas.

**DISPERSOID:** Matter in a form produced by a disperse system.

**DOP:** Dioctyl phthalate. DOP is an oil commonly used with vinyl resins to make soft vinyl plastics.

**DOP AEROSOL:** A dispersion of dioctyl phthalate (DOP) droplets in air with the following approximate light-scattering mean droplet-size distribution:

99+%, less than 3.0  $\mu\text{m}$

50+%, less than 0.7  $\mu\text{m}$

10+%, less than 0.4  $\mu\text{m}$

Note: Recent research has indicated that there is a possibility that DOP may be carcinogenic under certain conditions. Alternatives, such as PSL are being investigated, developed, and currently in use.

**DOP AEROSOL GENERATOR, AIR OPERATED:** A device for producing a DOP aerosol, operated by compressed air at room temperature, equipped with Laskin nozzles to produce a heterogeneous DOP test aerosol.

**DOP AEROSOL GENERATOR, PRESSURIZED GAS-THERMAL:** A device for producing DOP aerosol, operated by pressurized inert gas and equipped with heating means.

**DOP, AIR GENERATED:** An aerosol generated by blowing air through liquid dioctyl phthalate at room temperature. When generated with a Laskin nozzle, the approximate light-scattering mean droplet size distribution is:

99 + percent less than 3.0  $\mu\text{m}$

50 + percent less than 0.7  $\mu\text{m}$

10 + percent less than 30.4  $\mu\text{m}$

**DOP, THERMALLY GENERATED:** An aerosol generated by quenching (condensing) vapor that has been evaporated from liquid dioctyl phthalate by heat. The aerosol mean particle diameter is between 0.2 and 0.4 microns with a maximum geometric standard deviation of 1.3.

**DOWNFLOW:** Vertical airflow (from ceiling to floor).

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**DUCT:** A passageway made of sheet metal or other suitable material, not necessarily leak-tight, used for conveying air or other gas at low pressures.

**DUST:** Small, solid particles which may be present on a surface or in a gas.

**ELECTROMAGNETIC INTERFERENCE (EMI):** Conducted or radiated electrical disturbances which can interfere with equipment operation, and can occur anywhere in the EM spectrum from less than 10 Hz up to cosmic rays, including radio, light, and X-rays.

**ENTHALPY:** The total quantity of heat energy contained in a substance, also called total heat; the thermodynamic property of a substance defined as the sum of its internal energy, plus the quantity  $Pv/J$ , where  $P$  = pressure of the substance,  $v$  = its volume, and  $J$  = the mechanical equivalent of heat.

**ENTROPY:** The ratio of the heat added to a substance to the absolute temperature at which it is added.

**ENTRANCE PLANE:** A plane perpendicular to the unidirectional airflow located immediately upstream of the region of interest (typically the work area unless otherwise specified) and having the same dimensions as the cross section of the clean zone perpendicular to the direction of the airflow.

**ENTRY/GOWNING AREA:** The Entry/Gowning area refers to an area of one or more stages designed to prepare personnel prior to entering a cleanroom.

**ENVIRONMENTAL TEST CHAMBER:** A vessel container in which space environments and/or atmospheric conditions can be simulated.

**ENVIRONMENT:** The aggregate of all the conditions and influences which affect the operation of equipment, components, and personnel. Examples of such conditions are temperature, pressure, humidity, bacterial count, etc.

**ENVIRONMENTAL MONITORING:** Monitoring of those environmental parameters in a cleanroom which relate to the process or product requirements. Typically monitored are parameters such as temperature, humidity, pressure, and particle concentration.

**EQUIVALENT:** Equal in performance.

**EQUIVALENT SPHERICAL ILLUMINATION:** A measure of lighting quality and quantity developed by the Illuminating Engineering Society.

**ELECTROSTATIC FORCE:** A force by which particles may be trapped in a filter but which has very little effect in filtration in a HEPA filter.

**ELECTROSTATIC DISCHARGE (ESD):** A transfer of electrostatic charge between objects at different electrostatic potentials caused by direct contact or induced by electrostatic field.

**FAB MODULE:** A complete fab area including all process areas such as Diffusion, Wet Chemistry, etc; Entry/Gowning Area, access aisles in and to the process areas; and process and facility service areas and access aisles. It does not include support areas such as BCD and toxic gas source building nor does it include auxiliary areas such as offices and docks.

**FACE AREA:** The total plane area of the portion of a grill, coil, filter, or other item bounded by a line tangent to the outer edges of the openings through which air can pass.

**FACE AREA, ACTIVE:** That portion of the face area through which air actually passes.

## A GLOSSARY OF CLEANROOM TERMS

**FIBER:** A particle having a length 100 micrometers or greater, and an aspect ratio of at least 1:10.

**FILTER, EXTENDED MEDIUM:** A filter having a pleated medium or a medium in the form of bags, socks, or other shape to increase the surface area relative to the frontal area of the filter.

**FILTER, FLOW RESISTANCE:** Resistance offered by a filter medium to fluid flow; the pressure difference required to give unit flow of a fluid of unit viscosity through a unit cube of filter medium.

**FILTER, MECHANICAL:** A device which mechanically removes particulate matter from a fluid by the mechanism of impaction, settling, screening, inertia, diffusion, or any combination of these.

**FINAL FILTER:** The last stage of filtration before the airstream enters the clean space. The performance grade of this filter determines the air quality entering the cleanspace.

**FIRST AIR:** The air which issues directly from the HEPA filter before it passes over any work location.

**FIRST WORK LOCATION:** The work location nearest the downstream side of the HEPA filters in a laminar airflow device or cleanroom. Most typically applies to horizontal flow cleanrooms and work stations.

**FLOWMETER:** An instrument for measuring the rate of flow of a fluid moving through a pipe or duct system. The instrument is calibrated to give volume or mass rate of flow.

**FLUID:** Gas, liquid, or vapor.

**FINGER COT:** A covering or sheath for a finger.

**FOOT CANDLE:** A measure of illumination at any point that is a distance of one foot from a uniform point source of one candle power. Unit of light flux density equal to one lumen per square foot. Also referred to as "Raw" Foot candle.

**FUMES:** Solid particles commonly formed by the condensation of vapors from normally solid materials such as molten metals. Fumes may also be formed by sublimation, distillation, calcination, or chemical reaction wherever such processes create airborne particles predominantly below one micron in size. Such solid particles sometimes serve as condensation nuclei for water vapor to form smog.

**FUNCTIONAL PROCESS AREA:** An area which is designed to house a group of similar equipments and their support facilities which are closely related and which require a similar environment.

**GARMENTS, CLEANROOM:** Special items of clothing designed to be worn to protect the cleanroom atmosphere from contaminants released by workers. Special clothing apparel includes footwear or covers, and head covers.

**GAS:** One of the three states of aggregation of matter, having neither independent shape or volume and tending to expand indefinitely.

**GENERATED PARTICLES:** Particles that are not already present in or on a medium, but which are generated in response to imparting energy to that medium. Particularly applied to cleanroom wipes.

**GLARE ZONE:** A zone directly under or in front of a luminary extending from 0 - 4 degrees from vertical for ceiling light or 0 - 40 degrees from horizontal for horizontal lighting.

## A GLOSSARY OF CLEANROOM TERMS

**GLOVE:** A covering for the hand having separate sections for each of the fingers and the thumb, often extending part way up the arm.

**GLOVES, CLEANROOM:** Cleanroom gloves are gloves specially designed to prevent spreading of oils or other contaminants from the hands to surfaces within the clean environment. While they may offer minimal protection to the hands, that is not their purpose. Their construction must be of materials which are not absorbent on the palm side and which provide a barrier to the transfer of body oils and particulate contamination. Cleanroom gloves should also be sturdy enough to provide reasonable wear for the duties to be performed.

**GOWNS, CLEANROOM:** Cleanroom gowns are garments, frequently referred to as "smocks", which are fabricated from low particulate materials and are designed to be worn over conventional clothing in the fashion of a lab coat.

**GLOVEBOX:** An enclosure, with or without gloves, that serves the nuclear, biomedical, semiconductor, chemical, and other industries where confinement to or from the atmosphere is required using low differential pressure. From the American Glovebox Society.

**GREINER'S PRINCIPLE:** A theory of defect density management which encompasses the TSC or Time/Sensitivity/Concentration concept.

Defect density is dependent upon three elements; the length of time a product is exposed, the susceptibility of the product to the given contaminant, and the concentration of the contaminant. See TSC.

- If any one of the three factors is zero, defect density will be zero.
- As the magnitude of any or all of the three factors are reduced sufficiently, defect density will be reduced accordingly.
- Reduction in concentration of a contaminant to which a product is not sensitive will not reduce defect density.
- Exposure during a time of non-sensitivity will not reduce defect density.
- Concentration of contaminants and sensitivity will have no effect upon defect density if a product is not exposed.

**GROSS CLEANING:** Preliminary or rough cleaning to remove scale, rust, metal chips, shop dirt, etc. This cleaning is usually accomplished in a normal working environment to visual inspection standards. Same as pre-cleaning.

**HEAD, STATIC:** See STATIC HEAD.

**HEAT:** The form of energy that is transferred by virtue of a temperature difference.

**HEAT, LATENT:** Change of enthalpy during a change of state, usually expressed in Btu per lb. With pure substances, latent heat is absorbed or rejected at constant temperature.

**HEAT, SENSIBLE:** Heat which is associated with a change in temperature; specific heat exchange of temperature; in contrast to a heat interchange in which a change of state occurs.

## A GLOSSARY OF CLEANROOM TERMS

**HEPA (HIGH EFFICIENCY PARTICULATE AIR) FILTER:** A replaceable, extended-medium, dry-type filter in a rigid frame, having a minimum particle-collection efficiency of 99.97% (that is, a maximum particle penetration of 0.03%) for 0.3  $\mu\text{m}$  particles of thermally generated DOP or specified alternative aerosol when tested in accordance with the methods of IES-RP-CC007. The particle size designated with efficiency for HEPA filters is the particle size that the HEPA filter is least efficient in filtering. The filter will have a higher efficiency in filtering all particles both larger and smaller than the designated rated size. 99.99% efficient HEPA filters should be considered as the least acceptable filter used in cleanroom applications including use in air-handler filter banks. HEPA is a generic term for all such filters, including ULPA and VLSI filters.

**HLF:** Horizontal Laminar Flow.

**HOODS, CLEANROOM:** Cleanroom hoods are garments designed to cover the head and neck. They are used as a head covering in higher levels of contamination control than are cleanroom caps. Cleanroom hoods may be constructed of low particulate fabric materials or of synthetic materials such as Tyvek. Their design should insure that the head and neck are completely covered, leaving only the face exposed, with provisions to "tuck" the hood into the cleanroom gown or coverall.

**HUMIDITY:** Water vapor within a given space.

**HUMIDITY, RELATIVE:** The ratio of the mole fraction of water vapor present in the air, to the mole fraction of water vapor present in saturated air at the same temperature and barometric pressure; approximately, it equals the ratio of the partial pressure or density of the water vapor in the air, to the saturation pressure or density, respectively, or water vapor at the same temperature.

**IMPACTION:** A forcible contact of particles of matter; a term often used synonymously with impingement.

**IN-PLACE LEAK TEST:** A test of an installed component or bank of components, as opposed to a pre-delivery or pre-installation test of individual components. Typically applies to HEPA filters, seals and related components.

**INCHES OF WATER GAGE (w. g.; W. G.; WG):** A unit of pressure or pressure differential equal to the pressure exerted by a column of water one inch high at sea level. 1 in WG = 0.036 psi.

**INDUCTION LEAK TEST:** A procedure to evaluate potential particle intrusion into a clean space by induction through unsealed construction joints, piping/utility penetrations or by back-streaming from work space openings.

**INERTIA:** A major mechanism of HEPA filtration which tends to capture large particles. See Langmuir's Principle.

**INTERCEPTION:** A mechanism of HEPA filtration which is independent of velocity whereby a particle centerline remains in the centerline of airflow but is captured by the HEPA filter fiber because the fiber is in the path of the particle. Main capture mechanism around the point of least efficiency.

**ION GRID:** A device generating a balanced shower of positive and negative ions intended to neutralize static electric charges within a given area.

## A GLOSSARY OF CLEANROOM TERMS

**IONIC CONTAMINATION:** Atoms, or groups of atoms, which have an electrical charge and which adversely affect a product or process. Particles containing ionic contamination.

**ISOAXIAL:** A condition of sampling in which the direction of the airflow into the sampling probe inlet is the same as that of the unidirectional airflow being sampled.

**ISOKINETIC:** A term describing a condition of sampling, in which the flow of gas into the sampling device (at the opening or face of the inlet) has the same flow rate and direction as the ambient atmosphere being sampled.

**ISOKINETIC SAMPLING:** The condition of isoaxial sampling in which the mean velocity of the air entering the probe inlet is the same as the mean velocity of the unidirectional airflow at that location.

**ISOLATION:** Segregation of elements into the smallest operational systems practical.

**ISOLATION TECHNOLOGY:** Methodology for isolating various elements of the cleanroom environment from each other or from outside factors in a manner to enhance the overall desired performance of the system.

**ISOPROPYL ALCOHOL:** Isopropyl Alcohol (IPA), high purity, semiconductor grade only, is typically used as a cleanroom cleaning solution for degreasing operations. It is mandatory to dilute the IPA with deionized water. Maximum allowable concentration is 15%.

**ISOTROPIC PARTICLES:** Particles with equal, uniform physical and chemical properties along all axes.

**LADDERS, CLEANROOM:** Ladders of conventional metal structure (or of epoxy-painted wooden or fiberglass construction if a non-conductive ladder is required) and dedicated to cleanroom use. Periodically wipe-downs are typically used to insure that they do not accumulate contamination.

**LAMINAR AIR FLOW:** Air flow that is unidirectional and at high velocity and tends to attract and direct particles in parallel paths.

**LANGMUIR'S PRINCIPLE:** The principle expressed in OSRD Report #865, that the effective filtering mechanisms of HEPA filters are inertia, diffusion, and interception and that the point of least efficiency is 0.3  $\mu\text{m}$ .

**LASKIN NOZZLE:** A nozzle used for the generation of a heterogeneous aerosol by compressed gas.

**LAUNDER-ABILITY:** The ability of an article such as a glove or a garment to be laundered to a specified level of cleanliness.

**LEAK, HEPA FILTER:** A gap or void in filter media or gaskets which permits unfiltered air to penetrate into the cleanroom or clean work station.

**LEAK-TIGHTNESS:** The condition of a component, unit, or system where leakage through the pressure boundary is less than a specified value at a specified differential pressure.

**LIGHT SCATTERING:** A technique for detecting, counting, and sizing particulate matter passing through a high intensity light beam, the distorted light beams being converted to electrical impulses by a photomultiplier tube and registered on appropriate counters and tapes. Also known as aerosol photometry.

## A GLOSSARY OF CLEANROOM TERMS

**LIGHTING EFFECTIVENESS FACTOR:** The ratio between ESI foot candles and "Raw" foot candles.

**LOT:** A grouping of material which is undergoing the same processing operations.

**LUMEN:** A measure of the time rate of flow of luminous energy (light) equal to the light intercepted by a surface of one square foot, all points of which are one foot distance from a uniform point source of one candle.

**MAKE-UP AIR:** Air introduced to the recirculated air system for the purpose of ventilation, pressurization, and replacement of exhaust air.

**MEMBRANE FILTER:** Porous membrane composed of pure and biologically inert cellulose esters, polyethylene, or other materials.

**MASKS, CLEANROOM:** Cleanroom masks are face masks designed to be worn with other cleanroom garments to prevent the spread of contamination from the mouth and nose.

**MATS, TACKY, FABRIC:** Strippable fabric mesh tacky mats used at entrances to clean environments early in clean construction operations during times plastic tacky mats become loaded up with contamination so rapidly that they may not be practically maintained.

**MATS, TACKY, PLASTIC:** Strippable plastic tacky mats used at entrances to clean environments.

**MEDIUM:** The filtering material in a filter.

**MEMBRANE FILTER:** Porous membrane composed of pure biologically inert cellulose esters, polyethylene, or other materials through which the air stream is passed for the purposes of filtration.

**MICROENVIRONMENT:** A means of providing contamination control by means of enclosures that protect the critical processing region separating it from operating personnel and locally controlling the environmental conditions.

**MICROMETER (Micron):** A unit of measurement equal to one-millionth of a meter or approximately 0.00003937 inch (e.g. 25 micrometers are approximately 0.001 inch).

**MICRON:** A micrometer, sometimes expressed as a  $\mu$  or a  $\mu\text{m}$ .

**MINI-ENVIRONMENT:** A means of providing contamination control through the enclosure of equipment and activities that are used in contamination-sensitive processes. General personnel are separated from areas surrounding the equipment or activity, while the environmental conditions within the enclosure are locally controlled. The enclosure may provide for access and intermittent usage by operators and maintenance personnel within the enclosure.

**MIXED AIRFLOW CLEANROOM:** A cleanroom in which the airflow is a mixture of both unidirectional and nonunidirectional.

**MONITORING:** The routine determination of airborne particle concentrations, as well as other relevant conditions, in cleanrooms and clean zones.

**MOPS, CLEANROOM:** A sponge mop with a wringer feature used for cleanroom mopping and dedicated to the cleanroom application only.

## A GLOSSARY OF CLEANROOM TERMS

**MOPS, DRY:** Conventional dry mops typically used only during the first stage of clean construction cleaning operations, typically subsequent to sweeping and prior to wet mopping or vacuuming.

**MOPS, WET:** Conventional wet mops typically used only in early stages of clean construction cleaning operations.

**NOMINAL SIZE:** The size by which an item is designated, but not necessarily the actual size. For example, a 2' x 4' HEPA filter may actually be smaller than two feet by four feet.

**NON-UNIDIRECTIONAL AIRFLOW:** Airflow which does not meet the definition of unidirectional airflow; previously referred to as "turbulent" or "non-laminar" airflow.

**NON-UNIDIRECTIONAL AIRFLOW CLEANROOM:** A cleanroom in which the airflow does not meet the definition of unidirectional airflow.

**ODOR:** That property of a substance which affects the sense of smell; any smell, scent, or perfume.

**OFFGASING:** The release of adsorbed or absorbed materials in a gaseous form from a substrate when the substrate is at atmospheric pressures. The substrate itself does not change form.

**OPERATIONAL CLEANROOM:** See Cleanroom, Operational.

**ORGANIC VAPORS:** Vapors that originate from solid or liquid organic materials; these typically result from outgassing or from chemical reaction, including combustion.

**OUT-GASSING:** The release of adsorbed or absorbed materials in a gaseous form from a substrate when the substrate is exposed to sub-atmospheric pressures. The substrate itself does not change form.

**PARALLEL AIRFLOW:** Unidirectional airflow, as demonstrated by introduction of an isokinetic visible vapor which exhibits a measured dispersion of not more than 14° from a straight line.

**PARTICLE:** A solid or liquid object generally between 0.001 and 1000  $\mu\text{m}$  in size.

**PARTICLE CONCENTRATION:** The number of individual particles per unit volume of air.

**PARTICLE COUNT:** Concentration expressed in terms of the number of particles per unit volume of air or other gas.

**PARTICLE COUNTER, AIRBORNE:** An instrument for continuous counting of airborne particles larger than a given threshold size. The sensing means may be optical, electrical, aerodynamic, etc.

**PARTICLE COUNTER, OPTICAL:** A light-scattering instrument with display and/or recording means to count and size discrete particles in air.

**PARTICLE DIAMETER (COUNT MEAN):** The arithmetic, or count mean, diameter is defined by equation:

$$d_g = (1/N) \times \sum N_i \times d_i \quad \text{where } N_i \text{ is}$$

the number of particles with diameter  $d_i$  and  $N$  is the total number of particles.

**PARTICLE DIAMETER (MASS MEDIAN SIZE):** A measure of particle diameter based on the particle mass. For the mass median size, one-half of the particle mass is contributed by particles with a size less than the mass median size, and one-half of the particle mass by those particles larger than that size.

## A GLOSSARY OF CLEANROOM TERMS

**PARTICLE DIAMETER (MATHEMATICAL RELATIONSHIP):** Mathematical definitions of the average diameters of particulate substance are related by the following equations:

$$\ln d_g = \ln d_m - 3.0 \ln^2 S$$

$$\ln d_g = \ln d_s - 3.1 \ln^2 S$$

where  $d_g$  is the count mean diameter,  $d_s$  is the light scattering mean diameter,  $d_m$  is the mass mean diameter and  $S$  the geometric standard deviation of the particle-size distribution.

**PARTICLE SIZE:** The apparent maximum linear dimension of the particle in the plane of observation as observed with a microscope, or the equivalent diameter of a particle detected by automatic instrumentation. The equivalent diameter is the diameter of a reference sphere having known properties and producing the same response in the sensing instrument as the particle being measured.

**PARTICLE SIZE DISTRIBUTION:** The relative percentage by weight or number of different particle size fractions.

**PARTICULATE:** A substance which consists of particles.

**PARTICULATE CONTAMINANT:** A contaminant consisting of particles.

**PASS-THROUGHS:** Small chambers with interlocked doors, used to pass materials into, out of, or between sections of a cleanroom. This device helps to limit traffic and maintain appropriate pressure in the cleanroom.

**PENETRATION:** The exit concentration of a given gas from an air cleaning device, expressed as percentage of inlet concentration.

**PENETROMETER:** A self-contained instrument for the determination of penetration characteristics of very high-efficiency filter medium and filter units with thermally-generated DOP, in accordance with MIL-STD-282.

**PERMEABILITY:** The process whereby a fluid or gas passes through a barrier at the molecular level. Passage of these materials through defects such as holes or tears does not constitute permeability.

**PHOTOMETER:** A light-scattering instrument with display and/or recording means to mass concentrations of aerosol in air.

**PLENUM CHAMBER:** A compartment designed to ensure an even distribution of flow in a gas system. Examples are, air distribution in air-conditioning and ventilation; the inlet to a filter system to create an even flow of gas to each filter unit.

**POLYURETHANES:** Synthetic plastics formed by action of diisocyanates on dihydric alcohols, polyesters or polyethers. As open cell foams are often used in air-conditioning filters.

**PRECIPITATION, ELECTROSTATIC:** The separation of particulate matter from air or other gases under the influence of an electrostatic field.

**PRECISION:** The degree of agreement of repeated measurements of the same property, expressed in terms of dispersion of test results about the mean result obtained by repetitive testing or a homogenous sample under specified conditions. The precision of a method is expressed quantitatively as the standard deviation computed from the results of a series of controlled determinations.

**PREFILTER:** A filter unit installed ahead of another filter unit to protect the second unit from high dust concentration or other

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environmental conditions. The prefilter usually has a lower efficiency than the filter it protects.

**PRESSURE DIFFERENTIAL:** The difference between two pressure gage readings.

**PRESSURE, GAGE:** The difference in pressure existing within a system and that of the atmosphere. Zero gage pressure is equal to atmospheric pressure.

**PRESSURE, STATIC:** The pressure of a fluid at rest, or in motion, exerted perpendicularly to the direction of flow.

**PRESSURE, TOTAL:** The pressure representing the sum of static pressure and velocity pressure at the point of measurement.

**PRESSURE, VELOCITY:** That pressure caused by and related to the velocity of the flow of fluid; a measure of the kinetic energy of the fluid.

**PREVENTATIVE MAINTENANCE:** Maintenance performed on a regularly scheduled basis which involves replacement, cleaning, adjustment, and checking of equipment and components before a failure occurs. Normally preventative maintenance schedules are statistically determined from past history of similar equipment or component failures or design limitations of anticipated lifetimes of equipment and components.

**PROBING OR SCANNING:** A method for disclosing leaks in filter units in which the probe nozzle of an aerosol photometer is held approximately one inch (2.54 cm) from the area to be tested and moved at a rate of not more than 10 ft/min (3.05 m/min) across the test area for DOP photometer scanning. If a particle counter is used, the scan rate shall be proportional to the upstream particle concentration as defined by a standard particle count scan nomogram or the equation:

$$R_n = (P_c \times L_m \times L_p) / 600$$

where  $R_n$  = maximum rate of scan from nomogram (in inches per second),  $P_c$  = concentration of aerosol challenge upstream of HEPA (per cu ft),  $L_m$  = theoretical leak (in percent), and  $L_p$  = length of probe in direction of scan (in inches).

**PROCESS ACTIVITY AREA:** Area in which personnel or equipment are directly interfacing with the process.

**PROCESS MODULE:** A single isolated module designed to provide a tightly controlled process area.

**PROCESS MODULE ACCESS AISLES:** That area which is used strictly to provide process personnel access to the Process Modules and to provide a path of material flow to and from the Process Modules.

**PROCESS MODULE SERVICE AISLES:** That area which is provided outside the physical area of the Process Modules and Process Access Aisles to house equipment, allow servicing of the equipment and provide access for facilities required by the equipment and process.

**PRODUCTION AND SUPPORT EQUIPMENT AND HARDWARE:** Equipment, tools and devices whose primary purpose is to perform an operation on a product or material. Production and support equipment shall include filters, conveyors, jigs, work tables and desks that are located in a cleanroom or laminar flow clean air device.

Equipment whose primary function is to provide an appropriate manufacturing environment for the product (air supply and exhaust equipment) is not considered production and support equipment.

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**PROTOCOL:** The specific disciplinary rules and requirements for operating a cleanroom. Typically include instructions on gowning, cleaning, personnel behavior, acceptable materials, maintenance and construction methods, and related procedures.

**PSL SPHERES:** Polystyrene latex spheres, a recent alternative challenge material used in place of DOP for filter leak testing or efficiency rating of HEPA filters.

**RADIO FREQUENCY INTERFERENCE:** Noise that disrupts desired instrument signals. As a general rule, interference is restricted to the RF spectrum of 10 kHz to 10 GHz.

**RECIRCULATED AIR:** That portion of the workspace or cleanroom air that is recirculated through the air-conditioning equipment.

**RECOMMENDED PRACTICE (IES):** Recommended practices are issued either in the form of guidelines or a handbook and describe preferred technical methodologies and procedures. Recommended Practices are the only authorized vehicle by which technical guidance or philosophy may be published or presented in the name of the IES.

**RELEASABLE PARTICLE:** Particles that are already present on the surface of a wiper or other surface and are readily releasable from it by changing environmental conditions, i.e., humidity, pressure, electrical charge, etc.

**RESISTANCE (FILTER):** The pressure drop across a filter at a stated flow and under given conditions; generally expressed in millimeters water gage or, in SI units, as N/m<sup>2</sup> or Pascals.

**REYNOLDS NUMBER:** A dimensionless number which is significant in the design of a model of any system in which the effect of viscosity is important in controlling the velocities or the flow pattern of a fluid: equal to the density of a fluid times its velocity, times a characteristic length, divided by the fluid viscosity.

**ROOM VELOCITY:** The residual air velocity level in the occupied zone of the controlled space.

**ROOM VELOCITY, AVERAGE:** The average velocity throughout the occupied zone of the controlled space.

**ROUGHING FILTER:** A prefilter with high efficiency for large particles and fibers but low efficiency for small particle, usually of the panel type.

**SAMPLING:** A process consisting of the withdrawal or isolation of a fractional part of a whole. In air or gas analysis, the separation of a portion of an ambient atmosphere with or without the simultaneous isolation of selected components.

**SAMPLING, CONTINUOUS:** Sampling without interruptions throughout an operation or for a predetermined time.

**SAMPLING, INSTANTANEOUS:** Obtaining a sample of an atmosphere in a very short period of time such that this sampling time is insignificant in comparison with the duration of the operation or the period being studied.

**SAMPLING, INTERMITTENT:** Sampling successively for a limited period of time throughout an operation or for a predetermined period of time. The duration of sampling periods and of the intervals between are not necessarily regular and are not specified.

## A GLOSSARY OF CLEANROOM TERMS

**SCALE DIVISION:** On a photometer with numbered major scale divisions (0,1,2,3,4,5), "one scale division" means the first intermediate division following the 0.

**SCANNING:** See PROBING.

**SENSITIVITY:** The ability of an instrument to measure and/or act upon variations of the measured condition.

**SENSOR:** A device designed to respond to a physical stimulus (as temperature, illumination, and pressure, etc.) and transmit a resulting signal for interpretation, or measurement, or for operating a control.

**SEPARATORS:** Corrugated paper or foil (usually aluminum alloy or plastic) used to separate the folds of a pleated filter medium and to provide air channels between them.

**SERVICE AREA ACCESS AISLES:** That area which is used strictly to provide service personnel access to the Process Module Service Area and to provide a path of maintenance supply flow to and from the Process Service Area.

**SETTLING VELOCITY:** The terminal rate of fall of a particle through a fluid as induced by gravity or other external forces.

**SHALL:** The action is compulsory. It must be done in order to meet the requirement of the statement.

**SHEDDING:** The generation of particles as a result of mechanical action on a material.

**SHOE CLEANER:** Shoe Cleaners are powered brush-type cleaners designed to remove contamination from shoes prior to entering a clean environment. They should be equipped with a vacuum source in order to be effective.

**SHOE COVERS, CLEANROOM:** Cleanroom shoe covers are garments which are designed to be worn over conventional footwear. Shoe covers are distinctive from booties, covering only the sole and sides of the shoes. Cleanroom shoe covers may be constructed of low particulate fabric synthetic materials such as Tyvek. The sole of the shoe cover should be fabricated from a strong material (such a plastic) which will not deteriorate easily.

**SHOES, CLEANROOM:** Cleanroom shoes are conventional closed-toed shoes, normally of leather construction, which are designed to be worn under cleanroom booties or shoe covers in the higher levels of contamination control. Cleanroom shoes are distinguished from conventional shoes only by the fact that the are completely dedicated for use within a clean environment.

**SHOULD:** Denotes a recommendation that an action be undertaken or the probability that an action will result. It is, however, non-mandatory and shall never be used when a specific action is required or will result.

**SINGLE PARTICLE COUNTER:** See discrete-particle counter.

**SMOKE:** The airborne solid and liquid particles and gases that evolve when a material undergoes pyrolysis or combustion. Note: chemical smoke is excluded from this definition.

**SOAP TEST:** A procedure to evaluate potential particle intrusion into a clean space through leakage from a high pressure source by applying a soap solution to potential leakage locations.

**SOLUTION:** A homogeneous substance, usually a single phase mixture of two or more materials.

**SOLVENT:** A substance which dissolves another to form a solution.

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**SOLVENT, CLEAN CONSTRUCTION:** Methanol, or isopropyl alcohol, either concentrated (20% maximum) or diluted with clean DI or distilled water.

**SOLVENT WIPE TEST:** Wipe area to be tested with lo-particulate wipes wetted with approved solvent. Wipes shall not exhibit any discoloration other than what might be caused by the solvent being used.

**SORBENCY:** A collective term describing the tendency of a wiper to hold fluids, whether by absorption (within the capillaries or pores of the wiper) or by adsorption (as a surface phenomenon).

**SORBENT:** A liquid or solid medium in or upon which materials are retained by absorption or adsorption.

**SORPTION:** A process consisting of either absorption or adsorption in which a liquid is taken up by a solid surface. See absorption and adsorption.

**SPECIFICATION - DESIGN:** A concise document defining technical requirements in sufficient detail to form the basis for a product or process. It indicates when appropriate, the procedure that determines whether or not the given requirements are satisfied.

**SPECIFICATION - PERFORMANCE:** A concise document which details the performance requirement for a product. The performance specification should include procedures and/or references for testing and certification of the product.

**STAGING AREA, CLEAN CONSTRUCTION:** An area adjacent to A cleanroom zone, where personnel will don cleanroom garments and clean/decontaminate material, tools and equipment prior to entry into the clean zone.

**STANDARD AIR:** Air at 50 percent relative humidity, 70°F, and 29.92 in. Hg (21°C and 760 mm Hg). These conditions are chosen in recognition of the data which has been accumulated on air-handling equipment. They are sufficiently near the 25°C and 760 mm Hg commonly used for indoor air contamination work that no conversion or correction ordinarily need be applied.

**STANDARD AIR DENSITY:** Air having approximate density of 0.075 lb/ft<sup>3</sup> (1.201 kg/m<sup>3</sup>). This corresponds to air at a pressure of 29.92 in Hg (760 mm Hg) at temperature of 69.8°F (21° C) with a specific volume of 13.33 ft<sup>3</sup>/lb (0.832 m<sup>3</sup>/kg).

**STANDARD LEAK PENETRATION:** The leak penetration that would be detected by a discrete-particle counter with a standard sample flow rate of 1.0 ft<sup>3</sup>/min (0.0283 m<sup>3</sup>/min), when the sampling probe is stationary over the leak.

**STATIC HEAD:** The pressure due to the weight of a fluid above the point of measurement.

**STRAINING:** A mechanism of filtration whereby a particle is large enough to be trapped in the filtering medium simply because it is too large to pass through. This mechanism has very little influence in HEPA filtration. See LANGMUIR'S PRINCIPLE.

**STRENGTH:** The properties of tensile strength, elongation, and modulus of materials. Accelerated aging may be included in the specification for strength.

**STOKE'S LAW:** A law governing the settling of particles. Has very little effect in HEPA filtration. See LANGMUIR'S PRINCIPLE.

**STUDENT'S T DISTRIBUTION:** The distribution:

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$t = [(\text{sample mean}) - (\text{population mean})] / [\text{standard error of the sample mean}]$   
obtained from sampling a normal (Gaussian) distribution. Tables of critical values are available in statistics texts.

**SURFACE FINISH, GLOVE:** The surface properties of a glove or finger cot which may be chemically or mechanically applied, affecting the adhesion, the abrasively, the hand or feel, or the hardness of the covering.

**SURFACTANT, CLEANROOM:** A low-sodium, non-ionic surfactant, such as Triton-X 100, which is used in cleanroom applications where a surfactant is required to perform cleaning operations. A very dilute solution (approximately 1 ml/gal. of DI water) is all that is normally used.

**THERMOANEMOMETER:** An instrument for measuring air velocities that contains an element heated by a regulated electric source and cooled by the air flow, and converts the temperature of the element to a velocity reading.

**THERMALLY-GENERATED DOP:** An aerosol generated by quenching (condensing) vapor that has been evaporated from liquid dioctyl phthalate by heat. The aerosol has a light-scattering mean diameter of about  $0.3\mu\text{m}$ , with a geometric standard deviation of about 1.4.

**TSC (TIME/SUSCEPTIBILITY/CONCENTRATION):** The concept that the crux of contamination control is to control three critical factors affecting the protected product, process, or function: time, susceptibility, and concentration. The effect of contamination is an integrated effect dependent upon the severity or level of the three factors. Protection is afforded by minimizing each of the three factors and at the same time protecting the product, process, or function against each of the three factors. See Greiner's Principles.

**U DESCRIPTOR:** The maximum allowable concentration (particles per cubic meter of air) of ultra-fine particles. The U descriptor serves as an upper confidence limit or as the upper limit for the location averages, or both, as appropriate. U descriptors are independent of airborne particulate cleanliness classes, and may be specified alone or in conjunction with one or more airborne particulate cleanliness classes.

**ULPA (ULTRA LOW PENETRATION AIR) FILTER:** A replaceable, extended-medium, dry-type filter in a rigid frame, having a minimum particle-collection efficiency of 99.999% (that is, a maximum particle penetration of 0.001%) for particles in the range of 0.1 to  $0.2\mu\text{m}$ , when tested in accordance with the methods of IES-RP-CC007. ULPA filters are HEPA filters.

**ULTRA-FINE PARTICLES:** Particles in the size range from approximately  $0.02\mu\text{m}$  to the upper limit of detectability of the DPC described in Appendix D of FED-STD-209E. Ultra-fine particles are operationally defined by the relationship for counting efficiency vs. particle size of Appendix D of FED-STD-209E.

**UNIDIRECTIONAL AIRFLOW:** Airflow having generally parallel streamlines, operating in a single direction, and with uniform velocity over its cross section; previously referred to as "laminar" airflow.

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**UNIDIRECTIONAL-AIRFLOW CLEANROOM:** A cleanroom in which airflows have generally parallel streamlines operating in a single direction and with uniform velocity over the cross section.

**UNIFORM AIRFLOW:** Uni-directional airflow pattern in which the point-to-point readings are within plus or minus 20% of the average airflow velocity for the total area of the laminar flow work zone.

**UPGRADE:** The incremental improvement, large or small, in cleanroom facilities or processing equipment.

**UPPER CONFIDENCE LIMIT (UCL):** An upper limit of the estimated mean which has been calculated so that, in a specified percentage of cases, its value exceeds the true population mean, both means having been sampled from a normal (Gaussian) distribution. In FED-STD-209E, a 95% UCL is used.

**VACUUM, HEPA FILTERED CLEANROOM:** A 99.99% efficient HEPA-filtered exhaust vacuum cleaner used in cleanroom operations.

**VACUUM, HOUSE CLEANROOM:** A vacuum cleaning system used in cleanroom operations which transmits the exhaust to an area outside of the clean environment.

**VALIDATION:** Establishing documental evidence that a system does what it purports to do.

**VAPOR:** A gas, particularly one near to equilibrium with the liquid phase of the substance and which does not follow the gas laws.

**VELOCITY:** A vector quantity which denotes, at once, the time rate and direction of linear motion.

**VERIFICATION:** The procedure for determining the compliance of air in a cleanroom or clean zone to an airborne particulate cleanliness class limit or a U descriptor, or both, as specified.

**VIABLES:** Living particles that are capability of performing biochemical processes and reproducing.

**VISIBLE VAPOR TEST:** A test utilizing a visible vapor formed from placing Dry Ice (frozen CO<sub>2</sub>) in warm water in order to provide a visible means of determining air flow directions.

**VISUAL CLEANLINESS:** The degree of freedom from contaminants that may be detected by the unaided eye.

**VISUAL DIFFICULTY FACTOR:** A measure of illumination requirements of a task which takes into account the difficulty of the task, the time duration of the task, and age or visual handicap factors.\

**VLF:** Vertical Laminar Flow.

**VISIBLE VAPOR GENERATOR:** System for generating a visible vapor, most commonly utilizing a heated container into which dry ice is dropped into DI water.

**WAFER:** Generic unit corresponding to the entity of material on which semiconductor devices are fabricated.

**WAFER HANDLING AREA:** A area in which wafers are exposed to the environment for process purposes.

**WATER, DEIONIZED:** Water which has been purified to a high degree and deionized. Commonly called DI water.

**WATER, TAP:** Water from domestic sources, commonly referred to as "city water".

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**WATER GAGE:** The measure of pressure expressed as the height of a column of water in inches or micrometers.

**WET BENCH:** An individual work bench designed to accommodate a wet chemical process. May or may not include laminar flow provisions. Special safety and exhaust provisions are necessary.

**WHITE ROOM:** A room designed to be free of dust and other contaminants but not controlled to the same degree as a cleanroom.

**WILL:** Denotes a specific consequence of an action. The consequence will occur.

**WIPERS, ABSORBENT CLEANROOM:** Cleanroom wipers with greater absorbency. They also tend to be sources of particulate contamination and should only be used during non-critical cleanroom operations.

**WIPERS, LOW-PARTICULATE CLEANROOM:** Cleanroom wipers with very low levels of particulates.

**WORKSTATION:** A miniature cleanroom. An enclosure smaller than a cleanroom which provides a level of contamination control for a process or product, or protects the environment or personnel from the product, process, or by-product.

**WORK ZONE:** That volume within the cleanroom which is designated for clean work and for which testing is required. The volume shall be identified by an entrance and exit plane normal to the airflow (where there is laminar).