Nano standards focus on facility safety and particle monitoring
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Abstract
Advancements in the field of nanotechnology have demonstrated the need for new approaches in areas ranging from facility design to cleanroom methods. As a result, the demand has grown for published standards and other documents to address these developments. This article describes IEST-RP-NANO205, a new recommended practice for nano facility safety; ISO/DIS 14644-12, a standard for monitoring the concentration of airborne nanoparticles; and other nanotechnology-related documents of interest to cleanroom designers and users.

Risks
Potential risks in nanotechnology research and production facilities are best addressed at the design stage, according to a new Recommended Practice (RP) from the Institute of Environmental Sciences and Technology (IEST). Nanotechnology Safety: Application of Prevention through Design Principles to Nanotechnology Facilities (IEST-RP-NANO205) explains the use of engineering controls, such as fixed barriers, rather than relying on operational controls to maintain safety.

Developed by a working group of experts involved with nanotechnology facilities, the RP passes along their practical insights to assist in implementing an effective environmental health and safety program. The document provides guidance and resources for addressing concerns such as the following:

- Risk mitigation related to incoming materials, products, processes, and byproducts.
- Response systems for normal operation as well as external and internal emergency conditions.
- Workplace safety at intermediate stages of processing that involve nanomaterials having high potential risk.
- Mechanisms for removal of airborne nanoparticles, such as impaction, interception, diffusion, and electrostatic attraction.

The "Prevention through Design" concept, put forth by the US National Institute for Occupational Safety and Health (NIOSH), holds that built-in controls lead people to safe operation. Additionally, it is more cost effective to implement controls early in the design cycle than to retrofit existing systems.

Monitoring nanoscale particles
Another document pertinent to cleanrooms in nanotechnology facilities addresses the unique origins, chemical properties, and transport behavior of nanoscale particles. Nanoparticles have higher coagulation rates in the air and higher deposition rates on surfaces than larger particles. Therefore, the table of classes of air cleanliness by particle concentration in Part 1 of the ISO 14644 Cleanroom Standards cannot necessarily be extrapolated to smaller particles than the stated lower limit.

The latest revision of ISO/DIS 14644-12, Cleanrooms and associated controlled environments—Part 12: Specifications for monitoring air cleanliness by nanoscale particle concentration, due out this fall, discusses monitoring the concentration of airborne nanoscale particles when the cleanroom is in an operational state. It provides a reference method for monitoring by condensation particle counting and information on particle counting efficiency and particle size cutoff.


More on environmental control in nano facilities
The Nanotechnology Safety RP is the latest in a series that are part of an IEST initiative to develop documents supporting controlled environments in nanotechnology research and fabrication. For more than 60 years IEST has played a dominant role in developing standards and RPs for contamination control and product testing/reliability, and several areas of nanotechnology intersect with these fields. The facilities typically require cleanrooms and other high-performance laboratory spaces where environmental controls of parameters such as electromagnetic interference (EMI), temperature, and vibration far surpass the requirements of a typical research facility.

In 2013, IEST published the groundbreaking design guide, IEST-RP-NANO200: Planning of Nanoscale Science and Technologies Facilities: Guidelines for Design, Construction, and Start-up. From site considerations to daily operations, the RP is intended as a roadmap for owners, scientists, architects, engineers, and constructors working on these complex facilities, possibly for the first time.

IEST-RP-NANO200 examines how process tools and their environmental requirements drive facility design and provides methods for incorporating these tools. The RP also describes cost-effective approaches for balancing conflicting requirements, such as temperature control versus vibration control.

Future RPs will cover a range of topics and include two documents currently in the works:

- IEST-RP-NANO207: Measuring and Reporting Vibrations in Advanced Technology Facilities will provide guidance for vibration measurements and standardized reporting with regard to sensitive equipment used in facilities for nanoscale R&D or production. The document will be valuable for other facilities in which vibration control is important, such as pharmaceutical and biological research, metrology laboratories, and the microelectronics industry.

- IEST-RP-NANO208: Testing Aerosol-Nanomaterial Containment Devices will describe methods of nanoaerosol generation and measurement in the context of evaluating the performance of aerosol
containment devices. The document will present test methods for determining an efficiency rating for quantifying the performance of containment devices and assessing the risk of fugitive nanoparticle emissions.

The working groups developing these documents invite participation by professionals experienced in these targeted disciplines.

**Education connection**

IEST recently became the sponsor of the University-Government-Industry Micro-Nano (UGIM) Symposium in the U.S. This biennial conference focuses on operational issues related to micro- and nano-level fabrication facilities. Papers presented at UGIM have been published in the Journal of the IEST.

Inquiries about the resources described in this article may be directed to information@iest.org.

### Standards

**New cleanroom equipment suitability standard (airborne particles)**

**John Neiger**

ISO 14644 Part 14: Assessment of suitability for use of equipment by airborne particle concentration

The most recent standard to be published in the ISO 14644 series of standards for cleanrooms and associated controlled environments is ISO 14644-14:2016 – Part 14: Assessment of suitability for use of equipment by airborne particle concentration. Part 14, published on 15 September 2016, is the first of two similar standards and links the cleanroom classification of air cleanliness by particle concentration as specified in ISO 14644-1 to the suitability of equipment for use in cleanrooms and associated controlled environments. In the pipeline is a second standard, at present at the DIS stage:

**Part 15: Assessment of suitability for use of equipment and materials by airborne chemical concentration.**