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Updated *IEST-RP-CC012* a "Must Read" for Cleanroom Planners and Designers

A *Journal of the IEST* interview with Michael A. Fitzpatrick

Revised edition *IEST-RP-CC012.2: Considerations in Cleanroom Design* expands the document with a wealth of new information.

Keywords
Performance criteria, specifications, construction protocol

A newly revised Recommended Practice (RP) published by the Institute of Environmental Sciences and Technology (IEST) explores the factors to consider in the design of cleanroom facilities and provides a framework to establish performance criteria. Cleanroom designers, constructors, owners, and users will find *IEST-RP-CC012.2, Considerations in Cleanroom Design* "an essential first step" in the design process, says Michael A. Fitzpatrick, Chair of IEST Working Group CC012, which developed the document.

As with the previous edition, the document is organized into two primary sections: planning and design requirements. The planning section uses the widely accepted architectural programming methodology developed by W. Peña[1], which sets forth a logical process for identifying and achieving project requirements. This section helps users develop a utility matrix to establish the equipment and processes to be used in the cleanroom, to determine the manufacturing layout, and to identify relevant contamination control, life safety, and environmental issues. Ergonomics, budget, and schedule projections are also reviewed. The section on design requirements provides detailed discussions on each of the facility systems.

The *Journal of the IEST* recently spoke with Fitzpatrick about the new and updated material in the revised edition of the RP.

What topics have been added to the planning section?

The new subsection on energy efficiency is particularly useful because cleanroom environmental systems account for up to 50% of the total energy use in the cleanroom (see Figure 1). As the RP points out, decisions made during the early design phase may have long-term energy implications and should be based not only on initial costs but also on life-cycle cost. The discussion includes recommendations for reducing energy consumption along with case-study data.

Another new subsection covers the unique demands related to the alteration of existing facilities, which requires different strategies than new construction. This discussion reviews the logistics involved in remodeling a cleanroom, including the extraordinary measures to enter the cleanroom and the potential impact to operations. The section also emphasizes isolation of clean areas, whether the work is performed while the cleanroom is at rest or in operation.

[1] Peña, W. 1987. Problem Seeking. 3rd ed. Washington: AIA Press.

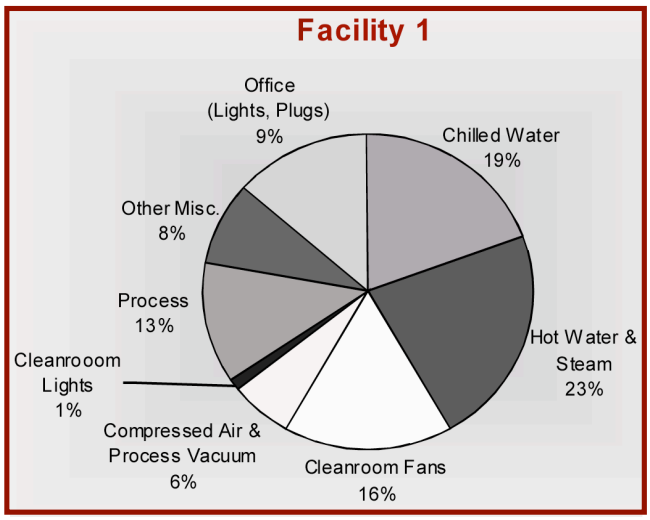

Figure 1—Relative energy use of various components in a sample cleanroom facility (reprinted from *IEST-RP-CC012.2*).

Other new topics in the planning section include fire protection and ergonomics. In addition, an expanded section on special requirements covers issues that are frequently overlooked during the design process, including maintainability, redundancy, and flexibility.

The design requirements section contains considerable new material on air systems. What are some of the highlights?

The design requirements section opens with a guide to cleanroom airflow patterns, including unidirectional, non-unidirectional, and mixed airflow layouts. Following this discussion is an expanded section on airflow guidelines.

A new subsection on air filtration opens with a discussion of make-up air filtration. This subsection also covers the application of in-line and terminal filters, including filter properties, layout considerations, and integrity testing criteria.

A subsection on airborne molecular contamination (AMC) has been added to help users identify and control potential contamination sources. In addition to covering design practices and construction, operational, and maintenance procedures, the AMC subsection reviews the integration of special filters into the HVAC system.

The subsection on HVAC system configuration includes guidelines, certification requirements, and design parameters for temperature, humidity, pressure, and exhaust. A discussion of exhaust-determined systems, cooling-determined systems, and cleanliness classification-determined systems is intended to help users select the appropriate system.

What other special systems are considered in this edition of *IEST-RP-CC012.2*?

Many cleanroom facilities today incorporate technology such as factory automation (FA) and facility monitoring systems. The RP contains new subsections on each of these types of systems.

FA refers to any component of equipment that provides for automated transport, storage, and retrieval of production materials used in a cleanroom. This extensive subsection provides guidance for designing and implementing these systems. Layout topics include ceiling height; ceiling filter placement vs. tool placement; installation and removal of equipment; floor loading; access for maintenance and work retrieval; interfacing with tools; and other considerations. Environmental and safety factors also are covered.

Facility monitoring systems provide real-time information regarding critical operating parameters such as airborne particle levels, temperature and humidity, room pressurization, and so forth. As explained in the facility monitoring subsection, the three general categories of monitoring systems are overall facility, process specific, and process tool specific. This subsection also covers data management and sensor installation, calibration, and maintenance.

How can *IEST-RP-CC012.2* help in decommissioning a cleanroom facility?

When facilities become obsolete, manufacturers may shut down process lines and sell, convert, or demolish the facilities or building components. These activities, known as decommissioning, can have severe economic, environmental, and life safety implications, and the goal is to remove systems in a contamination-free manner. A new section in the RP provides guidance for developing a project-specific closure plan that includes a review of applicable regulatory requirements, procedures for removing and disposing of equipment and systems, sequence of removal, and decontamination of components to be demolished.

The new edition contains an in-depth section on cleanroom construction protocol and a related appendix. Why was this material added?

While the previous edition touched briefly on the purpose of a cleanroom construction protocol, the Working Group felt that implementing such a program is essential in preventing surface contamination that could result from construction activities. Protocol in construction is phased, starting with the original site conditions and progressing until the desired cleanliness level of the finished clean space is achieved. An effective protocol will enable the cleanroom to achieve tool installation and qualification cleanliness levels in a timely manner. A new section reviews the planning, logistics, and procedures such as perimeter isolation, controlled access, training, and continuous cleaning requirements. The supplementary appendix provides a detailed sample protocol document users can adapt to their needs.

Which existing sections of the RP have been expanded?

The section on minienvironments has been expanded significantly to reflect technological advances. The focus is on the integration of minienvironments with the building systems. The section incorporates material from *IEST-RP-CC028.1: Minienvironments* to help users determine the

Focus on Planning and Design

The two main sections of *IEST-RP-CC012.2: Considerations in Cleanroom Design*, "Planning Procedures" and "Design Requirements," contain detailed subsections on the following topics:

PLANNING PROCEDURES

Mission statement ■ Goals and strategy ■ Collection and analysis of facts ■ Alteration of existing facilities ■ Energy efficiency ■ Ergonomics ■ Constructibility ■ Determination of needs

DESIGN REQUIREMENTS

Airflow pattern ■ Airflow guidelines ■ Air filtration ■ HVAC system configuration ■ Temperature ■ Humidity and dew point ■ Pressure ■ Exhaust ■ Airborne molecular contamination (AMC) ■ Microorganisms (viables) ■ Noise ■ Vibration ■ Electrical power ■ Back-up electrical power systems ■ Electrostatic interferences ■ Grounding systems ■ Cleanroom lighting ■ Life safety systems (LSS) ■ Minienvironments ■ Factory automation ■ Facility monitoring ■ Decommissioning

appropriate types and configurations of minienvironments, whether a simple unidirectional hood or a stand-alone, ultra-clean chamber.

Other important additions include the following:

- The noise and vibration sections incorporate two new vibration criteria curves—VC-F and VC-G—that are applicable to nanotechnology.
- The section on cleanroom electrical power now covers redundancy, safety, emergency power and back-up power systems, electrostatic interference, and lighting.
- A discussion of toxic-gas monitoring systems and leak detection has been added to the life safety section.

Who will benefit from the information in *IEST-RP-CC012.2*?

This comprehensive RP is a "must read" for owners, users, designers, and builders of cleanrooms serving all industries. The document leads the user through the planning and design considerations and assists owners and designers in developing design criteria to meet specific needs. The information will also be of interest to personnel representing functional groups involved in planning, such as production and operations, engineering, quality assurance, safety, and facilities management. *IEST-RP-CC012.2* is an indispensable resource for anyone involved in the planning and design of cleanrooms.

Michael A. Fitzpatrick, vice president of McGill Cleanroom Systems, has been involved in the design and construction of semiconductor facilities for more than 27 years. A Senior Member of IEST, he is Chair of WG-CC012, Considerations in Cleanroom Design, and WG-CC0028, Minienvironments. He has served on the IEST Executive Board.