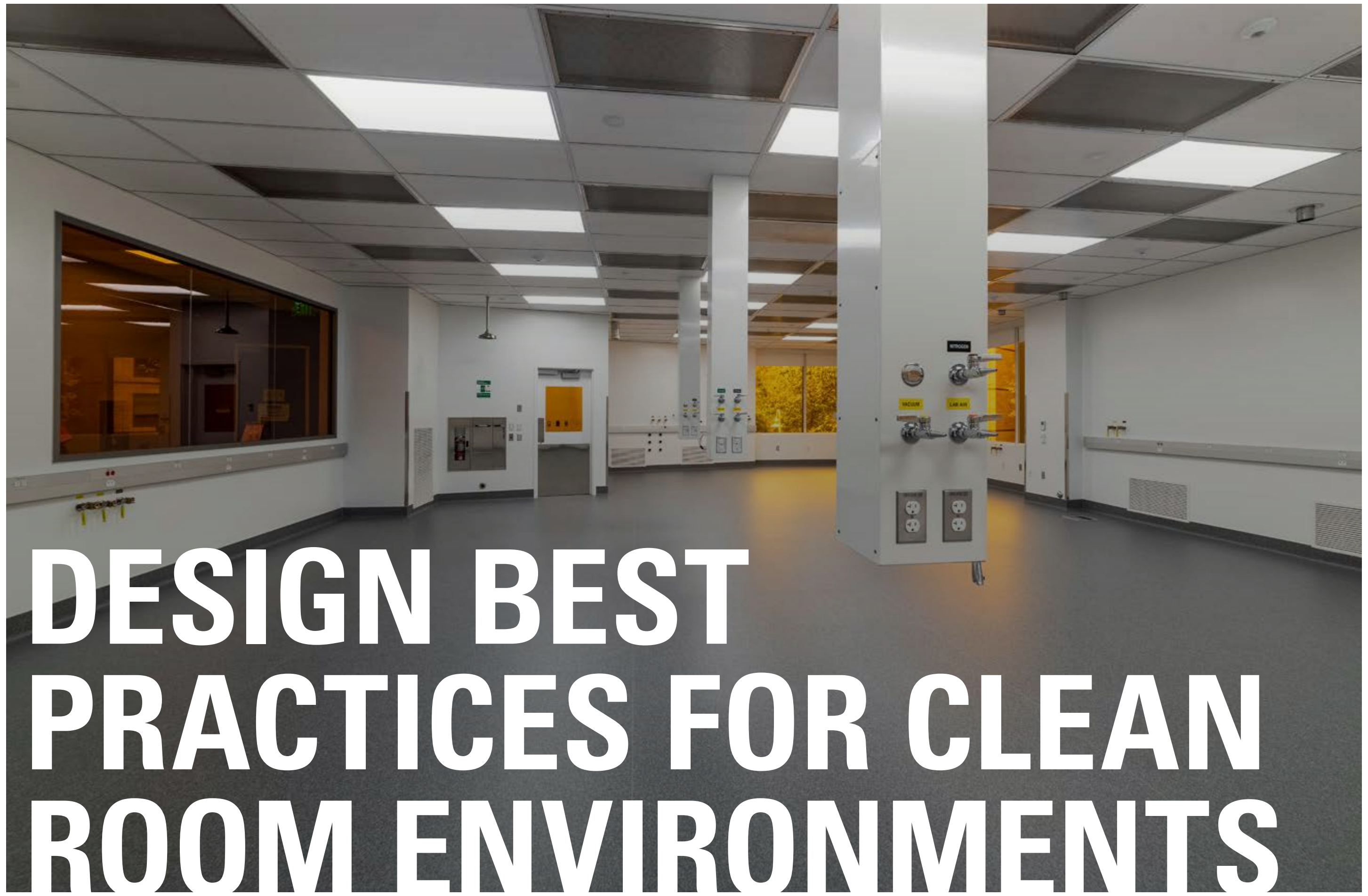

DESIGN BEST PRACTICES FOR CLEAN ROOM ENVIRONMENTS

Architectural and engineering design plays a **pivotal role** in creating optimal clean room environments by ensuring proper airflow, minimizing contamination risks, and **optimizing** the layout for **efficient** operations.

Clean rooms are highly controlled environments. Whether in a pharmaceutical, biotechnology, electronics, clean manufacturing or a healthcare environment, clean rooms must maintain strict air quality and cleanliness standards. At HED, our integrated architectural, laboratory planning and engineering teams focus on the following critical aspects first to design clean rooms that meet the programmatic goals and compliance needs of our clients.

FACILITY LAYOUT AND ZONING

Fundamental to effective operations and contamination control, layout and zoning of a clean room facility must account for:

Separation of Clean Zones: Implementing a zoned approach by segregating the facility into distinct clean zones, such as gowning areas, buffer zones, and critical processing areas, helps minimize cross-contamination and ensures compliance with cleanliness standards.

Logical Flow of Materials and Personnel: Designing a logical flow of materials and personnel, with separate entry and exit points, prevents contamination from entering clean areas and facilitates efficient movement within the facility.

Clear Room Hierarchy: Establishing a clear hierarchy of clean rooms based on the required cleanliness level, from ISO Class 9 (least clean) to ISO Class 1 (most clean), ensures that contamination risks are minimized at each stage of the process.

Integration with Manufacturing: Establishing a clear line of demarcation between specific manufacturing requiring a clean room environment with other non-cleanroom critical spaces.

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HVAC SYSTEM DESIGN

The design and implementation of Heating, Ventilation, and Air Conditioning (HVAC) systems are critical for maintaining the desired air quality and particle control in clean room environments, including:

Positive Pressure Cascades: Creating positive pressure differentials between adjacent clean rooms and non-clean areas prevents the infiltration of contaminated air, ensuring that air flows from cleaner to less clean spaces.

High-Efficiency Particulate Air (HEPA) Filters: Installing HEPA filters in the HVAC system effectively removes particles of various sizes, contributing to the desired air cleanliness levels.

Proper Air Distribution: Achieving uniform air distribution within the clean room through carefully designed air diffusers and exhaust systems helps maintain consistent air quality throughout the space.

Humidity Control: Achieving precise low humidity environments designed to integrate with the HVAC system to safely drop and maintain specified humidity levels for precise manufacturing.

Integrated Control: Designing the HVAC system to communicate and integrate with the Building Management System (BMS) to allow facility operations to have constant statistical data on room performance.

MATERIAL SELECTION AND FINISHES

Material and finish selection is crucial for minimizing particle generation and increasing the efficiency of cleaning practices. Select materials and finishes to support:

Smooth and Non-shedding Surfaces: Choosing smooth and non-porous surfaces, such as stainless steel or epoxy-coated finishes, reduces the accumulation of particles and facilitates effective cleaning and decontamination.

Minimizing Static Generation: Selecting anti-static materials or employing static dissipative flooring systems helps minimize the generation of static electricity, which can attract and disrupt airborne particles.

Compatibility with Cleaning Agents: Using materials that are compatible with the cleaning agents and disinfectants used in clean room environments ensures that the integrity of the materials is maintained while effectively eliminating contaminants.

LIGHTING & ENVIRONMENTAL CONTROLS

Proper lighting and environmental controls are essential for maintaining a comfortable and productive clean room environment that supports laboratory technicians, equipment, and results.

Appropriate Lighting Levels: Designing lighting systems that provide adequate illumination for work tasks while minimizing glare and heat generation contributes to a comfortable working environment for personnel.

Temperature and Humidity Control: Implementing precise temperature and humidity controls helps ensure stable conditions within the clean room, which is essential for certain processes and the well-being of personnel.

Environmental Monitoring Systems: Installing comprehensive monitoring systems for temperature, humidity, particle counts, and air pressure differentials allows real-time assessment of the clean room environment and helps identify potential issues that may affect air quality.

PERSONNEL FLOW AND GOWNING AREAS

Efficient flow of people and materials and well-designed and placed gowning areas are critical for preventing contamination from entering clean rooms. Key considerations include:

Proper Gowning Protocols: Designing dedicated gowning areas with clear protocols and appropriate storage for cleanroom garments, including changing benches, lockers, and pass-through cabinets, ensures that personnel adhere to necessary gowning procedures.

Separation of Dirty and Clean Areas: Maintaining a clear separation between dirty and clean areas through designated airlocks and gowning zones prevents cross-contamination and ensures that personnel enter clean areas in the required attire.

Flow of Personnel and Materials: Establishing well-defined paths for personnel and material flow within the clean room facility minimizes the risk of contamination and ensures smooth and efficient operations.

The correct consideration and planning from an experienced team can create a clean room that supports optimal operations, minimizes contamination risks, and ensures the integrity of sensitive processes across a variety of industries.

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