

White Paper

Cleanrooms Vs. Data Centers

Executive Summary

Data centers and ISO Cleanrooms are distinct environments, though both prioritize controlled conditions they differ in Purpose and Function. Data Centers are designed to house IT equipment (servers, networking gear) for data storage, processing, and communication. Their primary goal is ensuring Uptime, cooling, and operational efficiency for IT infrastructure. ISO Cleanrooms are built for industries like pharmaceuticals, semiconductor manufacturing, or biotechnology, where the primary goal is to Minimize Airborne Particulate Contamination to protect sensitive processes or products (e.g., chip fabrication, drug production).

Introduction

Yes, ISO Cleanroom Standards, particularly ISO 14644-1, are associated with Data Centers to ensure controlled environments with minimal airborne particulate contamination, which is critical for maintaining the reliability and performance of sensitive IT equipment. With that said Data centers are considered "Controlled Environments" rather than traditional Cleanrooms, but they often adhere to ISO Class 8 Standards (up to 3,520,000 particle less than 0.5 micron per cubic meter), as recommended by ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers), to limit airborne particles that could damage delicate electronics. While ISO Cleanrooms can range from ISO Class 1 (strictest, allowing only 10 particles less than 0.1 micrometers per cubic meter) to Class 9, depending on the application. Industries like semiconductor manufacturing often require ISO Class 1–5 for ultra-clean environments.

Environmental Control

- ✓ Data Centers focus on temperature, humidity, and airflow control to optimize cooling and equipment performance. Cleanliness is secondary, with HEPA filtration used but not always designed for sub-micron particles. Airflow prioritizes cooling over unidirectional flow.

- ✓ ISO Cleanrooms emphasize strict control of airborne particles, often using laminar airflow, high-efficiency filtration (e.g., ULPA filters), and Positive Pressure to prevent contamination. Temperature and humidity are tightly controlled for process stability, not just equipment cooling.

Infrastructure and Design

- ✓ Data Centers lack features like airlocks, gowning rooms, or sticky mats unless highly specialized. Access is controlled but less restrictive, and materials like cardboard may be restricted but not always eliminated.
- ✓ ISO Cleanrooms include specialized infrastructure like air showers, gowning areas, and seamless surfaces to prevent particle accumulation. Personnel wear full-body suits, gloves, and masks to minimize contamination.

Operational Requirements:

- ✓ Data Centers operate continuously with staff, equipment, and cabling changes that introduce particles. Cleaning occurs periodically (e.g., every 12 months) to maintain ISO Class 8, but the environment tolerates more activity and disruption.
- ✓ ISO Cleanrooms: Operate under strict protocols with limited personnel access, rigorous gowning, and frequent cleaning to maintain low particle counts. Any deviation (e.g., equipment introduction) requires revalidation.

Cost and Complexity

- ✓ Data Centers achieving ISO Class 8 is cost-effective, balancing cleanliness with operational needs. Stricter standards (e.g., ISO Class 7) are rare due to high costs and airflow restrictions that could impair cooling.
- ✓ ISO Cleanrooms require significant investment in filtration, construction, and maintenance to achieve and sustain lower ISO classes, justified by the critical nature of the processes they support.

Summary

Data Centers adopt ISO 14644-1 Class 8 as a practical standard to protect IT equipment from dust, but they are not True Cleanrooms. ISO Cleanrooms, designed for highly sensitive manufacturing or research, enforce stricter particle control, specialized infrastructure, and operational protocols far beyond Data Center requirements. The distinction lies in their differing goals: Data Centers prioritize IT performance, while Cleanrooms prioritize contamination-free processes.