

General Information

First of all it is always important to define what a cleanroom is and according to IEST-RP-CC006.3 a cleanroom is “*a room in which the air supply, air distribution, filtration of air supply, materials of construction and operating procedures are regulated to control airborne particle concentrations to meet established air cleanliness levels, as defined by ISO 14644-1*”.

Having defined what a cleanroom is – the actual type of tests to be carried often depends very much on the type of cleanroom design and the user’s specified requirement (usually from the product/process consideration) The standard cleanroom definition are:

1. Unidirectional Airflow Cleanroom

A Cleanroom in which the filtered air entering the room makes a single pass through the work area in a parallel-flow pattern, with a minimum of turbulent flow areas. Unidirectional airflow rooms typically have HEPA or ULPA filter coverage of 80% or more of the ceiling (vertical flow) or one wall (horizontal flow).

2. Nonunidirectional Airflow Cleanroom

A Cleanroom in which the filtered air entering the room or passing through the work zone is characterised by nonuniform velocity or turbulent flow. Such rooms exhibit nonuniform, random airflow pattern throughout the enclosure.

3. Mixed Airflow Cleanroom

A hybrid Cleanroom containing both unidirectional and non-unidirectional types of airflow within the same enclosure.

There is a need for Cleanroom Performance testing to verify that the Cleanroom has been built to specifications, that the operating “clean” system is working properly and that the various parameters defined, like airborne particle counts, air velocity, Room pressurization, Temperature and RH, to name a few, meet with the acceptance criteria as laid out at the commencement of the project . This reflects on the proper operation of the Cleanroom and ensures that the product being manufactured and produced in that Cleanroom facility, is appropriately protected within the “clean” environment . The Cleanroom Performance Testing (CPT for short) should only be conducted by suitably qualified and certified independent testing agency, engaged either by the builder or the owner .

Cleanroom Performance testing is therefore vital to the final acceptance of the Cleanroom facility and only after the operating parameters have been verified can the actual “product” to be manufactured.

Choice of Tests

The choice of tests for Cleanroom certification may be based on factors such as the design of the Cleanroom and / or its operational status, and the required level of certification. The choice of test methods will depend on the specific operational status of the Cleanroom as defined in IEST-RP-CC006.3 – Testing Cleanrooms :

1. As – Built

This operational mode or phase refers to a facility that is complete and ready for operation with all services connected and functional, but without equipment or operating personnel in the facility.

2. At – Rest

This operational phase refers to a facility that is complete, with all services functioning and with equipment installed and operable or operating, on specified, but without operating personnel in the facility.

3. Operational

This phase refers to a facility in normal operation, with all services functioning and with equipment and personnel, if applicable, present and performing their normal work functions in the facility.

Cleanroom contracts normally specify performance testing at least in the as-built phase - this is a pre-requisite . Testing in the at-rest and operational phases is sometimes skipped due to a tight project schedule and omission of this requirement in the project specification.

It is however recommended that the builder or the owner have their Cleanroom facility tested in both the as-built and operational phases . This will ensure that the Cleanroom has been built to specifications (verified and corrected during as-built testing) and that the Cleanroom continues to function and operate according to the design specifications in the operational phase as well . This also ensure that whatever corrective/remedial action taken after the As-Built testing continue to perform.. Also, the values for certain parameters or tests like the airborne particle counts, sound pressure level (Noise level), airflow parallelism and the temperature and RH will change (in most cases) during the operational phase . And this is the very reason why most clients or owners recommend and state different acceptance criteria for the different tests at each operating phase . This helps to streamline the Cleanroom testing protocol in a step by step manner as the Cleanroom evolves from the as-built phase to the operationally ready phase . This step by step testing process helps when diagnosing and troubleshooting certain parameters that fail to meet with the acceptance criteria as a trend can be seen if a certain parameter, for eg the airborne particle count meets with the specifications during the as-built phase and fails during operational phase . This could be attributed to poor housekeeping, improper wipe down of machines during hook up, poor cleaning procedures), poor Cleanroom discipline, in correct positioning of large machines (blocking return air or HEPA/ULPA filtered supply air) etc, etc .

It is hence recommended that the CPT be conducted in at least 2 phases .

Standards / Recommended Practices

All of the Cleanroom performance tests are mostly based on the following Internationally accepted standards and recommended practices :

1. ISO 14644-1 (1999) : Cleanrooms & associated controlled environments – Part 1 : Classification of air cleanliness
2. IES-RP-CC006.3 (2004) : Testing Cleanrooms
3. NEBB Handbook (1996) : Procedural Standards for the Certified Testing of Cleanrooms

These standards and recommended practices assist in the initial formulation of the guidelines and parameters under which the Cleanroom facility can be certified and qualified . However, deviations are normally made and incorporated in the test procedures, specifications and acceptance criteria by the builder and the owner based on specific final product/process requirement. Most of the acceptance criteria is based on the mutual agreement between the builder and the owner, with some input and recommendations from the testing agency . The independent testing firm can usually advise appropriate testing procedures based on the type of Cleanroom facility being built. We recommend they get involved right from the start when the test procedures, specifications and acceptance criteria for the various parameters are being worked out . The independent testing firm serves as a check, a referee or a moderator between the builder and the owner . We recommend that the owner engages the Independent testing agency rather than the builder and that the agency works together with the QA personnel of the owner .

Tests

Some of the more commonly performed cleanroom tests include :

1. Airflow velocity, volume & uniformity tests
2. HEPA/ULPA filter installation leak tests
 - Air generated aerosol challenge & aerosol photometer filter scan test method
 - Alternative source aerosol particle challenge & discrete particle counter filter scan test method
3. Airborne particle count test
4. Room pressurization test
5. Airflow parallelism test
6. Temperature/RH tests

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7. Lighting level test
8. Sound Pressure (Noise) level Test
9. Flooring Resistance Test
 - Point to Point Test
 - Point to Ground Test
10. Testing of Swing / Balance voltage and decay time of ionizers
(Electrostatics / Air Ionizer Performance Tests)