Environmental monitoring program for clean room

Bioburden and ETO limits

Environmental monitoring program for a class 9 clean room that manufactures enteral feeding sets

Abstract

A clean room is an internal clean environment that is often used for manufacture or scientific research with a low level of environmental pollutants such as air bourn microbes, dust or chemical vapors. A clean room has a controlled level of contamination that is specified by the particles that are permitted per cubic meter and also the size of the particles is specified. A clean room has a special meaning that is defined by the International Standards Organization (ISO). ISO has defined a clean room as a ‘ room in which the concentration of airborne particles is controlled and which is constructed and used in a manner to minimize the introduction, generation and retention of particles inside the room and in which other relevant parameters, e. g temperature, humidity and pressure are controlled as necessary’. Clean rooms are usually supplied with air that has been filtered through high efficiency air filters. This air is then changed a number of times depending on the class and purpose of the clean room. A clean room is built with materials that do not generate particles or outgas airborne chemical contamination and can be cleaned easily. Finally personnel that operate inside the clean room where protective clothing knows as bunny suits to minimize their dispersion of particles and microorganisms.

An enteral feeding tube provides a means of maintaining nutritional intake when oral intake is inadequate or when there is restricted access to the

gastrointestinal tract, eg owing to obstruction. ETFs are now commonly used for a wide range of clinical conditions and across a wide range of people (Rebecca White, Vicky Bradnam , Handbook of drug administration via enteral feeding tubes, 2007) . Enteral feeding devices include enteral feeding pumps, pump sets, enteral feeding tubes and kits. Enteral feeding is often used to supply patients with nutrition who cannot consume by swallowing. Patients may not be able to consume by swallowing due to injury or illness such as pancreatitis, cancer and malnutrition.

Introduction

Cleanrooms are monitored according to two well-known standards, ISO 1644-1 and Federal standard 209E. Federal Standard 209E is the standards that the USA comply with whereas ISO 1644-1 are the standards that are applied internationally. ISO 14644 part 1 has been revised as a new second edition draft international standard ISO/DIS 14644-1. 2(2014). ISO 14644-1 is part of a series of documents concerned with cleanrooms and associated subjects. This part of ISO 14644 specifies the classes of air cleanliness in terms of particle concentration in air volume. It also specifies testing methods that are used to determine classification. These include selection of sampling locations and evaluation of class from the data collected. The most significant change in this new set of standards is the use of a more consistent statistical approach to the selection and the number of sample locations and the evaluation of data collected. The statistical confidence is calculated based on the hypergeometric distribution.

- Non-Viable Particles-Air

- Microbial Contamination-Air and Surface
- Pressure differential
- Water quality
- Temperature and Humidity

Annex A

There are a number of test parameters that ISO state that have to be tested when testing the air in a clean room. These recommended tests are listed in Annex A. Annex A provides the recommended tests and the recommended order in which to carry them out . The parameters are listed as follows. Airflow test, Air pressure difference test, humidity test, temperature test, particle disposition test, installed filter leakage test, Airflow directional test and visualization, Airborne particle test for macro particles, Airborne particle test for ultrafine particles, Electrostatic and ion generator test, Particle deposition test, Recovery test, Containment leak test. A checklist is provided to assist in testing criteria. This check list in encoded Annex A. Annex A also gives a series of recommended tests when sampling.

5. Test report

The result of each test should be recorded in a test report and the test report should include the following information:

- Name and address of the testing organization and the date which the test was carried out.
- Number and year of publication of this part of ISO 14644.

- Clear identification of the physical location of the clean room or clean zone tested, and specific designations for coordinates of all sampling locations.
- Specific designation criteria for the clean room or clean zone, including the ISO classification, the relevant occupancy state and the considered particle size.
- Details of the test method used and identification of the test instrument and it’s current calibration certificate.
- Test result, including data reported as specifically required in the clause of Annex B, and a statement regarding compliance.
- Any other specific requirements defined relevant to the clause of Annex B.

A. 1 General

The test procedures that are used in this part of ISO 14644 may be used for demonstrating compliance with the performance criteria of a user specified installation and for performing periodic testing

The choice of tests are usually based on the required level of classification, operational states and the design of installation.

Test Parameter	Class	Time interval	Test Procedure
Installed filter leakage	All Classes	24 Months	ISO 14644-3-clause B6
Airflow	All	24 Months	ISO-14644-3-Clause

Visualization	Classes		B7
Recovery	All Classes	24 Months	ISO-14644-3-Clause B13
Containment leakage	All Classes	24 Months	ISO-14644-3-Clause B14

Table 1 provides optional tests that are recommended by the international standards organization and table 2 is the bioburded limits provided by ISO for a class 9 cleanroom.

Annex B

(B. 1. 1) This test method is a specification of the measurement of airborne particle concentrations with size distributions having a threshold size between 0. 1 micrometer and 5 micrometers. Measurements are often made according to three defined occupancy states. These occupancy states are as follows; as-built, at rest and operational. The measurements are made to verify the cleanliness classification in accordance with ISO 14644-1.

(B. 1. 2. 1) This part of Annex B is known as B1. The location selection, sampling points, clean zone classification determination and the quality of data required should be in accordance with ISO 14644-1. One of the main aspects of B1 is to provide reference methods. Annex B also provides a risk assessment for the clean room.

>/= 0. 1 um >/= 0. 2um >/= 0. 3um >/= 0. 5um >/= 1um >/= 5um

ISO 9	1. 0X10^9	2. 37X10^8	1. 02X10^8	35, 200, 000	8, 320, 000	23900 0

(B. 1. 2. 2) Procedure for airborne particle count

ISO recommends the installation of a DPC intake at a specified sampling location. In sampling locations where the airflow is not controlled or predictable the inlet of the sample probe should be directed vertically upwards. The transit tube from the sample probe inlet to the DPC sensor must be as short as possible. If samples that are greater than or equal to one micrometer, the transit tube must not exceed the manufactures recommended length and diameter.

B3 Airborne particle count for macroparticles

The test methods that are described here are for the testing of particles larger than 5 micrometers in diameter. Measurements for macro-particles can be made in any of the three occupancy states of a clean room. These measurements are made in order to determine the concentration of macro-particles.

B. 3. 3 Measurements methods for macroparticles

ISO has assigned two general categories for macro-particles, therefore comparable results may not be produced if different measurement methods are used. Therefore correlation between different methods is not possible

1. Collection by filtration or inertial effects, which is then followed by microscopic measurement of the number and size, or measurement of the mass of collected particles.

(1). Filter collection and microscopic measurement (B. 3. 3. 2. 1) will report macro-particles using particle size based upon the agreed diameter.

(2). Cascade impact collector and microscopic measurement will report macro-particles using particle size base upon the microscopists choice of reported particle diameter.

(3). Cascade impact collector and weight collector will macro-particles using particle size based upon an aerodynamic diameter.

(b). In situ measurement of the concentration and size of macro-particles with a time of flight particle counter or a DPC.

(1). DPC measurement will report macro-particles using particle size based upon an equivalent optical diameter.

(2). Time of flight particle size measurement (B. 3. 3. 3. 3) will report macro-particles using particle size based upon an aerodynamic diameter.

B. 3. 3. 3 macro-particle measurement without particle collection

B. 3. 3. 3. 1 Macro-particles can be measured without collecting particles from the air. This process involves the optical measurement of the particles that are suspended in the air. An air sample is taken through a DPC, which reports either the equivalent optical diameter or the aerodynamic diameter of particles.

B. 3. 3. 3. 2 Discrete particle counter (DPC) measurement.

The procedure is the same as in B. 1. DPC does not require sensitivity for detection of particles that are less than 1 micrometer. Care is required in order to ensure that the DPC samples directly from the air at the sample location. If sample tubes are longer than 1 meter to the DPC then they should not be used. The DPC often has a sample flow of 0. 00047 m^3/s and should be fitted with an inlet sized for isokinetic sampling in unidirectional flow zones. The DPC should be set facing upwards in areas where non-unidirectional airflow takes place.

The DPC size range settings are established so that only macro-particles are detected.

B. 3. 3. 3. 3 Time of flight particle size measurement

The dimensions of macro-particles can be measured by using a device that is known as time of flight apparatus and accelerated through a nozzle into a partial vacuum, where the measurement region is located. Any particles that are in the air sample will accelerate to match the air velocity in the measurement region. It is this relationship between the air velocity and particle velocity at the point of measurement that can be used to determine the aerodynamic diameter of the particle.

B. 3. 4 Procedure for macro-particle count

The sample inlet probe must be set up on the selected apparatus. The required air volume must be sampled to collect at least 20 macro-particles at each sample point and make measurements as specified in ISO 14644-1 or ISO 14644-2. The M-discriptor concentration in the selected particle size

ranges must be calculated as agreed between customer and supplier, and report the data.

B. 3. 5 Test reports

The following information and data should be recorded as described in clause 5.

(a). Definition of the particle parameter to which the apparatus responds

(b). Type of measurement: classification or test M descriptor determination or monitoring

(c). Type designations of each measurement instrument and apparatus used and it’s calibration state.

(d). Cleanliness classification of the installation

(e). Macro-particle size range(s) and the count for each size range reported

(f). Apparatus inlet sample flow rate and flow rate through sensing volume.

(g). Sample point locations

(h). Sampling schedule plan for classification or sampling protocol plan for testing

(I). Occupancy state(s)

(j). Stability of macro-particle concentration, if required

(k) Other data relevant for measurement.