

## Dynamic Design: The Cleanroom

## How Clean is Clean?

### STUDENT TEXT

#### What is Clean?

Clean is a relative term. Think about the cleanliness level in your home. Some rooms are cleaner than others. For instance, the kitchen is cleaner than the garage. This is because the activities that take place in these rooms are very different. When the door is open, dirt and leaves often gather in the garage. The kitchen is cleaner than the garage because the door to the kitchen is smaller and the kitchen is cleaned more frequently because it is used to prepare food. Like your house, laboratories and businesses have different levels of clean.

Standards are used in industry to give an accurate measure of the quality of a particular process or product. According to the dictionary a standard is “a degree or level of requirement, excellence, or attainment.” Science teachers rely on the National Science Education Standards to guide their teaching strategies, professional development, and support necessary to deliver high quality science education to all students. Standards also exist for cleanrooms. Federal Standard 209E establish standards for cleanliness for airborne particulate levels in cleanrooms. This document also describes methods for monitoring the air in the cleanroom and procedures for verifying the classification level of cleanrooms. Classifications of cleanrooms are established by the number of particulates that are one micron ( $\mu\text{m}$ ) or larger in a cubic foot of space per minute. One micron is equal to one millionth of a meter or 1/1000 millimeter. The chart below shows examples of common objects that are measured in microns.

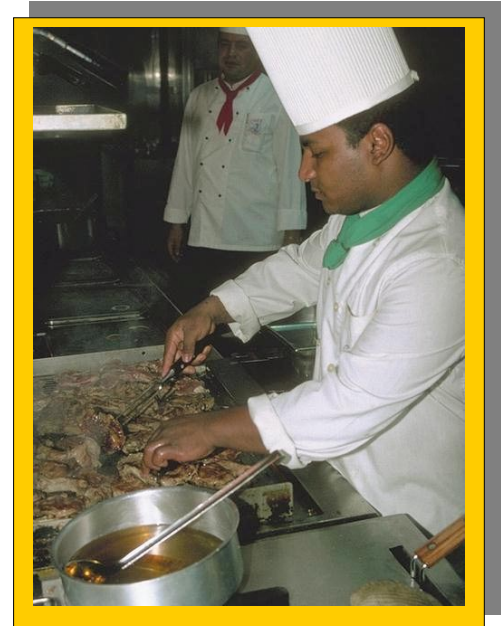


Table 1: Examples of items measured in microns

Example	Size ( $\mu\text{m}$ )
Cigarette smoke particles	0.01 – 1
Bacteria	0.3 – 40
Household dust	0.5 – 20
Diameter of human hair	40 - > 100

Jet Propulsion  
Laboratory

The class number is an indicator of how clean a cleanroom is. If a cleanroom has a class number of 100,000, that means that no more than 100,000 particles any larger than 0.5  $\mu\text{m}$  in size are allowed in each cubic foot of air. (See the video, [Cleanroom Technology, NASA Genesis Mission](#) for animations and examples of different class numbers in common rooms.)

#### Cleanrooms at Johnson Space Center

The mission of Astromaterials Curation at Johnson Space Center in Houston, Texas is to protect, preserve, and distribute for study samples from the moon, Mars, and interplanetary space in support of solar system exploration. Much of the research done on these samples involves measuring small differences in composition. The smallest amounts of contaminants from Earth can ruin the accuracy of scientific measurements. (<http://www-curator.jsc.nasa.gov/curator/welcome.htm>)

Building 31 N at Johnson Space Center was constructed in 1979 to provide permanent storage of lunar samples in a secure and non-contaminating environment. This building is the main



Johnson Space Center

repository of samples from the Apollo missions. All materials used in constructing and equipping the building were carefully screened to exclude chemical elements that would contaminate the lunar samples. For a virtual tour of the Lunar Sample Laboratory Facility go to: <http://www-curator.jsc.nasa.gov/curator/lunar/lun-fac.htm>. Johnson Space Center also has cleanrooms for cosmic dust, meteorites and solar wind samples which will be returned by the Genesis mission in 2004. The various cleanrooms have different class numbers. The class number is often an upper limit for the cleanliness of the room. The actual level of clean is often much lower as described in Table 2.

Table 2: Class Numbers and Actual Levels of Clean for Cleanrooms at Johnson Space Center (April 2000)

Cleanroom	Class Number	Actual Level of Clean
<b>Genesis</b>	<b>10</b>	<b>About 1</b>
<b>Cosmic Dust</b>	<b>100</b>	<b>About 10</b>
<b>Lunar</b>	<b>1,000</b>	<b>500</b>
<b>Meteorite</b>	<b>10,000</b>	<b>2,000</b>

### Class 10 Cleanrooms at Johnson Space Center

The cleanroom facility at Johnson Space Center shown in the figure below, contains two class 10 cleanrooms connected by a class 1000 viewing corridor. (For more information on the certification of the Genesis cleanroom, visit the mission milestone page on the Genesis Web site <http://genesismission.jpl.nasa.gov>). One of the Class 10 rooms (cleaning room) is used for cleaning both materials used in payload assembly and the science canister with ultra-pure water. The second Class 10 room (payload assembly room) is used for assembling the payload. Equipment can be transferred through a pass-through between the rooms without leaving the Class 10 environment. The facility also includes rooms for payload disassembly, sample storage, and donning cleanroom garments.

### Keep it Closed

Has one of your parents ever asked you to close the refrigerator door as you contemplated what to eat or drink? They probably were concerned that more electricity would

be needed to keep the contents in the refrigerator at the set temperature. In order to save energy, it is important to keep doors and windows closed during times of hot or cold weather. Most stores or restaurants in mild climates have an entryway that contains two doors. This provides a buffer between the outside weather and the inside area that is climate controlled with heating or air conditioning. Often these buffer areas are used for putting on coats or finding your umbrella before going outside. When entering a store the outside door is opened and then closed before the inside door is opened.

In the same way it is important in cleanrooms to follow the same protocol for opening and closing doors. In the diagram above, one would enter the cleanroom by the steps in the upper left-hand side of the drawing. By that door there is a tacky mat on the floor so that dust on the shoes will be removed before entering the De-Integration Room. When one enters this room only the first door is allowed to be opened. The first door must be closed before the door to the Gowning Room is opened. This allows for each room that you enter to be more and more clean. If doors to the Gowning Room and the class 1000 viewing corridor were opened at the same time, then contamination from the Deintegration Room could end up in the class 1000 viewing corridor. In the "Levels of Clean" activity you will discover why it is important to observe this protocol when in the cleanroom.

Figure 1 Floor plan of Genesis Cleanroom

