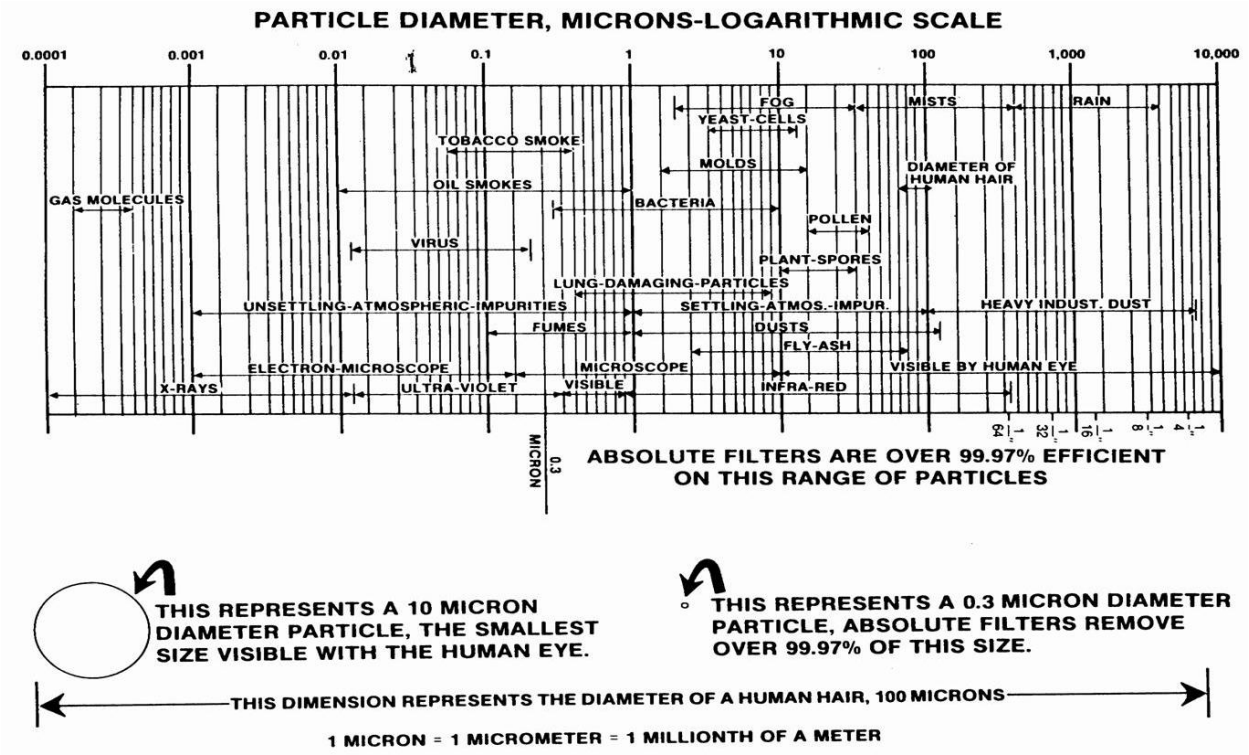
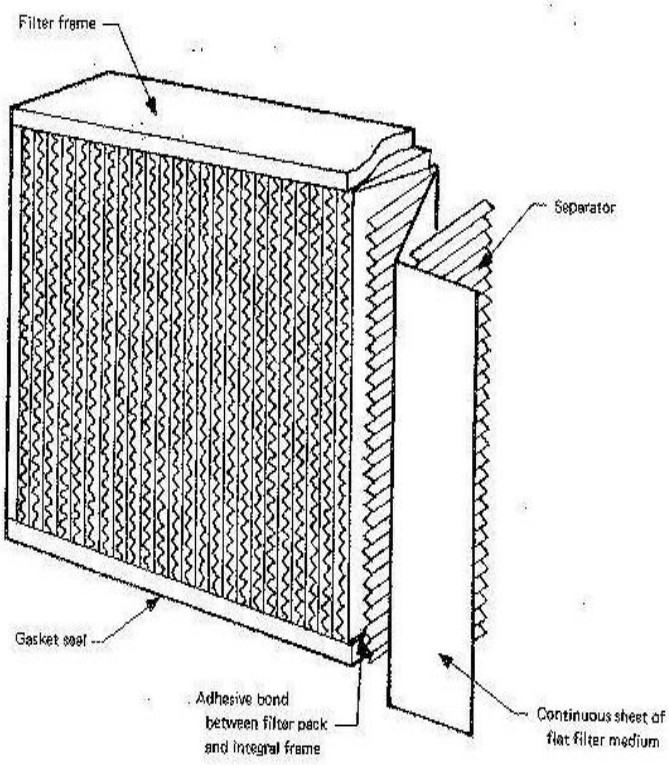
High Efficiency Particulate Air (HEPA) Filters Description and Testing

Modified from ATI Test Laboratory materials and DOE Nuclear Air Cleaning Handbook (DOE HDBK-1169-2003)

A second category also is comprised of single-use, disposable filters called HEPA filters. By definition, a HEPA filter is a throwaway, extended-medium, dry-type filter with: (1) a minimum particle removal efficiency of no less than 99.97 percent for 0.3-µm particles, (2) a maximum resistance, when clean, of 1.0 inches water gauge (in.wg) when operated at 1,000 cfm, and (3) a rigid casing that extends the full depth of the medium. All high-efficiency filters are now made from a mixture of glass fibers. These are sometimes referred to as "absolute filters." Particulate diameters for common materials and the relative comparison of these particulates are shown below.



Most HEPA filter units are constructed the same way. A continuous length of filter paper is folded back and forth into pleats and corrugated separators are inserted between each fold. The assembly is then sealed into a rigid, open-faced rectangle. The components of a fabricated HEPA filter include: (1) extensively pleated filter medium, (2) separators that provide air passages and keep adjacent pleats apart, (3) a rigid filter case that encloses and protects the fragile filter medium, (4) sealants used to bond the filter pack (consisting of the assembled pleated medium and separators) to the filter case and to eliminate leak paths between filter pack components, and (5) gaskets attached to the filter case on one or both open faces to provide an airtight seal between the filter and the mounting frame. A schematic of a typical construction of a HEPA filter is shown below.



HEPA filters for nuclear service undergo a series of testing regimens. The first regimen consists of stringent visual examination and penetration tests by the manufacturer. DOE then performs independent inspection and penetration testing for all filters purchased at a designated DOE Filter Test Facility (FTF) prior to installation at the final destination. At the FTF the individual filters are leak tested uses a mono-dispersed aerosol (0.3 micron mean diameter) to evaluate penetration. Filters failing to meet the FTF specification acceptance criteria are rejected.

The second regimen is an in-place leak test. The in-place leak test is done after filters are installed at a DOE nuclear facility to ensure the performance of the confinement ventilation system. The in-place leak test and visual inspection of HEPA filters are performed initially upon installation to detect bypasses and damage to filters and periodically to establish current condition of a nuclear air cleaning system and its components. Specific objectives of in-place filter testing are (1) to test the aggregate performance to filters in a filter bank, (2) to evaluate the effectiveness of seals between the filter gasket and the filter housing, (3) to assess the leak-tightness of the filter housing, and (4) to determine whether bypasses exist around the filter housing. Each time repairs are made, the system, as a whole, must be retested until it meets the established criteria for leaktightness. The in-place leak test uses a poly-dispersed aerosol (0.7 micron mean diameter) and determines the system efficiency where the system components (i.e., gaskets, frame, housing, etc.) are challenged.

The service life of HEPA filters can often be extended by using less efficient filters that selectively remove the largest particles and fibers from the incoming airstream. Assessment of an acceptable combination of prefilters and HEPA filters depends on the dust-loading and efficiency characteristics of the different filter types available for the particular aerosol to be filtered. The clogging susceptibility of HEPA filters will vary with the dust and filtration characteristics of the prefilters. In some cases, HEPA filter lifetimes can be increased by as much as four times with multiple prefilter changes during the interval between HEPA filter changes.

WIPP Underground Filtration HEPA Filter Arrangement and Description

(Excerpted from SDD VU00, Section 3.5.3.2)

The two parallel High Efficiency Particulate Air (HEPA) filter units are walk-in type units. Each unit has one series bank of moderate efficiency prefilters (roughing filters), one series bank high efficiency prefilters and two series banks of HEPA filters. Each filter unit has a rated air flow capacity of 30,000 SCFM, providing a total capacity of 60,000 SCFM. The filters are mounted in parallel between a common inlet plenum and common outlet plenum. The overall layout of the filter units, ductwork and dampers can be seen on the following figure.

Each filter unit is approximately 17 feet wide by 27 feet long and 8 feet tall. Each filter bank contains 21 filters, clamped into frames, seven filters wide and three filters high. An individual prefilter element is 24 inches wide, 24 inches high and 12 inches deep. An individual HEPA filter element is also 24 inches wide, 24 inches high and 12 inches deep. These filters all use a pleated fiberglass media, folded and separated by aluminum spacers in a metal frame. The first prefilter bank or the roughing filters contains 60% efficient filter units. The second prefilter bank of high efficiency filters contains 90% efficient filter units. The HEPA filter banks contain filters with a 99.97% (0.3μ) efficiency. The efficiency of the prefilters is determined by tests prescribed by ASHRAE while the efficiency of the HEPA filters is determined by aerosol tests. The filter banks are designed so that the individual filters can be bagged out to minimize spread of contamination. Aerosol distribution sampling manifolds are provided ahead of each HEPA filter bank so that these filters can be routinely tested. The last in-place testing of the WIPP Underground Exhaust HEPA filtration was performed on May 13, 2013 and showed an efficiency of greater than 99.99%.