Designation: D7712 – 11

StandardTerminology for Sampling and Analysis of Asbestos[1]

This standard is issued under the fixed designation D7712; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This terminology standard is a collective vocabulary relating to sampling and analysis of asbestos. As a convenience to general interest, it contains most of the standard terms, definitions, and nomenclature under the jurisdiction of Committee D22.

1.2 Many of the entries in this terminology are copied (with attribution) from the standards of origin referenced in Section 2. The standards of origin are noted in bold type at the right margin of the applicable definition.

1.3 Certain terms in the common language that comprise multiple concepts are included herein with the definition specific to standards and practices of Committee D22. Alternative definitions for starred terms may be found in the USGS Tabulation of Asbestos-Related Terminology, Open-File Report 02-458.

2. Referenced Documents

2.1 *ASTM Standards:*

D1356 Terminology Relating to Sampling and Analysis of Atmospheres

D2946 Terminology for Asbestos and Asbestos–Cement Products

D5755 Test Method for Microvacuum Sampling and Indirect Analysis of Dust by Transmission Electron Microscopy for Asbestos Structure Number Surface Loading

D5756 Test Method for Microvacuum Sampling and Indirect Analysis of Dust by Transmission Electron Microscopy for Asbestos Mass Surface Loading

D6281 Test Method for Airborne Asbestos Concentration in Ambient and Indoor Atmospheres as Determined by Transmission Electron Microscopy Direct Transfer (TEM)

D6480 Test Method for Wipe Sampling of Surfaces, Indirect Preparation, and Analysis for Asbestos Structure Number Surface Loading by Transmission Electron Microscopy

D6620 Practice for Asbestos Detection Limit Based on Counts

D7200 Practice for Sampling and Counting Airborne Fibers, Including Asbestos Fibers, in Mines and Quarries, by Phase Contrast Microscopy and Transmission Electron Microscopy

D7201 Practice for Sampling and Counting Airborne Fibers, Including Asbestos Fibers, in the Workplace, by Phase Contrast Microscopy (with an Option of Transmission Electron Microscopy)

D7390 Guide for Evaluating Asbestos in Dust on Surfaces by Comparison Between Two Environments

2.2 *Government Standards:*

USGS Open-File Report 02-458 Tabulation of Asbestos-Related Terminology

3. Terminology

acicular, *adj*—the shape shown by an extremely slender crystal with cross-sectional dimensions that are small relative to its length, that is, needle-like. **D6281**

actinolite asbestos, *n*—asbestiform variety of the monoclinic amphibole silicate minerals of the tremolite-actinolite series. **D2946**

activity generated aerosol, *n*—a dispersion of particles in air that have become airborne due to physical disturbances such as human activity, sweeping, airflow, etc. **D7390**

amosite, *n*—the acronym assigned to grunerite asbestos, and derived from the name of the first developers of a major deposit of this mineral. **D2946**

amphibole, *n*—a group of more than 60 different silicate minerals with similar crystal structures and complex compositions that conform to the nominal formula:

$$A_{0-1}B_2C_5T_8O_{22}(OH,F,Cl)_2$$

where:

A	=	K, Na, Ca;
B	=	Fe^{2+}, Mn, Mg, Ca, Na;
C	=	Al, Cr, Ti, Fe^{3+}, Mg, Fe^{2+};and
Mn and T	=	Si, Al, Cr, Fe^{3+}, Ti.

In some varieties of amphibole, these elements can be partially substituted by Li, Pb, Zn, Be, Ba, or Ni. Amphiboles are characterized by a complex monoclinic or orthorhombic structure that includes a double chain of T-O tetrahedra with a T:O ratio of approximately 4:11; a variable morphology that

[1] This terminology standard is under the jurisdiction of ASTM Committee D22 on Air Quality and is the direct responsibility of Subcommittee D22.07 on Sampling and Analysis of Asbestos.

Current edition approved Sept. 1, 2011. Published October 2011. DOI:10.1520/D7712-11.

ranges from columnar to prismatic to acicular to fibrous; and good prismatic cleavage at angles of about 56 and 124°. The cleavage may not be readily exhibited by small crystals that are bound by irregular growth and fracture surfaces. **D6281**

amphibole asbestos, *n*—asbestiform amphibole silicate minerals including the orthorhombic anthophyllite series and the monoclinic cummingtonite (grunerite asbestos [amosite]) series, the tremolite-actinolite series, and the alkali amphibole (riebeckite asbestos [crocidolite]) series, among others.

DISCUSSION—The amphiboles contain essential (OH) groups in the structure, and the Si:O ratio is 4:11. A considerable amount of elemental substitution can take place in these varieties of asbestos. The crystal structures are composed of strips or ribbons of linked polyhedral that join to form fibrils. The individual strips are made up from three components; these are two double chains of linked (Si, Al)O4 tetrahedra and a strip of linked MgO_6, FeO_6, or AlO_6 octahedra. **D2946**

, *n*—amphibole in an asbestiform habit. **D6281 D6480**

analytical sensitivity, *n*—the calculated airborne asbestos structure concentration in asbestos structures/L, equivalent to the counting of one asbestos structure in the analysis. **D6281**

, *n*—the calculated airborne asbestos structure concentration in asbestos structures/square centimeter, equivalent to counting of one asbestos structure in the analysis calculated using Eq. 2 in D6480. **D6480**

anthophyllite asbestos, *n*—asbestiform variety of the orthorhombic amphibole silicate minerals of the anthophyllite series.

DISCUSSION—Its empirical formula is $Mg_7Si_8O_{22}(OH)_2$. Its Chemical Abstracts number is 77536-67-5. **D2946**

area sample, *n*—an air sample collected so as to represent the concentration of airborne dust in a specific mine location, or area, or room of a workplace. **D7200**

, *n*—an air sample collected so as to represent the concentration of airborne dust in a specific area or room, which, in the case of this practice, refers to an area or room of a workplace. **D7201**

asbestiform, *adj*—having an inherent fine-textured morphology, resulting from unequal relative development of the principal crystal axes in a silicate mineral, that predetermines subdivision into strong flexible fibers having microscopic to submicroscopic thickness and a high length to width ratio when the mineral is subjected to comminution.

DISCUSSION—Term derived from "asbestos." **D2946**

, *adj*—a special type of fibrous habit in which the fibers are separable into thinner fibers and ultimately into fibrils. This habit accounts for greater flexibility and higher tensile strength than other habits of the same mineral. **D5755 D5756**

, *adj*—a specific type of fibrous habit in which the fibers are separable into thinner fibers and ultimately into fibrils. This habit accounts for greater flexibility and higher tensile strength than other habits of the same mineral. **D6281**

, *adj*—a specific type of fibrous mineral growth habit in which the fibers and fibrils exhibit a polyfilamentous growth habit and possess high tensile strength and flexibility. All materials regulated as asbestos are asbestiform, but not all asbestiform minerals are classified as asbestos. Characteristics such as tensile strength and flexibility cannot be ascertained from microscopic evaluation. **D7200 D7201**

asbestos, *n*—the generic term for naturally occurring inorganic hydrated silicates, occurring in layered structures composed of chains of silicon and oxygen tetrahedra, that can subdivide into flexible fibers. **D2946**

, *n*—a collective term that describes a group of naturally occurring, inorganic, highly fibrous, silicate dominated minerals, which are easily separated into long, thin, flexible fibers when crushed or processed.

DISCUSSION—Included in the definition are the asbestiform varieties of: serpentine (chrysotile); riebeckite (crocidolite); grunerite (grunerite asbestos); anthophyllite (anthophyllite asbestos); tremolite (tremolite asbestos); and actinolite (actinolite asbestos). The amphibole mineral compositions are defined in accordance with the nomenclature of the International Mineralogical Association. **D5755**

, *n*—a collective term that describes a group of naturally occurring, inorganic, highly fibrous, silicate minerals, which are easily separated into long, thin, flexible fibers when crushed or processed.

DISCUSSION—Included in the definition are the asbestiform varieties of: serpentine (chrysotile); riebeckite (crocidolite); grunerite (amosite); anthophyllite (anthophyllite asbestos); tremolite (tremolite asbestos); and actinolite (actinolite asbestos). The amphibole mineral compositions are defined according to nomenclature of the International Mineralogical Association. **D5756**

, *n*—a collective term that describes a group of naturally occurring, inorganic, highly-fibrous, silicate minerals, that are easily separated into long, thin, flexible, strong fibers when crushed or processed.

DISCUSSION—Included in the definition are the asbestiform varieties of serpentine (chrysotile); riebeckite (crocidolite); grunerite (grunerite asbestos [Amosite]); anthophyllite (anthophyllite asbestos); tremolite (tremolite asbestos); and actinolite (actinolite asbestos). The amphibole mineral compositions are defined according to the nomenclature of the International Mineralogical Association. **D6281 D6480**

, *n*—a term applied to six specific silicate minerals belonging to the serpentine and amphibole groups, which have crystallized in the asbestiform habit, causing them to be easily separated into long, thin, flexible, strong fibers when crushed or processed. The Chemical Abstracts Service Registry Numbers of the most common asbestos varieties are: chrysotile (12001-29-5), riebeckite asbestos (crocidolite) (12001-28-4), grunerite asbestos (Amosite) (12172-73-5), anthophyllite asbestos (77536-67-5), tremolite asbestos (77536-68-6) and actinolite asbestos (77536-66-4). The precise chemical composition of each species varies with the location from which it was mined. Other amphibole minerals which exhibit the characteristics of asbestos have also been observed. The nominal compositions of the most common asbestos varieties are: Chrysotile $Mg_3Si_2O_5(OH)_4$, Crocidolite $Na_2Fe_3^{2+}Fe_2^{3+}Si_8O_{22}(OH)_2$, Amosite (Mg,Fe)7Si8O22(OH)2,

Anthophyllite (Mg,Fe)7Si8O22(OH)2, Tremolite $Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$ [Mg/(Mg+Fe^{2+}) 0.9-1.0], Actinolite $Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$ [Mg/(Mg+Fe^{2+}) 0.5-0.9].

NOTE 1—Actinolite compositions in which Mg/(Mg+Fe^{2+}) is between 0 and 0.5 are referred to as ferroactinolite.

asbestos fiber, *n*—acicular silicate mineral, with a structure based upon silicon-oxygen tetrahedra, that fits the definition of a fiber, and is composed of single crystals in predominately parallel orientation.

DISCUSSION—Common usage also designates a collectivity of asbestos fibers as asbestos fiber. **D2946**

, *n*—a fiber of asbestos that meets the criteria specified below for "fiber." Phase Contrast Microscopy (PCM) does not identify fibers unequivocally as asbestos. Under the light microscope, a population of asbestos fibers may appear as a mixture of fiber agglomerates, fiber bundles (polyfilamentous growth, unique to asbestiform fibers), fibers with split ends, and single fibers, the relative occurrence and frequency of each type depending on the situation. **D7200** **D7201**

asbestos structure, *n*—a term applied to isolated fibers or to any connected or overlapping grouping of asbestos fibers or bundles, with or without other nonasbestos particles. **D6281**

, *n*—a term applied to isolated fibers or to any connected or overlapping grouping of asbestos fibers or bundles, with or without other nonasbestos particles. **D6480**

aspect ratio, *n*—the ratio of the length of a fibrous particle to its average width. **D5755** **D5756**

, *n*—the ratio of length to width of a particle. **D6281** **D6480**

, *n*—the ratio of the length of a fiber to its width. **D7200** **D7201**

background, *n*—a statistical distribution of structures introduced by (*i*) analyst counting errors and (*ii*) contamination on an unused filter or contamination as a consequence of the sample collection and sample preparation steps.

DISCUSSION—This definition of background is specific to this practice. The only counting errors considered in this definition of background are errors that result in an over-count (that is, false positives). Analyst counting errors are errors such as, determining the length of structures or fibers and whether, based on length, they should be counted; counting artifacts as fibers; determining the number of structures protruding from a matrix; and interpreting a cluster as one, two, or more structures that should be counted only as zero or one structure. For purposes of developing the DL, assume that background contamination sources have been reduced to their lowest achievable levels. **D6620**

background samples, *n*—samples taken from surfaces that are considered to have concentrations of asbestos in surface dust that are representative of conditions that exist in an environment that is affected by only prevailing conditions and has not experienced events, disturbances or activities unusual for the environment. **D7390**

blank, *n*—a structure count made on TEM specimens prepared from an unused filter to determine the background measurement. **D6281**

, *n*—a filter that has not been used to collect asbestos from the target environment. **D6620**

DISCUSSION—Blanks are used in this practice to determine the degree of asbestos contamination that is reflected in asbestos measurements. Contamination may be on the virgin filter or introduced in handling the filter in the field or when preparing it for inspection with a microscope. The data required to determine the degree of contamination consists, therefore, of measurements of field blanks that have experienced the full preparation process.

bundle, *n*—an assemblage of asbestos in which the fibers remain entirely in their original close packed parallel configuration (or not appreciably displaced therefrom) and having a transverse dimension typically between 2 and 8 mm. **D2946**

, *n*—a structure composed of three or more fibers in a parallel arrangement with the fibers closer than one fiber diameter to each other. **D5755** **D5756** **D6480**

camera length, *n*—the equivalent projection length between the specimen and its electron 195 diffraction pattern, in the absence of lens action. **D6281** **D6480**

chrysotile, *n*—an asbestos mineral belonging to the serpentine group, having a chemical composition close to $Mg_3SiO_5(OH)_4$.

DISCUSSION—Moderate amounts of aluminum may substitute for silicon and moderate amounts of iron may substitute for magnesium. Small amounts of MnO, CaO, K_2O, and Na_2O are also reported in the chemical analysis. The crystal structure of chrysotile asbestos consists of double layers, each consisting of a layer of linked SiO_4 tetrahedra that is coordinated to a second layer of linked $MgO_2(OH)_4$ octahedra linked through the sharing of oxygen atoms; the composite double layer rolls up, like a scroll to form long hollow tubes. The outer diameters of the individual tubes are in the order of 25 nm; the length-to-diameter ratio can vary from 20 to well over 10 000. Chrysotile is characterized by a combination of distinctive morphology, a chemical composition close to $Mg_3Si_2O_5(OH)_4$, and characteristic X-ray and electron diffraction patterns. Its Chemical Abstracts number is 12001-29-5. **D2946**

, *n*—a group of fibrous minerals of the serpentine group that have the nominal composition $Mg_3Si_2O_5(OH)_4$ and have the crystal structure of either clinochrysotile, orthochrysotile, or parachryosotile. Most natural chrysotile deviates little from this nominal composition. Chrysotile may be partially dehydrated or magnesium-leached, both in nature and in building materials. In some varieties of chrysotile, minor substitution of silicon by Al^{3+} may occur. Chrysotile is the most prevalent type of asbestos. **D6281** **D6480**

cleavage, *v*—the breaking of a mineral along one of its crystallographic directions. **D6281**

cleavage fragment, *n*—a fragment of a crystal that is bounded in whole or in part by cleavage faces. Some cleavage fragments would be included in the fiber definition used in this method. **D6281**

, *n*—mineral particles, normally formed by comminution of minerals, which often are characterized by parallel sides and a moderate aspect ratio (usually less than 20:1). Non-asbestiform cleavage fragments do not exhibit fibrillar bundling at any level of examination. **D7200**

cluster, *n*—a structure with fibers in a random arrangement such that all fibers are intermixed and no single fiber is isolated from the group; groupings of fibers must have more than two points touching. **D5755** **D6480**

, *n*—an aggregate of two or more randomly oriented fibers, with or without bundles. Clusters occur as two varieties: disperse clusters and compact clusters. **D5756**

, *n*—a structure in which two or more fibers or fiber bundles are randomly oriented in a connected grouping. **D6281**

compact cluster, *n*—a complex and tightly bound network in which one or both ends of each individual fiber or bundle are obscured, such that the dimensions of individual fibers or bundles cannot be unambiguously measured. **D5756**

compact matrix, *n*—a structure consisting of a particle or linked group of particles, in which fibers or bundles can be seen either within the structure or projecting from it, such that the dimensions of individual fibers and bundles cannot be unambiguously determined. **D5756**

control, *n*—an area that is used as the basis for a comparison. This could be an area where the dust has been previously characterized, an area thought to be suitable for occupancy, an area that has not experienced a disturbance of asbestos-containing materials, or that is for some other reason deemed to be suitable as the basis for a comparison. **D7390**

control samples, *n*—samples collected for comparison to the study samples. These differ from background samples in that they are collected either: in an area where the dust has been previously characterized, or in an area that has not experienced a disturbance of asbestos containing materials, or in an area that is for some other reason deemed to be suitable as the basis for comparison. **D7390**

count, *n*—the number of fibers or structures identified in a sample. **D6620**

crocidolite, *n*—common name for riebeckite asbestos.

DISCUSSION—Also known as blue asbestos. **D2946**

d-spacing or interplanar spacing, *n*—the perpendicular distance between identical adjacent and parallel planes of atoms in a crystal. **D6480**

d-value or interplanar spacing, *n*—the perpendicular distance between identical adjacent and parallel planes of atoms in a crystal. **D6281**

debris, *n*—materials that are of an amount and size (particles greater than 1 mm in diameter) that can be visually identified as to their source. **D5755**

, *n*—materials that are of an amount and size (particles greater than 1 mm in diameter as defined by a 1.0 by 1.0 mm screen) that can be visually identified (by color, texture, etc.) as to their source. **D5756**

detection limit, *n*—the mean of a structure count population that is sufficiently large so a measurement from this population would have a high probability (for example, 0.95 or larger) of exceeding the decision value that determines detection.

DISCUSSION—The DL is the value of a parameter, the true mean of a structure count population in the statistical hypothesis testing problem, that underlies the DL concept. Specifically, it is the true mean of the alternative hypothesis that ensures a sufficiently high power for the statistical test that determines detection. **D6620**

differential counting, *v*—a term applied to the practice of excluding certain kinds of fibers from the fiber count because they do not appear to be morphologically consistent with fibers of a specific variety thus modifying the definition of fiber given below. **D7200** **D7201**

disperse cluster, *n*—a disperse and open network in which both ends of one of the individual fibers or bundles can be separately located and its dimensions measured. **D5756**

disperse matrix, *n*—a structure consisting of a particle or linked group of particles, with overlapping or attached fibers or bundles in which at least one of the individual fibers or bundles can be separately identified and its dimensions measured. **D5756**

dust, *n*—any material composed of particles in a size range of <1 mm. **D5755** **D5756** **D7390**

electron diffraction, *n*—techniques in electron microscopy, including selected area electron diffraction (SAED) and microdiffraction, by which the crystal structure of a specimen is examined. **D6281** **D6480**

electron scattering power, *n*—the extent to which a substance scatters electrons from their original courses. **D6281**

energy dispersive X-ray analysis, *n*—measurement of the energies and intensities of X-rays by use of a solid state detector and multichannel analyzer system. **D6281** **D6480**

environment, *n*—well defined three-dimensional area and everything that is in it. **D7390**

eucentric, *n*—the condition when the area of interest of an object is placed on a tilting axis at the intersection of the electron beam with that axis and is in the plane of focus. **D6281** **D6480**

fiber, *n*—any material in a form such that it has a minimum length to average maximum 310 transverse dimension of 10 to 1, a maximum cross-sectional area of 5.06 by 10^{-2} mm^2 (corresponding to a circular cross section of 0.254 mm in