## Selected pneumoconiotic agents: Geometric mean exposures and percent exceeding designated occupational exposure limits, MSHA and OSHA samples, 1979–2003 (page 1 of 4)

| Year | Aluminum Oxide Fume and Dust MSHA | | | | Aluminum Oxide and Alpha Aluminum OSHA | | | | Antimony and Compounds OSHA | | | | Beryllium Fume and Dust MSHA | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | GM ($mg/m^3$) | No. of Samples | % > PEL | % > REL | GM ($mg/m^3$) | No. of Samples | % > PEL | % > REL | GM ($mg/m^3$) | No. of Samples | % > PEL | % > REL | GM ($\mu g/m^3$) | No. of Samples | % > PEL | % > REL |
| **1979** | 0.117 | 145 | 0.0 | - | 0.209 | 22 | 18.2 | - | 0.015 | 60 | 6.7 | 6.7 | 0.334 | 65 | 13.8 | - |
| **1980** | 0.025 | 152 | 0.0 | - | 1.155 | 15 | 0.0 | - | 0.011 | 146 | 1.4 | 1.4 | 0.164 | 53 | 0.0 | - |
| **1981** | 0.017 | 170 | 0.6 | - | 0.196 | 6 | 0.0 | - | 0.020 | 96 | 7.3 | 7.3 | 0.176 | 83 | 1.2 | - |
| **1982** | 0.010 | 85 | 1.2 | - | 1.184 | 26 | 19.2 | - | 0.012 | 61 | 4.9 | 4.9 | 0.183 | 72 | 4.2 | - |
| **1983** | 0.017 | 148 | 0.0 | - | 0.642 | 9 | 22.2 | - | 0.009 | 94 | 0.0 | 0.0 | 0.189 | 171 | 2.9 | - |
| **1984** | 0.018 | 160 | 0.0 | - | 0.043 | 21 | 0.0 | - | 0.012 | 87 | 6.9 | 6.9 | 0.161 | 155 | 0.0 | - |
| **1985** | 0.020 | 177 | 0.0 | - | 0.024 | 37 | 8.1 | - | 0.007 | 173 | 1.2 | 1.2 | 0.164 | 168 | 0.0 | - |
| **1986** | 0.019 | 121 | 0.0 | - | 0.029 | 17 | 5.9 | - | 0.009 | 73 | 2.7 | 2.7 | 0.215 | 81 | 1.2 | - |
| **1987** | 0.031 | 139 | 0.7 | - | 0.007 | 28 | 0.0 | - | 0.006 | 129 | 2.3 | 2.3 | 0.172 | 81 | 0.0 | - |
| **1988** | 0.033 | 112 | 1.8 | - | 0.041 | 30 | 3.3 | - | 0.004 | 78 | 1.3 | 1.3 | 0.189 | 97 | 0.0 | - |
| **1989** | 0.025 | 133 | 0.0 | - | 0.050 | 20 | 5.0 | - | 0.007 | 101 | 5.9 | 5.9 | 0.166 | 75 | 1.3 | - |
| **1990** | 0.030 | 182 | 1.6 | - | 0.013 | 21 | 0.0 | - | 0.007 | 90 | 3.3 | 3.3 | 0.160 | 64 | 0.0 | - |
| **1991** | 0.022 | 143 | 0.7 | - | 0.014 | 33 | 0.0 | - | 0.005 | 120 | 1.7 | 1.7 | 0.169 | 48 | 0.0 | - |
| **1992** | 0.029 | 120 | 1.7 | - | 0.004 | 11 | 0.0 | - | 0.004 | 74 | 0.0 | 0.0 | 0.159 | 39 | 0.0 | - |
| **1993** | 0.009 | 140 | 0.0 | - | 0.019 | 29 | 3.4 | - | 0.005 | 61 | 0.0 | 0.0 | 0.150 | 107 | 0.0 | - |
| **1994** | 0.012 | 241 | 0.0 | - | 0.021 | 26 | 0.0 | - | 0.002 | 135 | 0.7 | 0.7 | 0.152 | 217 | 0.0 | - |
| **1995** | 0.011 | 206 | 0.0 | - | 0.057 | 38 | 5.3 | - | 0.004 | 116 | 1.7 | 1.7 | 0.152 | 183 | 0.0 | - |
| **1996** | 0.006 | 765 | 0.0 | - | 0.040 | 14 | 7.1 | - | 0.005 | 102 | 2.9 | 2.9 | 0.153 | 582 | 0.2 | - |
| **1997** | 0.008 | 227 | 0.0 | - | 0.004 | 18 | 0.0 | - | 0.004 | 80 | 1.3 | 1.3 | 0.162 | 113 | 0.0 | - |
| **1998** | 0.005 | 67 | 0.0 | - | 0.020 | 41 | 0.0 | - | 0.009 | 33 | 9.1 | 9.1 | 0.166 | 43 | 0.0 | - |
| **1999** | 0.002 | 101 | 0.0 | - | 0.010 | 28 | 0.0 | - | 0.010 | 104 | 1.9 | 1.9 | 0.169 | 88 | 0.0 | - |
| **2000** | 0.004 | 97 | 0.0 | - | - | 0 | - | - | - | 0 | - | - | 0.168 | 91 | 0.0 | - |
| **2001** | 0.003 | 113 | 0.0 | - | - | 0 | - | - | - | 0 | - | - | 0.150 | 113 | 0.0 | - |
| **2002** | 0.003 | 64 | 0.0 | - | - | 0 | - | - | - | 0 | - | - | 0.150 | 64 | 0.0 | - |
| **2003** | 0.003 | 88 | 0.0 | - | - | 0 | - | - | - | 0 | - | - | 0.150 | 96 | 0.0 | - |

See footnotes at end of table.

## Selected pneumoconiotic agents: Geometric mean exposures and percent exceeding designated occupational exposure limits, MSHA and OSHA samples, 1979–2003 (page 2 of 4)

| Year | Beryllium and Compounds OSHA | | | | Carbon Black OSHA | | | | Cobalt Fume and Dust MSHA | | | | Cobalt, Metal, Fume and Dust OSHA | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | GM ($\mu g/m^3$) | No. of Samples | % > PEL | % > REL | GM ($mg/m^3$) | No. of Samples | % > PEL | % > REL | GM ($\mu g/m^3$) | No. of Samples | % > PEL | % > REL | GM ($\mu g/m^3$) | No. of Samples | % > PEL | % > REL |
| **1979** | 0.045 | 29 | 6.9 | - | 0.460 | 16 | 0.0 | 0.0 | 4,001.200 | 2 | 100.0 | 100.0 | 3.728 | 46 | 2.2 | 4.3 |
| **1980** | 0.102 | 58 | 8.6 | - | 1.531 | 30 | 20.0 | 20.0 | 26.026 | 3 | 33.3 | 33.3 | 8.042 | 66 | 4.5 | 13.6 |
| **1981** | 0.046 | 60 | 5.0 | - | 1.376 | 30 | 16.7 | 16.7 | 1.442 | 4 | 0.0 | 0.0 | 7.962 | 85 | 7.1 | 12.9 |
| **1982** | 0.042 | 51 | 2.0 | - | 1.008 | 29 | 10.3 | 10.3 | - | 0 | - | - | 9.170 | 162 | 11.7 | 21.6 |
| **1983** | 0.069 | 55 | 5.5 | - | 1.141 | 29 | 10.3 | 10.3 | 0.485 | 111 | 0.9 | 1.8 | 5.981 | 163 | 6.1 | 10.4 |
| **1984** | 0.032 | 676 | 1.5 | - | 1.093 | 27 | 22.2 | 22.2 | 0.313 | 124 | 0.0 | 0.0 | 5.579 | 174 | 7.5 | 12.6 |
| **1985** | 0.037 | 701 | 3.1 | - | 1.946 | 31 | 25.8 | 25.8 | 0.382 | 123 | 0.0 | 0.8 | 8.401 | 165 | 10.3 | 18.2 |
| **1986** | 0.027 | 574 | 0.2 | - | 0.898 | 34 | 11.8 | 11.8 | 0.426 | 55 | 0.0 | 0.0 | 5.997 | 225 | 9.3 | 13.3 |
| **1987** | 0.031 | 778 | 1.2 | - | 0.713 | 26 | 15.4 | 15.4 | 0.410 | 89 | 0.0 | 0.0 | 3.024 | 248 | 7.3 | 12.5 |
| **1988** | 0.035 | 803 | 1.2 | - | 0.780 | 41 | 4.9 | 4.9 | 0.390 | 60 | 0.0 | 0.0 | 3.350 | 327 | 5.2 | 8.0 |
| **1989** | 0.033 | 380 | 1.1 | - | 0.432 | 35 | 5.7 | 5.7 | 0.366 | 102 | 0.0 | 0.0 | 3.111 | 416 | 3.4 | 3.4 |
| **1990** | 0.033 | 795 | 1.8 | - | 0.917 | 40 | 15.0 | 15.0 | 0.376 | 105 | 0.0 | 1.0 | 6.291 | 212 | 14.6 | 14.6 |
| **1991** | 0.031 | 603 | 0.3 | - | 0.896 | 24 | 25.0 | 25.0 | 0.367 | 72 | 0.0 | 1.4 | 6.774 | 289 | 15.2 | 15.2 |
| **1992** | 0.029 | 642 | 0.6 | - | 0.509 | 39 | 7.7 | 7.7 | 0.393 | 41 | 0.0 | 0.0 | 3.556 | 242 | 10.3 | 10.3 |
| **1993** | 0.034 | 561 | 1.4 | - | 0.499 | 41 | 4.9 | 4.9 | 0.286 | 105 | 0.0 | 0.0 | 3.576 | 117 | 6.8 | 11.1 |
| **1994** | 0.029 | 404 | 0.5 | - | 0.904 | 34 | 8.8 | 8.8 | 0.329 | 212 | 0.9 | 1.9 | 1.719 | 185 | 2.7 | 5.9 |
| **1995** | 0.027 | 373 | 0.0 | - | 0.899 | 39 | 10.3 | 10.3 | 0.306 | 187 | 0.0 | 0.0 | 0.871 | 366 | 3.6 | 5.5 |
| **1996** | 0.029 | 301 | 0.7 | - | 0.592 | 18 | 16.7 | 16.7 | 0.270 | 580 | 0.2 | 0.2 | 0.330 | 726 | 1.8 | 2.2 |
| **1997** | 0.030 | 429 | 0.7 | - | 0.633 | 33 | 15.2 | 15.2 | 0.309 | 102 | 0.0 | 1.0 | 0.388 | 633 | 1.3 | 2.4 |
| **1998** | 0.028 | 350 | 0.9 | - | 0.663 | 28 | 7.1 | 7.1 | 0.287 | 44 | 0.0 | 0.0 | 0.409 | 478 | 2.3 | 2.5 |
| **1999** | 0.035 | 322 | 1.6 | - | 0.337 | 28 | 0.0 | 0.0 | 0.308 | 90 | 0.0 | 0.0 | 0.433 | 302 | 0.0 | 0.3 |
| **2000** | - | 0 | - | - | - | 0 | - | - | 0.300 | 91 | 0.0 | 0.0 | - | 0 | - | - |
| **2001** | - | 0 | - | - | - | 0 | - | - | 0.271 | 114 | 0.0 | 0.9 | - | 0 | - | - |
| **2002** | - | 0 | - | - | - | 0 | - | - | 0.270 | 64 | 0.0 | 0.0 | - | 0 | - | - |
| **2003** | - | 0 | - | - | - | 0 | - | - | 0.271 | 96 | 0.0 | 0.0 | - | 0 | - | - |

See footnotes at end of table.

## Selected pneumoconiotic agents: Geometric mean exposures and percent exceeding designated occupational exposure limits, MSHA and OSHA samples, 1979–2003 (page 3 of 4)

| Year | Iron Oxide Fume MSHA | | | | Iron Oxide Fume OSHA | | | | Talc, Nonfibrous, < 1% quartz MSHA | | | | Tin, inorganic compounds except oxide, as Sn OSHA | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | GM ($mg/m^3$) | No. of Samples | % > PEL | % > REL | GM ($mg/m^3$) | No. of Samples | % > PEL | % > REL | GM (mppcf) | No. of Samples | % > PEL | % > REL | GM ($\mu g/m^3$) | No. of Samples | % > PEL | % > REL |
| **1979** | 0.432 | 155 | 1.9 | 3.2 | 1.362 | 597 | 6.0 | 18.1 | 7.980 | 56 | 14.3 | - | 6.975 | 124 | 1.6 | 1.6 |
| **1980** | 0.485 | 155 | 0.6 | 5.2 | 1.087 | 873 | 5.5 | 16.4 | 5.391 | 35 | 8.6 | - | 5.065 | 124 | 0.8 | 0.8 |
| **1981** | 0.336 | 226 | 0.9 | 2.2 | 0.948 | 1,166 | 5.1 | 16.5 | 3.932 | 61 | 4.9 | - | 6.743 | 57 | 1.8 | 1.8 |
| **1982** | 0.398 | 119 | 2.5 | 4.2 | 0.893 | 1,222 | 5.4 | 13.9 | 5.969 | 33 | 6.1 | - | 5.644 | 39 | 0.0 | 0.0 |
| **1983** | 0.212 | 152 | 1.3 | 4.6 | 0.472 | 1,232 | 3.4 | 9.8 | 1.702 | 68 | 7.4 | - | 8.946 | 26 | 0.0 | 0.0 |
| **1984** | 0.283 | 182 | 1.6 | 3.3 | 0.753 | 859 | 4.5 | 14.4 | 2.086 | 22 | 9.1 | - | 7.921 | 113 | 0.0 | 0.0 |
| **1985** | 0.303 | 211 | 0.5 | 4.7 | 0.501 | 995 | 4.2 | 12.5 | 2.874 | 14 | 7.1 | - | 6.142 | 173 | 1.7 | 1.7 |
| **1986** | 0.241 | 171 | 0.6 | 2.3 | 0.484 | 935 | 1.9 | 9.0 | 4.738 | 29 | 3.4 | - | 6.851 | 119 | 0.0 | 0.0 |
| **1987** | 0.215 | 181 | 1.1 | 5.0 | 0.406 | 863 | 2.3 | 8.1 | 5.412 | 18 | 11.1 | - | 5.961 | 218 | 0.0 | 0.0 |
| **1988** | 0.329 | 136 | 0.7 | 3.7 | 0.333 | 963 | 3.0 | 8.9 | 4.899 | 30 | 6.7 | - | 6.023 | 158 | 0.6 | 0.6 |
| **1989** | 0.285 | 163 | 2.5 | 5.5 | 0.583 | 1,117 | 4.3 | 13.1 | 5.651 | 24 | 8.3 | - | 6.532 | 165 | 0.0 | 0.0 |
| **1990** | 0.200 | 213 | 2.3 | 5.2 | 0.435 | 1,045 | 3.7 | 11.2 | 8.108 | 9 | 33.3 | - | 6.490 | 293 | 0.3 | 0.3 |
| **1991** | 0.200 | 177 | 1.1 | 3.4 | 0.293 | 957 | 1.3 | 4.3 | 3.414 | 6 | 0.0 | - | 7.124 | 261 | 0.0 | 0.0 |
| **1992** | 0.199 | 136 | 1.5 | 5.9 | 0.315 | 894 | 1.3 | 4.7 | 2.551 | 13 | 0.0 | - | 5.711 | 162 | 0.0 | 0.0 |
| **1993** | 0.097 | 136 | 1.5 | 4.4 | 0.349 | 912 | 1.5 | 5.2 | 6.497 | 11 | 18.2 | - | 6.105 | 130 | 0.0 | 0.0 |
| **1994** | 0.109 | 200 | 3.0 | 4.0 | 0.392 | 853 | 2.8 | 7.3 | - | 0 | - | - | 4.852 | 200 | 0.0 | 0.0 |
| **1995** | 0.111 | 173 | 0.0 | 2.9 | 0.294 | 854 | 2.2 | 6.3 | - | 0 | - | - | 6.214 | 184 | 0.5 | 0.5 |
| **1996** | 0.062 | 381 | 1.1 | 3.4 | 0.311 | 755 | 4.8 | 7.9 | 26.049 | 5 | 40.0 | - | 4.455 | 174 | 0.0 | 0.0 |
| **1997** | 0.058 | 154 | 0.0 | 1.9 | 0.308 | 782 | 2.2 | 5.4 | 3.000 | 1 | 0.0 | - | 5.244 | 94 | 0.0 | 0.0 |
| **1998** | 0.127 | 58 | 0.0 | 0.0 | 0.346 | 513 | 2.1 | 8.6 | - | 0 | - | - | 5.539 | 84 | 0.0 | 0.0 |
| **1999** | 0.027 | 40 | 0.0 | 0.0 | 0.316 | 469 | 1.7 | 6.0 | - | 0 | - | - | 7.079 | 46 | 2.2 | 2.2 |
| **2000** | 0.233 | 55 | 0.0 | 0.0 | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - |
| **2001** | 0.174 | 79 | 0.0 | 1.3 | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - |
| **2002** | 0.119 | 44 | 0.0 | 0.0 | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - |
| **2003** | 0.074 | 69 | 0.0 | 1.4 | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - |

See footnotes at end of table.

## Selected pneumoconiotic agents: Geometric mean exposures and percent exceeding designated occupational exposure limits, MSHA and OSHA samples, 1979–2003 (page 4 of 4)

| Year | Titanium Dioxide Fume and Dust MSHA | | | | Welding Fumes (total particulate) MSHA | | | | Welding Fumes (total particulate) OSHA | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | GM ($\mu g/m^3$) | No. of Samples | % > PEL | % > REL | GM ($mg/m^3$) | No. of Samples | % > PEL | % > REL | GM ($mg/m^3$) | No. of Samples | % > PEL | % > REL |
| **1979** | 21.708 | 111 | 0.0 | - | 2.389 | 165 | 13.3 | - | 7.047 | 7 | - | - |
| **1980** | 4.127 | 56 | 0.0 | - | 1.591 | 175 | 9.1 | - | 3.183 | 33 | - | - |
| **1981** | 6.503 | 116 | 0.0 | - | 1.076 | 212 | 4.7 | - | 3.063 | 24 | - | - |
| **1982** | 2.577 | 97 | 0.0 | - | 0.932 | 117 | 2.6 | - | 2.232 | 119 | - | - |
| **1983** | 3.699 | 124 | 0.0 | - | 0.908 | 94 | 3.2 | - | 2.845 | 40 | - | - |
| **1984** | 2.432 | 129 | 0.0 | - | 0.932 | 47 | 4.3 | - | 4.116 | 27 | - | - |
| **1985** | 3.450 | 145 | 0.0 | - | 1.569 | 79 | 11.4 | - | 2.982 | 33 | - | - |
| **1986** | 3.224 | 100 | 0.0 | - | 1.344 | 45 | 0.0 | - | 0.924 | 12 | - | - |
| **1987** | 4.961 | 123 | 0.0 | - | 1.985 | 31 | 16.1 | - | 2.213 | 51 | - | - |
| **1988** | 7.271 | 104 | 0.0 | - | 1.775 | 44 | 6.8 | - | 2.359 | 25 | - | - |
| **1989** | 7.322 | 106 | 0.9 | - | 1.530 | 20 | 0.0 | - | 3.557 | 77 | 48.2 | - |
| **1990** | 4.236 | 145 | 0.0 | - | 0.169 | 5 | 0.0 | - | 1.806 | 247 | 27.5 | - |
| **1991** | 6.514 | 108 | 0.0 | - | 1.948 | 2 | 0.0 | - | 1.356 | 333 | 20.7 | - |
| **1992** | 3.787 | 55 | 0.0 | - | 0.070 | 1 | 0.0 | - | 1.650 | 344 | 18.3 | - |
| **1993** | 1.298 | 119 | 0.0 | - | 1.000 | 1 | 0.0 | - | 1.385 | 275 | 22.1 | - |
| **1994** | 1.375 | 215 | 0.0 | - | - | 0 | - | - | 1.508 | 181 | - | - |
| **1995** | 1.064 | 188 | 0.0 | - | - | 0 | - | - | 0.946 | 136 | - | - |
| **1996** | 0.677 | 578 | 0.0 | - | - | 0 | - | - | 0.865 | 197 | - | - |
| **1997** | 0.824 | 128 | 0.0 | - | - | 0 | - | - | 0.770 | 153 | - | - |
| **1998** | 1.488 | 48 | 0.0 | - | - | 0 | - | - | 0.999 | 208 | - | - |
| **1999** | 0.488 | 86 | 0.0 | - | - | 0 | - | - | 0.874 | 180 | - | - |
| **2000** | 0.755 | 95 | 0.0 | - | - | 0 | - | - | - | 0 | - | - |
| **2001** | 0.663 | 113 | 0.0 | - | - | 0 | - | - | - | 0 | - | - |
| **2002** | 0.949 | 64 | 0.0 | - | - | 0 | - | - | - | 0 | - | - |
| **2003** | 0.674 | 88 | 0.0 | - | - | 0 | - | - | - | 0 | - | - |

- indicates incalculable field. PEL - permissible exposure limit REL - recommended exposure limit GM - geometric mean $mg/m^3$ - milligrams per cubic meter $\mu g/m^3$ - micrograms per cubic meter mppcf - millions of particles per cubic foot MSHA - Mine Safety and Health Administration OSHA - Occupational Safety and Health Administration

NOTE: Pneumoconiotic agents with at least 300 total samples in MSHA or OSHA for the time period 1979-2003 are presented. From March 1, 1989 to March 22, 1993, the OSHA PELs in force differed from those employed before and after those dates. NIOSH has designated beryllium and titanium dioxide as potential occupational carcinogens, and recommends reducing exposures to as low as feasible. The % > REL cannot be calculated for talc because the REL is in units of $mg/m^3$, but MSHA samples and analyzes for talc using units of millions of particles per cubic foot (mppcf). For welding fumes - OSHA, the % > PEL is based on fewer samples than the number reported for the years 1989 and 1993 because OSHA adopted a PEL for welding fumes that was enforced from March 1, 1989 through March 22, 1993. Samples collected in 1989 before March 1, or in 1993 after March 23 are not compared to a PEL. See appendices for source description, methods, and agents.

SOURCE: MSHA metal/nonmetal mine data. OSHA Integrated Management Information System.