

COME L'URANIO SI SOSPENDE E DISPENDE NELL'ARIA A CAUSA DEL VENTO -UN DOCUMENTO STRAORDINARIO PER I LETTORI DELL'OSSERVATORIO MILITARE

Di Leonard A. Dietz - 19 Febbraio 1993 (l'Uomo Ombra dell'Uranio Impoverito)Questo STRAORDINARIO documento era stato pubblicato su internet ma è sparito!Ci riproviamo ancora con l'OSSERVATORIO MILITARE perché per "qualcuno" questo testo è una vera e propria complicazione e a noi, certa gente piace vederla davvero imbarazzata!Questo scottante ed incredibile documento - introvabile -, è estremamente importante per capire quanto vasta può essere l'area interessata dai fenomeni di dispersione di Uranio nell'atmosfera. Basta ingerirne o respirarne una (1) sola particella per essere a rischio-tumore per tutta la vita.

How Micrometer-Size Uranium Particles Can Become Suspended in Air and Dispersed by Wind

Leonard A. Dietz , February 19, 1993

Stokes's law for a sphere falling freely under gravitational attraction in a viscous medium and the phenomenon of electrostatic attraction are used to explain how wind action can transport minute particles of uranium metal or its oxide great distances from where they originate.

Environmental assessments for sites which process depleted uranium (DU) or test fire DU munitions typically downplay the potential for widespread fallout of DU particles. For example, in one such environmental impact study [1], the following statement is made: 'Because of the mass and density of the DU particle, it only travels short distances when airborne. These two factors alone preclude the off-site release of DU.' This statement is untrue for μm -size ($1 \mu\text{m} = 1 \times 10^{-6}$ meter) particles of uranium metal or its oxide.

In **1979** the author worked at the Knolls Atomic Power Laboratory in Schenectady, NY. He and his colleagues in the mass spectrometer component discovered DU aerosols collected in environmental air filters exposed at the Knolls site, including four particles identified isotopically as DU [2]. A local newspaper [3] reported that NL Industries (National Lead Co.) was fabricating DU penetrators for 30 mm cannon rounds at their plant 10 miles east of the Knolls site. Depleted uranium also was measured in air filters exposed at a site 26 miles north-west of the NL plant. Unrelated to the discover of DU in air filters, in 1980 NY State forced NL to close, because they exceeded a state radioactivity limit of 150 microcuries (approximately 387 grams of DU) for airborne emissions in a given month [4].

Four DU particles in the size range of approximately 4-6 μm ($2.5 \mu\text{m} = 0.0001$ inch

[0,00025 cm]) were extracted from air filters and were analyzed separately for their uranium isotopic content. All four particles contained pure depleted uranium. Three of the particles were irregularly shaped, the fourth was a 3.8- μm diameter sphere. Its spherical shape indicates that it had solidified from a molten state. Because uranium metal is pyrophoric, at its melting temperature the uranium would have become oxidized and then solidified as an uranium oxide particle, UO_2 . The density of uranium metal is 19 g/cm^3 (grams per cubic centimeter); for UO_2 it is 11 g/cm^3 , which is equal to the density of lead. How can uranium particles with the density of lead or greater remain airborne long enough to be transported by wind at distance of 10 miles or more?

Just as a parachute jumper in a free fall through the lower atmosphere quickly reaches a constant terminal velocity of approximately 120 miles per hour, so too a μm size uranium particle falling under gravitational attraction through still air will reach a constant terminal velocity that is determined by its size, density, geometrical shape and air viscosity. Stokes's law [4] allows one to calculate the terminal velocity of a micro-sphere of uranium metal or uranium oxide of known radius and density falling through air. It is given by the expression

$V_s = \frac{2}{9} \frac{G (R_s)^2 (D_s - D_m)}{C_v}$, where
 R_s is the radius of the sphere, D_s and D_m are the densities of the sphere and medium respectively, and C_v is the coefficient of viscosity. The terminal velocity V_s will be in cm/sec (centimeters per second) if G is in cm/sec^2 , R_s is in cm , D_s and D_m are in g/cm^3 and C_v is in poises.

According to Gofman [5], a 5 μm uranium particle is approximately the largest that can become trapped permanently in lung tissue. Constant bombardment of lung tissue within the short range (about 33- μm in water) of alpha particles emitted from this size DU particle can produce a very high yearly radiation dose to this tissue - a radioactive hot spot in the lung. For a 5- μm diameter UO_2 sphere we have

$G = 980.4 \text{ cm}/\text{sec}^2$ is the acceleration due to gravity;

$R_s = 2.5 \times 10^{-4} \text{ cm}$ is the radius of the 5 μm uranium oxide sphere;

$D_s = 11 \text{ g}/\text{cm}^3$ is the density of UO_2 ;

$D_m = 0.001213 \text{ g/cm}^3$ is the density of air at 1 atmosphere and 18°C ;

$C_v = 1.827 \times 10^4$ poise is the viscosity of air at 1 atmosphere and 18°C

Substituting these values into the expression for Stokes's law gives the calculated terminal velocity V_s of a $5\text{-}\mu\text{m}$ diameter UO_2 sphere as $V_s = 0.82 \text{ cm/sec}$; in still air it will fall approximately 97 feet in one hour [29,58 m]. A $5\text{-}\mu\text{m}$ diameter sphere of uranium metal falls at 1.42 cm/sec in air, or approximately 168 feet in one hour [51,24 m]

Stokes's law is valid for fluid flow described by a Reynolds number Re for a sphere is given by

$$Re = 2R_s D_m V_s / C_v$$

where the terms are defined above. For a $5\text{-}\mu\text{m}$ diameter uranium metal sphere falling at 1.42 cm/sec in air, $Re = 0.0047$. This value is much less than the upper limit of 0.1, below which Stokes's law is accurate.

Exhaust air from a DU processing plant is warmer than ambient outside air and it can raise rapidly several hundred feet above the exhaust stacks.

From Stokes's law, the $3.8 \mu\text{m}$ diameter UO_2 sphere collected at the Knolls site had a terminal velocity of 0.47 cm/sec , or 56 feet/hour. It had to reach a height of only 200 feet [61 m] above the NL Industries plant for a gentle breeze averaging 3 miles per hour toward the west to carry it 10 miles to the Knolls site. Because irregularly shaped particles are not streamlined like spheres, they have substantially lower terminal velocities than spheres of equivalent size and density and will remain airborne longer and travel farther.

A second and even more effective natural phenomenon can greatly extend the dispersed range of uranium oxide particles. It is the electrostatic attraction between dust particles and UO_2 particles. Both can become electrically charged by frictional forces generated by air turbulence. In addition, a UO_2 particle can become highly charged when an alpha particle from its interior passes through its surface. It is well known that a high velocity ion striking a metal oxide surface can dislodge 10 or more secondary electrons from the surface [7]. An alpha particle is a high velocity helium ion, and it will generate a large number of secondary electrons below the surface of an uranium oxide particle as it passes through the surface. Many of the momentarily free electrons

just below the surface will escape from the particle, leaving it in a positively charged state. Like an electrostatic precipitator collecting dust in a room, a charged UO₂ particle and an oppositely charged dust particle will attract each other and join together.

From then on they move as a single particle. Depending on the mass and density of the dust particle, the average density of both particles joined together may be only 3-4 grams per cubic centimeter. In the case, the rate of fall of the UO₂ particle is reduced to less than a third of its former rate and its fallout range is more than tripled.

The preceding discussion explains how μm -size uranium metal and uranium oxide particles can be dispersed great distances by the wind. In Kuwait, soot from the large oil fires there probably aided dispersal of depleted uranium particles throughout the entire Persian Gulf region.

[1] 'Environmental Assessment for the Depleted Uranium Testing Program at the Nevada Test Site by the United States Army Ballistic Research Laboratory', US Dept. of Energy, Nevada Field Office, Las Vegas, Nevada. Report No NV-89-06, March 1992, page 12.

[2] L.A. Dietz, CHEM-434 LAD, 'Investigation of Excess Alpha Activity Observed in Recent Air Filter Collections and Other Environmental Samples', Jan 24, 1980, unclassified technical report, Knolls Atomic Power Laboratory, Schenectady, NY 12301; obtained under the Freedom of Information Act. Copies available upon request from Ms Cathy Hinds, Director, Military Toxics Project, P.O. Box 845, Sabattus, ME 04280, or from Ms. Grace Bukowski, Citizen Alert, P.O. Box 5339, Reno, NV 89513.

[3] Schenectady Gazette newspaper: 'Colonie Uranium Plant Closes as Radiation Continues Unchecked', February 6, 1980.

[4] B. S. Massey, Mechanics of Fluids, 6th Ed., Van Nostrand Reinhold (International), page 172, 1989.

[5] J. W. Gofman, Radiation and human Health, Sierra Club Books, San Francisco 1981, page 489.

[6] R. W. Fox and A. T. McDonald, Introduction to Fluid Mechanics, 4th Ed. Wiley, New York, page 444 (1992)

[7] L. A. Dietz and J. C. Sheffield, 'Secondary electron emission induced by 5-30 KeV monatomic ions striking thin oxide films', Journal of Applied Physics, Vol. 46, No 10, October 1975, page 4361.

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