

# **Properties of Depleted Uranium**

**Presentation by**

**Thomas B. Cochran**

**Natural Resources Defense Council**

**At the**

**Symposium on the**

**Health Effects of Depleted Uranium Munitions**

**New York**

**June 14, 2003**

# Density of Selected Materials

<b>Material</b>	<b>Density</b>
<b>_____</b>	<b><u>(g/cc)</u></b>
<b>Water</b>	<b>1</b>
<b>Steel</b>	<b>7.8</b>
<b>UO<sub>2</sub></b>	<b>10.96</b>
<b>Lead</b>	<b>11.35</b>
<b>DU</b>	<b>18.95</b>
<b>Tungsten</b>	<b>19.3</b>

# Uranium is Pyrophoric

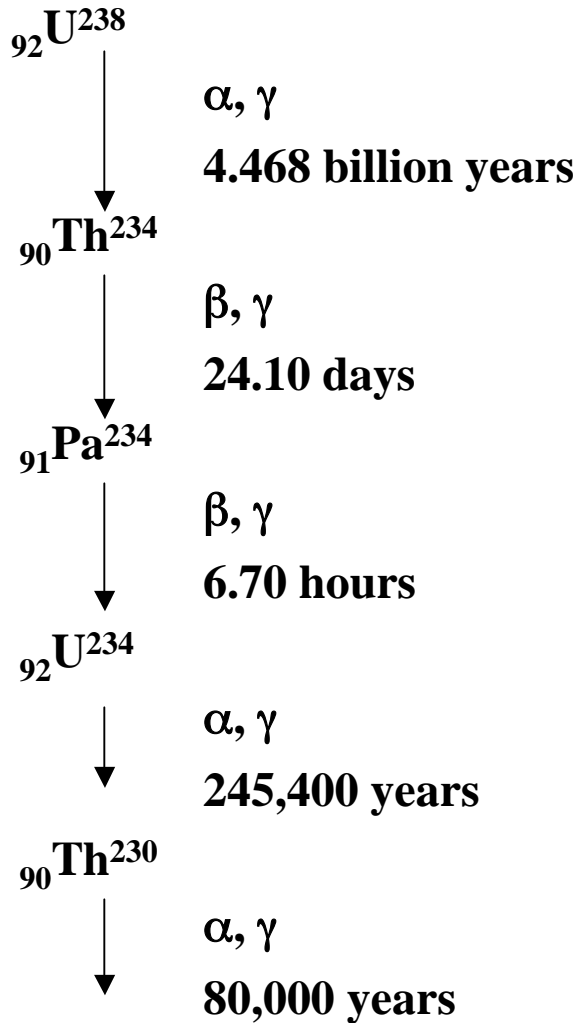
**As it penetrates armor DU flakes off particles, i.e., powder and aerosols, that ignite spontaneously (oxidize) when sufficient oxygen is present. Oxides of DU include  $\text{UO}_2$ ,  $\text{UO}_3$ , and  $\text{U}_3\text{O}_8$ .**

# Isotopic Abundance of Uranium

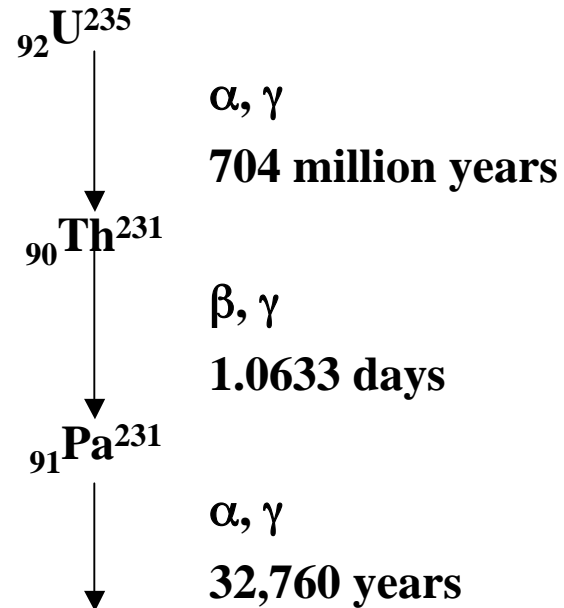
(weight percent)

Isotope	<u>Uranium</u>	
	<u>Natural</u>	<u>Depleted</u>
U-238	99.2836	99.98
U-235	0.711	0.2-0.3
U-234	0.0054	0.001-0.002

# Radioactive Decay



decay chain  
continues



decay chain  
continues

**U:** uranium  
**Th:** thorium  
**Pa:** protactinium  
**Subscript:** protons  
**Superscript:**  
 protons+neutrons

# Uranium Radioactivity

<u>Isotope</u>	<u>Half-life</u>	<u>Specific Activity (Ci/g)</u>	
U-238	4.5 billion years	$\alpha, \gamma$	0.000000336
U-235	704 million years	$\alpha, \gamma$	0.00000216
U-234	245 400 years	$\alpha, \gamma$	0.00622
<u>At equilibrium</u>		<u>(Ci/g U)</u>	
Th-231	25.52 hours	$\beta, \gamma$	same as U-235
Th-234	24.10 days	$\beta, \gamma$	same as U-238
Pa-234	6.70 hours	$\beta, \gamma$	same as U-238
Compared to:			
Cs-137	30 years	$\beta, \gamma$	87.0 Ci/g
Ba-137m	same	$\beta, \gamma$	same as Cs-137

# **Radiation from Depleted Uranium**

**(0.3 wt.% U-235)**

## **Activity (disintegrations/sec-kg)**

**89.4 % due to U-238 (including Th-234 and Pa-234)**

**1.2 % due to U-235 (including Th-231)**

**9.5 % due to U-234**

## **Energy released (MeV/sec-kg)**

**75.9 % due to U-238 (including Th-234 and Pa-234)**

**1.3 % due to U-235 (including Th-231)**

**22.7 % due to U-234**

## **Energy released (MeV/sec-kg)**

**86.7 % due to alpha ( $\alpha$ )**

**12.9 % due to beta ( $\beta$ )**

**0.4 % due to gamma ( $\gamma$ )**

# Transuranic and Fission Product Contamination

Enrichment plant uranium feed was contaminated with neptunium-237, plutonium-239, technetium 99, and other fission products due to recycling uranium recovered at chemical separation facilities by processing production reactor spent nuclear fuel and targets.

<u>Isotope</u>	<u>Half-life</u>	<u>Specific Activity (Ci/g)</u>	
Np-237	2.14 million years	$\alpha, \gamma$	0.000705
Pu-239	24,110 years	$\alpha, \gamma$	0.06204
Te-99	213,000 years	$\beta$	0.0170

Np-237 concentration was about 0.1 gram per ton of  $\text{UO}_3$ .

These contaminants do not concentrate in the DU and do not appear to be of concern beyond the enrichment plants.



# External Radiation Dose at Surface of Uranium Metal

## Radiation Type

**Alpha**                      **does not penetrate the skin**

**Beta**                         **230 mrem/hour (Nat U)**

**Gamma**                      **~20 mrem/hour**

**(includes bremsstrahlung-photons emitted due to the slowing down of the  $\alpha$ s and  $\beta$ s)**

**Beta and gamma dose fall off rapidly with distance from the source.**

# Inhalation

## Dose Conversion Factors

**Adult intake of Class Y compounds of uranium—uranium in the form of an insoluble compound, e.g., UO<sub>2</sub>—resulting in a committed dose equivalent of 5 mrem:**

	<b>Inhalation Intake</b>	
	<u>(pCi)</u>	
<b>U-234, -235, -238</b>	<b>40</b>	
<b>Th-231</b>	<b>5,700,000</b>	
<b>Th-234</b>	<b>140,000</b>	
<b>Pa-234</b>	<b>6,100,000</b>	
<b>UO<sub>2</sub> Particle diameter</b>		
<u>(microns)</u>	<u>Particles/5 mrem</u>	<u>Bq/5mrem</u>
<b>1</b>	<b>18,000,000</b>	<b>3.8</b>
<b>2</b>	<b>2,300,000</b>	<b>3.8</b>
<b>5</b>	<b>145,000</b>	<b>3.8</b>

# Good Source of DU Data

**[http://www.gulflink.osd.mil/du\\_ii/index.htm](http://www.gulflink.osd.mil/du_ii/index.htm)**