Maywood Chemical Company Superfund Site

ADMINISTRATIVE RECORD

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Radiation is a natural part of our environment. When our planet was formed, radiation was present—and radiation surrounds it still. Natural radiation showers down from the distant reaches of the cosmos and continuously radiates from the rocks, soil, and water on the Earth itself.

During the last century, mankind has discovered radiation, how to use it, and how to control it. As a result, some manmade radiation has been added to the natural amounts present in our environment.

Many materials—both natural and manmade—that we come into contact with in our everyday lives are radioactive. These materials are composed of atoms that release energetic particles or waves as they change into more stable forms. These particles and waves are referred to as radiation, and their emission as radioactivity.

As the chart on the left shows, most environmental radiation (82%) is from natural sources. By far the largest source is radon, an odorless, colorless gas given off by natural radium in the Earth's crust. While radon has always been present in the environment, its significance is better understood today. Manmade radiation—mostly from medical uses and consumer products—adds about eighteen percent to our total exposure.

**TYPES OF IONIZING RADIATION**

Radiation that has enough energy to disturb the electrical balance in the atoms of substances it passes through is called ionizing radiation. There are three basic forms of ionizing radiation.

**Alpha**

Alpha particles are the largest and slowest moving type of radiation. They are easily stopped by a sheet of paper or the skin. Alpha particles can move through the air only a few inches before being stopped by air molecules. However, alpha radiation is dangerous to sensitive tissue inside the body.

**Beta**

Beta particles are much smaller and faster moving than alpha particles. Beta particles pass through paper and can travel in the air for about 10 feet. However, they can be stopped by thin shielding such as a sheet of aluminum foil.

**Gamma**

Gamma radiation is a type of electromagnetic wave that travels at the speed of light. It takes a thick shield of steel, lead, or concrete to stop gamma rays. X rays and cosmic rays are similar to gamma radiation. X rays are produced by manmade devices; cosmic rays reach Earth from outer space.
Units of Measure

Radiation can be measured in a variety of ways. Typically, units of measure show either 1) the total amount of radioactivity present in a substance, or 2) the level of radiation being given off.

The radioactivity of a substance is measured in terms of the number of transformations (changes into more stable forms) per unit of time. The curie is the standard unit for this measurement and is based on the amount of radioactivity contained in 1 gram of radium. Numerically, 1 curie is equal to 3.7 billion transformations per second. The amounts of radioactivity that people normally work with are in the millicurie (one-thousandth of a curie) or microcurie (one-millionth of a curie) range. Levels of radioactivity in the environment are in the picocurie, or pCi (one-trillionth of a curie) range.

Cosmic Radiation

Cosmic radiation is high-energy gamma radiation that originates in outer space and enters our atmosphere. Cosmic radiation is measured in millicuries/hour or microcuries/liter.

- Sea Level.......................... 26 mrem/year
- Atlanta, Georgia (1,050 feet)........................................... 3 mrem/year
- Denver, Colorado (5,280 feet)........................................ 50 mrem/year
- Minneapolis, Minnesota (315 feet)................................. 30 mrem/year
- Salt Lake City, Utah (4,400 feet).................................... 46 mrem/year

Terrestrial Radiation

Terrestrial sources are naturally radioactive elements in the soil and water such as uranium, radium, and thorium. Average levels of these elements are 1 pCi/g of soil.

- United States (average)....26 mrem/year
- Denver, Colorado....63 mrem/year
- Niter Delta, Egypt.....350 mrem/year
- Paris, France.............350 mrem/year
- Coast of Kwaia, India.....400 mrem/year
- McAlpine, Brazil.........2,558 mrem/year
- Pecos De Caldas, Brazil...7,000 mrem/year

Buildings

Many building materials, especially granite, contain naturally radioactive elements.

- U.S. Capitol Building.........85 mrem/year
- Base of Statue of Liberty.....325 mrem/year
- Grand Central Station.........525 mrem/year
- The Vatican.........................800 mrem/year

Radon levels in buildings vary, depending on geographic location, from 0.1 to 200 pCi/liter. Average indoor radon level is 1.5 pCi/liter.

Occupational Working Limit.....100 pCi/liter

Radiation in the Environment

Because the radioactivity of individual samples varies, the numbers given here are approximate or represent an average. They are shown to provide a perspective for concentrations and levels of radioactivity rather than dose.

<table>
<thead>
<tr>
<th>mrem</th>
<th>pCi = picocurie</th>
</tr>
</thead>
</table>

Consumer Goods

- Cigarettes-two packs/day (potassium-40)........6,000 mrem/year
- Color Television....1 mrem/year
- Gas Lantern Mantle (thorium-232)........2 mrem/year
- Highway Construction........4 mrem/year
- Airplane Travel at 39,000 feet (cosmic).........0.5 mrem/day
- Natural Gas Heating and Cooking (radon-222)....2 mrem/year
- Propane Fertilizers........4 mrem/year

Natural Radioactivity in Florida Phosphate Fertilizers (in pCi/g)

<table>
<thead>
<tr>
<th>Np-236</th>
<th>Np-237</th>
<th>Cesium-137</th>
</tr>
</thead>
<tbody>
<tr>
<td>21.3</td>
<td>21.0</td>
<td>33.0</td>
</tr>
<tr>
<td>23.0</td>
<td>58.0</td>
<td>6.0</td>
</tr>
<tr>
<td>16.9</td>
<td>48.0</td>
<td>13.0</td>
</tr>
<tr>
<td>0.6</td>
<td>1.3</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Parachute Tents (uranium)........1,500 mrem/year
- Radium Inertizing Clock (radium-226)........1 mrem/year
- Smoke Detector (amuminum-241)........0.01 mrem/year

International Nuclear Weapons Test Fallout from pre-1980 atmospheric tests

| Average for a U.S. citizen | 1 mrem/year |

References


The curie is a standard measure for the intensity of radioactivity contained in a sample of radioactive material. It was named after French scientists Marie and Pierre Curie for their landmark research into the nature of radioactivity.

The basis for the curie is the radioactivity of one gram of radium. Radium decays at a rate of about 2.2 trillion disintegrations ($2.2 \times 10^{12}$) per minute. A picocurie is one trillionth of a curie. Thus, a picocurie represents 2.2 disintegrations per minute.

To put the relative size of one trillionth into perspective, consider that if the Earth were reduced to one trillionth of its diameter, the "pico earth" would be smaller in diameter than a speck of dust. In fact, it would be six times smaller than the thickness of a human hair.

The difference between the curie and the picocurie is so vast that other metric units are used between them. These are as follows:

- **1 Millicurie** = $1,000$ (one thousandth) of a curie
- **1 Microcurie** = $1,000,000$ (one millionth) of a curie
- **1 Nanocurie** = $1,000,000,000$ (one billionth) of a curie
- **1 Picocurie** = $1,000,000,000,000$ (one trillionth) of a curie

The following chart shows the relative differences between the units and gives analogies in dollars. It also gives examples of where these various amounts of radioactivity could typically be found. The number of disintegrations per minute has been rounded off for the chart.

<table>
<thead>
<tr>
<th>UNIT OF RADIOACTIVITY</th>
<th>SYMBOL</th>
<th>DISINTEGRATIONS PER MINUTE</th>
<th>DOLLAR ANALOGY</th>
<th>EXAMPLES OF RADIOACTIVE MATERIALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Curie</td>
<td>Ci</td>
<td>$2 \times 10^{12}$ or 2 Trillion</td>
<td>2 Times the Annual Federal Budget</td>
<td>Nuclear Medicine Generator</td>
</tr>
<tr>
<td>1 Millicurie</td>
<td>mCi</td>
<td>$2 \times 10^{9}$ or 2 Billion</td>
<td>Cost of a New Interstate Highway from Atlanta to San Francisco</td>
<td>Amount Used for a Brain or Liver Scan</td>
</tr>
<tr>
<td>1 Microcurie</td>
<td>μCi</td>
<td>$2 \times 10^{6}$ or 2 Million</td>
<td>All-Star Baseball Player's Salary</td>
<td>Amount Used in Thyroid Tests</td>
</tr>
<tr>
<td>1 Nanocurie</td>
<td>nCi</td>
<td>$2 \times 10^{3}$ or 2 Thousand</td>
<td>Annual Home Energy Costs</td>
<td>Consumer Products</td>
</tr>
<tr>
<td>1 Picocurie</td>
<td>pCi</td>
<td>2</td>
<td>Cost of a Hamburger and Coke</td>
<td>Background Environmental Levels</td>
</tr>
</tbody>
</table>

Chart provided by W.L. Beck, Bechtel National, Inc.
## Comparison of 1992 Results to DOE Guidelines

### Maywood Interim Storage Site

<table>
<thead>
<tr>
<th></th>
<th><strong>DOE Guidelines</strong></th>
<th><strong>1992 Results</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Radon in Air</td>
<td>3.0 pCi/L</td>
<td>&lt;0.4 pCi/L</td>
</tr>
<tr>
<td>Thoron in Air</td>
<td>3.0 pCi/L</td>
<td>1.4 pCi/L</td>
</tr>
<tr>
<td>External Gamma Radiation</td>
<td>100 mrem/yr.</td>
<td>0.6 mrem/yr.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th><strong>Groundwater</strong></th>
<th><strong>Surface Water</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Thorium-232 in Water</td>
<td>50 pCi/L</td>
<td>1.5 pCi/L</td>
</tr>
<tr>
<td>Total Uranium in Water</td>
<td>600 pCi/L</td>
<td>3.3 pCi/L</td>
</tr>
<tr>
<td>Radium-226 in Water</td>
<td>100 pCi/L</td>
<td>0.5 pCi/L</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th><strong>Sediments</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Thorium-232 in Surface Soils</td>
<td>5 pCi/g</td>
</tr>
<tr>
<td>Radium-226 in Surface Soils</td>
<td>5 pCi/g</td>
</tr>
</tbody>
</table>

1.0 pCi/g

0.5 pCi/g
Surface Water and Sediment Sampling Location

Background Radon/Thoron and External Gamma Radiation Monitoring Location

Scale
0 300 600 Feet
0 90 180 Meters

Note: Radon/Thoron and External Gamma Radiation Monitoring Location 14 is at the Public Health Building in Paterson, NJ, between Van Houten St. and Broadway Ave., 5.5 miles west of Miss.

Offsite Radon/Thoron, External Gamma Radiation, Surface Water, and Sediment Monitoring Locations in the Miss Area