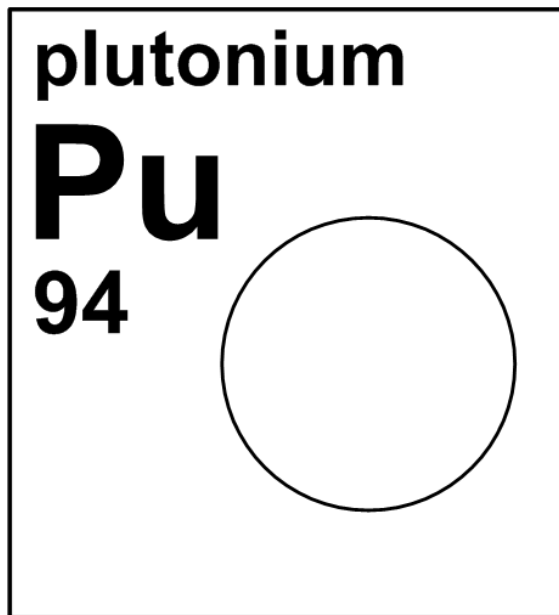





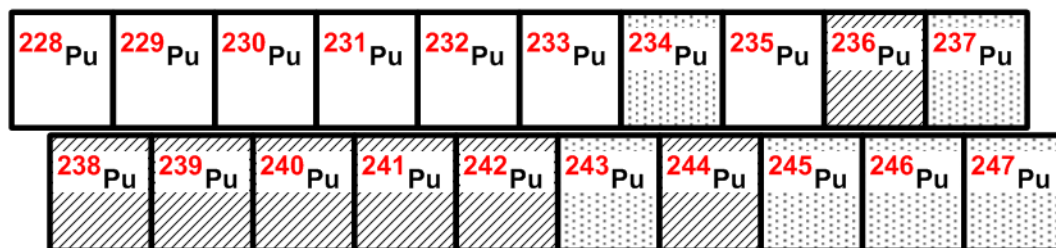
4.94 plutonium



Stable isotope	Relative atomic mass	Mole fraction
(none)		

Half-life of radioactive isotope

Less than 1 hour 
 Between 1 hour and 1 year 
 Greater than 1 year 



4.94.1 Plutonium isotopes in industry

^{238}Pu (with a **half-life** of 87.7 years) is used in radiothermal generators as a heat source to produce electricity. These radiothermal generators are used to power unmanned spacecraft and interplanetary probes that venture too far from the Sun to use solar power, such as the Cassini Orbiter, the Galileo spacecraft, and the Huygens and Galileo probes [72, 603-605]. ^{238}Pu has been used in the Apollo lunar missions as part of a **nuclear battery**. The SNAP-27 (systems nuclear auxiliary power) system produced approximately 75 W of electrical power at 30 VDC per unit (Figure 4.94.1). The energy source was a 2.5-kg rod of ^{238}Pu providing thermal power of approximately 1250 W [606]. ^{238}Pu is used in pacemakers (Figure 4.94.2).

^{239}Pu (with a half-life of 2.41×10^4 years) is used in nuclear weapons. ^{239}Pu is easily made in nuclear reactors by bombarding ^{238}U with **neutrons**. The ^{239}Pu made by this reaction can itself be split by neutrons to release energy and is used for energy generation in nuclear reactors [72, 607, 608].

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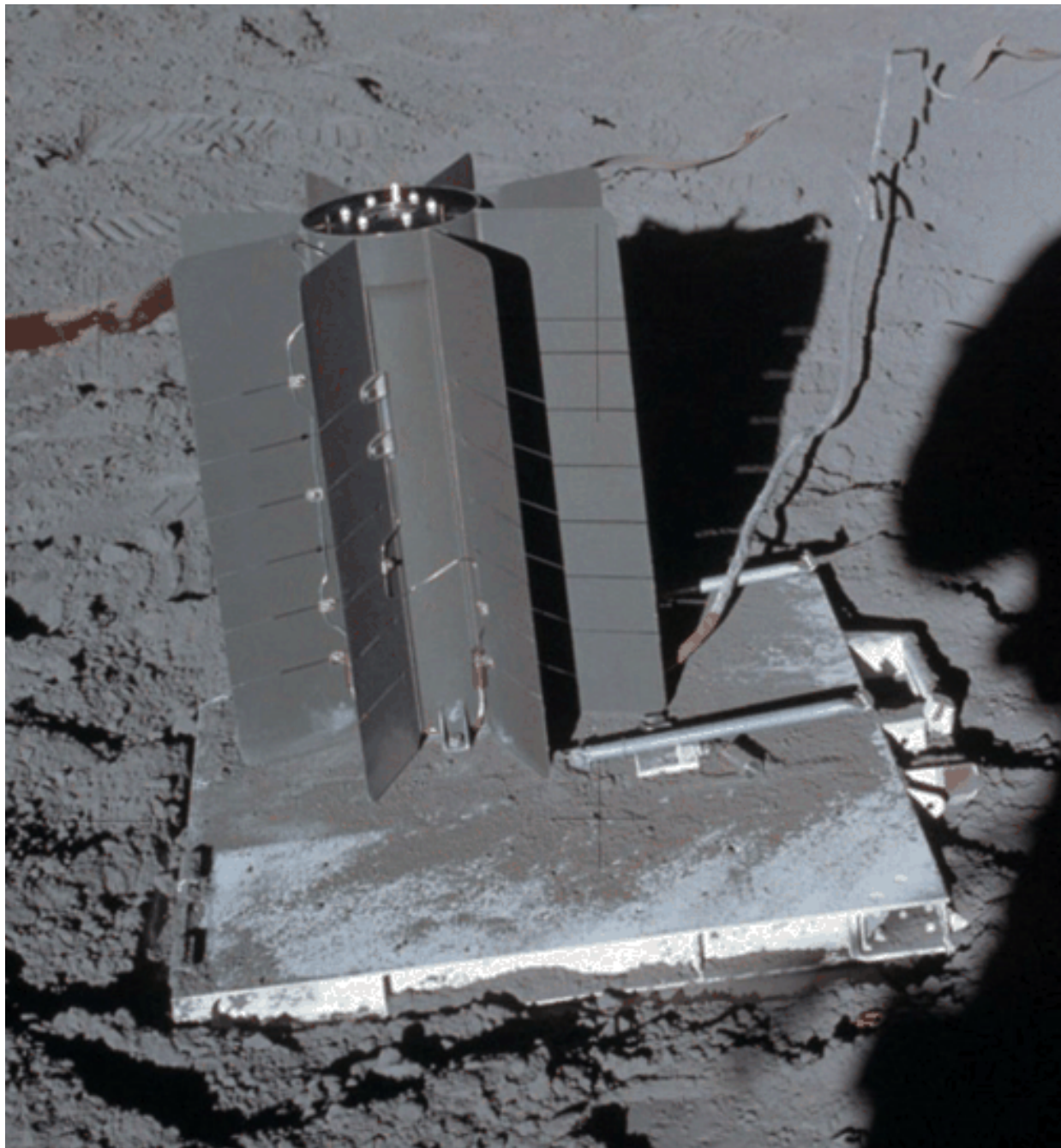


Fig. 4.94.1: ^{238}Pu is used in the SNAP-27 radiothermal generator as a heat source to produce electricity to power spacecrafts, such as for Apollo missions 12, 14, 15, 16, and 17. (Image source: NASA)[609].

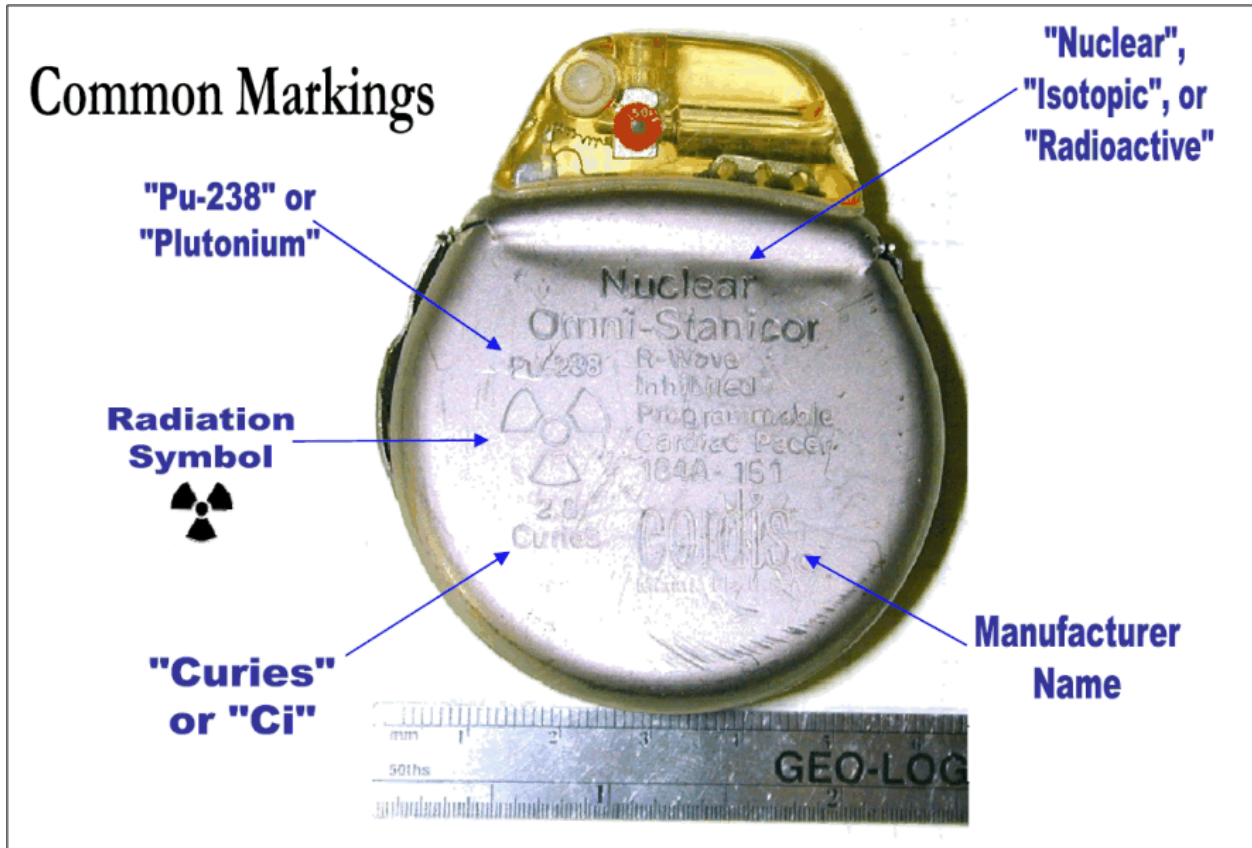


Fig. 4.94.2: ^{238}Pu is used in cardiac pacemakers, and they should be disposed of properly upon removal (modified from [610]).