Iridium

Symbol:	**Ir**
Atomic Number: *(protons in nucleus)*	**77**
Atomic Weight: *(naturally occurring)*	**192**

What Is It? Iridium is a silvery white metal named after the Latin word for rainbow because its salts are highly colored. Iridium is hard and brittle with low ductility, which makes it very difficult to machine and form. It is quite dense, about twice as dense as lead, and occurs in nature as two stable isotopes. (Isotopes are different forms of an element that have the same number of protons in the nucleus but a different number of neutrons.) Iridium-193 is the most prevalent form, comprising about 63% of natural iridium, with iridium-191 accounting for the rest.

Radioactive Properties of Key Iridium Isotopes

Isotope	Half-Life	Specific Activity *(Ci/g)*	Decay Mode	Radiation Energy *(MeV)*		
				Alpha (α)	Beta (β)	Gamma (γ)
Ir-192	74 days	9,200	β, EC	-	0.22	0.82
Ir-192m	240 yr	7.8	IT	-	-	0.16
Ir-194m	170 days	4,000	β	-	0.16	2.3

EC = electron capture, IT = isomeric transition, Ci = curie, g = gram, and MeV = million electron volts; a dash means the entry is not applicable. (See the companion fact sheet on Radioactive Properties, Internal Distribution, and Risk Coefficients for an explanation of terms and interpretation of radiation energies.) Iridium-192 decays by two means: emitting a beta particle (95%) and electron capture (5%). Values are given to two significant figures.

Of the 15 major radioactive iridium isotopes, only three have half-lives longer than a month and warrant concern; these are shown in the box at right. The half-lives of the other isotopes are less than 2 weeks. Iridium-192 has a half-life of 74 days, and it decays to stable platinum-192 and osmium-192 by emitting a beta particle and by electron capture; most of these decays (95%) are by beta emission. Iridium-192m (the "m" means metastable) has a half-life of 240 years, and it decays to iridium-192 by isomeric transition and by emitting a relatively low-energy gamma ray. Iridium-194m has a half-life of 170 days, and it decays to stable platinum-194 by emitting a beta particle and several gamma rays. Of these three radioactive isotopes, iridium-192m presents the lowest acute or short-term hazard from external exposures as a result of its relatively low specific activity and gamma radiation; the other two iridium isotopes have high specific activities and significant gamma radiation. Iridium-192 is the isotope of most concern based on general availability; it is used in a number of industrial and medical applications.

Where Does It Come From? Iridium is found uncombined in nature with platinum and other metals in the platinum group, and it can be obtained from platinum ores and as a byproduct of nickel mining. Naturally occurring iridium alloys include osmiridium and iridiosmium, which are mixtures of iridium and osmium. The highest iridium concentration on earth is at its core, and it can be released to the earth's surface in volcanoes. Iridium-192 is produced by neutron activation of iridium metal, usually in nuclear reactors. The strength of an iridium-192 source is related to the amount of neutron irradiation. Natural iridium contains 37% iridium-191, and when this isotope absorbs a neutron it produces iridium-192. Neutron absorption by iridium-193, the other naturally occurring isotope, produces iridium-194. Iridium-194 has a short half-life of 19 hours, and it decays to stable platinum-194 in a few days; very little iridium-192m and iridium-194m are produced in this process.

How Is It Used? Iridium is used as an alloying agent with a number of other metals to produce composites that are extremely hard and have good corrosion resistance. Its principal use is as a hardening agent in platinum alloys. Iridium is used for high-temperature applications, including in crucibles and thermocouples and as electrodes in spark plugs for severe operating conditions, such as those experienced by jet engine igniters. Radioactive iridum-192 is used industrially as a radiotracer in the oil industry and in gamma radiography to identify flaws in metal castings and welded joints. These radiographic sources are constructed of metal discs or pellets in a welded stainless steel capsule, and their activity levels range from less than one curie to several hundred curies.

Iridium-192 is also used medically in brachytherapy to treat various types of cancer. (Brachytherapy is a method of radiation treatment in which sealed sources are used to deliver a radiation dose at a distance of up to a few centimeters by surface, intracavitary, or interstitial application.) Iridium-192 implants are used especially in the head and breast. They are produced in wire form and are introduced through a catheter to the target area. After being left in place for the time required to deliver the desired dose, the implant wire is removed. This procedure is very effective at providing localized radiation to the tumor site while minimizing the patient's whole-body dose.

What's in the Environment? Iridium is naturally present in the earth's crust at a concentration of about 1 microgram per kilogram (µg/kg), or part per billion. In contrast, the concentration of iridium in some meteorites is about 500 µg/kg. A thin layer of iridium exists worldwide in a layer of deep sediment that was put down at the end of the Cretaceous period (roughly 150 million years ago), which is seen as evidence that the earth was struck by a large meteor or asteroid at that time. Dust from that impact would have spread around the globe, depositing iridium. As a very corrosion-resistant metal, iridium is quite insoluble in water. This means the iridium that is present in soil and rock tends to stay in place rather than being mobilized and transported in solution toward groundwater. There is no evidence that the three radioactive isotopes are present in soil around the world. These isotopes are not fission products so they would not exist in radioactive fallout from past atmospheric weapons tests. Only one isotope (iridium-192m) has a half-life longer than a year, and that isotope is not produced in any significant quantities.

What Happens to It in the Body? Iridium can be taken into the body by eating food, drinking water, or breathing air. Gastrointestinal absorption from food or water is the likely source of internally deposited iridium in the general population. After ingestion or inhalation, most iridium is excreted from the body and never enters the bloodstream; only about 1% of the amount taken into the body by ingestion is absorbed into the blood. Twenty percent of the iridium that reaches the blood is excreted right away, 20% deposits in the liver, 4% deposits in the kidney, 2% deposits in the spleen, and the remaining 54% is evenly distributed among other organs and tissues of the body. Of the iridium that deposits in any organ or tissue, 20% leaves the body with a biological half-life of 8 days and 80% clears with a biological half-life of 200 days. On the basis of animal studies, retention of iridium was determined to be the same for all age groups. Most inhaled iridium compounds appear to clear the lungs quite rapidly.

What Are the Primary Health Effects? The three radioactive iridium isotopes pose both an internal and external hazard, and the main health concern is associated with the increased likelihood of cancer. External exposure is a concern because of the strong gamma radiation (especially for iridium-192 and iridium-194m), and shielding is needed to handle iridium-192 radiographic and medical sources. Iridium can concentrate in several organs depending on its chemical form, so while there is no dominant organ of health concern the liver is a main organ of deposition. Inside the body, these iridium isotopes can pose a hazard from both beta and gamma radiation.

What Is the Risk? Lifetime cancer mortality risk coefficients have been calculated for nearly all radionuclides, including iridium *(see box at right)*. While ingestion is generally the most common means for entry into the body, the risk coefficients for that route are lower than for inhalation. Similar to other radionuclides, the risk coefficients for tap water are about 70% of those for dietary ingestion.

In addition to the risks from internal exposures, a risk from external gamma radiation is associated with these iridium isotopes. To estimate the lifetime cancer mortality risk, if it is assumed that 100,000 people were continuously exposed to a thick layer of soil with an initial average concentration of 1 pCi/g iridium-192m, then 10 of these people would be predicted to incur a fatal cancer. (This is in comparison to the 20,000 people from this group predicted to die of cancer from all other causes, per the U.S. average.) While the gamma radiation for iridium-192 and iridium-194m is much greater than for iridium-192m, these radionuclides will decay to very low levels in a few years. Because of this decay, less than one additional cancer fatality is predicted to occur among 100,000 people exposed to soil with an initial concentration of 1 pCi/g of either isotope. However, the respective external gamma radiation risks for acute exposures to iridium-192 and iridium-194m are 6 and 19 times higher than for iridium-192m.

Radiological Risk Coefficients

This table provides selected risk coefficients for inhalation and ingestion. Maximum values are given for inhalation (no default absorption types were provided), and dietary values were used for ingestion. Risks are for lifetime cancer mortality per unit intake (pCi), averaged over all ages and both genders (10^{-9} is a billionth and 10^{-12} is a trillionth). Other values, including for morbidity, are also available.

Isotope	Lifetime Cancer Mortality Risk	
	Inhalation (pCi^{-1})	**Ingestion** (pCi^{-1})
Iridium-192	2.1×10^{-11}	6.0×10^{-12}
Iridium-192m	1.7×10^{-11}	8.7×10^{-13}
Iridium-194m	4.0×10^{-11}	7.3×10^{-12}

For more information, see the companion fact sheet on Radioactive Properties, Internal Distribution, and Risk Coefficients and the accompanying Table 1.