Have there been major accidents at industrial irradiation facilities?

Medical sterilization facilities have been operated in the US for more than 30 years, without a fatal accident. Over 100 such facilities are currently licensed, along with at least that many medical radiation treatment centers, and bone marrow transplant centers (which also use Cobalt 60 to irradiate patients). No events have been documented in this country that led to exposure of the population at large to radioactivity. In other countries, a small number of fatal incidents have been documented in which a worker by-passed multiple safety steps to enter the chamber while the source was exposed, resulting in a severe or even lethal radiation injury to themselves.

Who makes sure that the irradiation facilities are operated safely?

The effectiveness of the treatment in eliminating pathogens will be regulated as a food safety process, by either the USDA or the FDA, often in concert with State authorities, just as is the case now for milk pasteurization or retort canning.

The safety of operations of irradiation facilities is regulated separately. This requires extensive worker training, supervision, and regulatory oversight. Facilities using radioactive sources are regulated by the Nuclear Regulatory Commission (NRC). To be licensed, the facility must have been designed with multiple fail-safe measures, and must establish extensive and well documented safety procedures, and worker training. The safe transport of the radioactive sources is regulated by the Department of Transportation.

Can an accident at a irradiation facility lead to a "meltdown" with release of radioactivity that would contaminate the environment and endanger people living nearby?

No. It is impossible for a "meltdown" to occur in a gamma irradiator or for the radiation source to explode. The source of radiation used at irradiators cannot start a fission chain reaction, and it does not emit neutrons that could activate materials. The walls of the irradiation cell through which the food passes, the machinery inside the cell, and the product being processed cannot become radioactive. No radioactivity is released into the environment.

Do irradiation facilities have radioactive waste disposal problems?

No. The food irradiation facilities themselves do not become radioactive, and do not create radioactive waste. Cobalt 60 is manufactured in a commercial nuclear reactor, by exposing non-radioactive cobalt to intense radiation in the reactor core. The cobalt sources used in irradiation facilities decay by 50% in five years, and therefore require periodic replacement. The sources are removed from the irradiator when the radioactivity falls to a low level, usually between 6% and 12% of the initial level (this takes 16 to 21 years for cobalt-60). The small radioactive cobalt "pencils" are shipped back to the original nuclear reactor, where they can be re-activated for further use. The shipment occurs in special hardened steel canisters that have been designed and tested to survive crashes without breaking. Cobalt is a solid metal, and even if somehow something should break, it will not spread through the environment. Cobalt 60 may also be disposed of as a radioactive waste. Given its relatively short half life (5 years) and its stable metallic form, the material is not considered to be a problematic waste.

E-beams and X-ray facilities do not involve radioactive substances.

This brochure has been prepared by the **UW Food Irradiation Education Group,** based on the information provided by:

http://www.iaea.org/worldatom/inforesource/other/food/
http://www.cdc.gov/ncidod/dbmd/diseaseinfo/foodirradiation.htm
http://www.food-irradiation.com/
http://www.fda.gov/

For more information:

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UW Food Irradiation Education Group

The Food Irradiation Process

What is Food Irradiation?

Food irradiation is a promising new food safety technology that can eliminate disease-causing microorganisms such as E. coli O157:H7, Campylobacter, and Salmonella from foods.

The Food and Drug Administration has approved irradiation of meat and poultry and allows its use for a variety of other foods, including fresh fruits and vegetables, and spices. The agency determined that the process is safe and effective in decreasing or eliminating harmful bacteria. Irradiation also reduces spoilage bacteria, insects and parasites, and in certain fruits and vegetables it inhibits sprouting and delays ripening.

The effects of irradiation on the food and on animals and people eating irradiated food have been studied extensively for more than 40 years. These studies show clearly that when irradiation is used as approved on foods:

- Disease-causing microorganisms are reduced or eliminated
- The nutritional value is essentially unchanged
- The food does not become radioactive

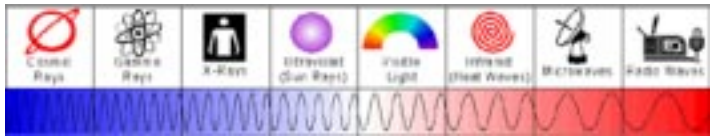
Irradiation is a safe and effective technology that can prevent many foodborne diseases.

The Food irradiation process

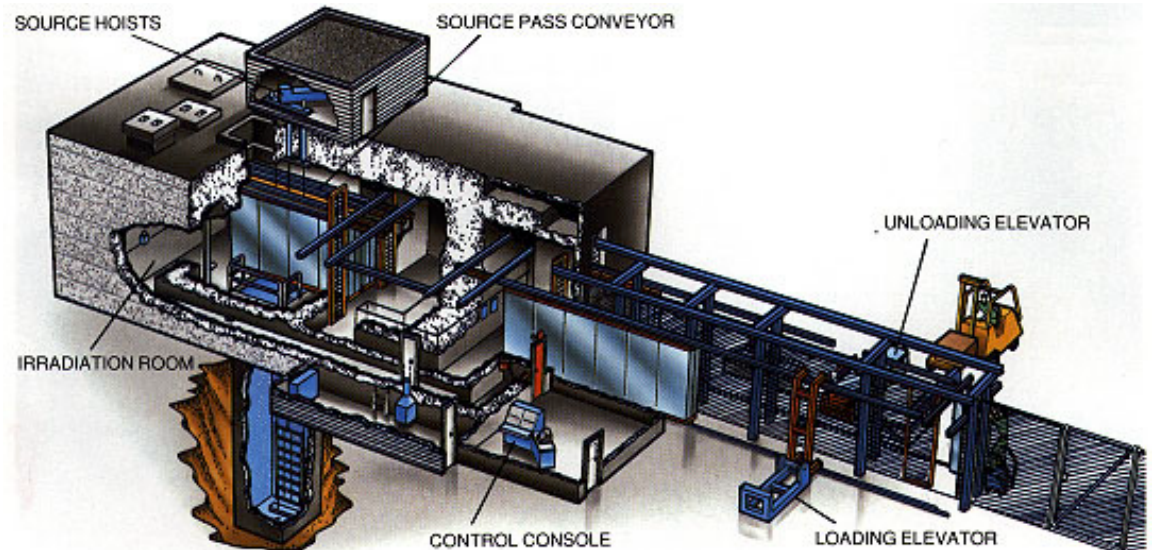
The radiation used in processing materials is limited to radiation from high-energy gamma rays, X-rays and accelerated electrons. These types of radiation are called “ionizing” because their energy is high enough to dislodge electrons from atoms and molecules and to convert them to electrically charged particles called ions.

- **Accelerated electrons:** The electron beam is a stream of high energy electrons, propelled out of an electron gun. This electron gun apparatus is a larger version of a standard television tube. The electron beam generator can be simply switched on or off. There are no radioactive materials in the process. The electrons can penetrate food only to a depth of three centimeters, or a little over an inch, so the food to be treated must be no thicker than that to be treated all the way through. Two opposing beams can treat food that is twice as thick. E-beam medical sterilizers have been in use for at least fifteen years.

- **Gamma rays and X-rays** form part of the electromagnetic spectrum, like radio waves, microwaves, ultraviolet and visible light rays. Gamma rays and X-rays are in the short wave length, high-energy region of the spectrum. Both Gamma and X-rays can penetrate foods to a depth of several feet.



➢ **X-rays** are caused by atomic transitions and they are usually less energetic than gamma rays. They have the same properties and effects on materials, their origin being the main difference between them. X-rays with varying energies are generated by machines. The X-ray machine is a more powerful version of the machines used in many hospitals and dental offices to take X-ray pictures. To produce the X-rays, a beam of electrons is directed at a thin plate of gold or other metal, producing a stream of X-rays. Like gamma rays, X-rays can pass through thick foods, and require heavy shielding for safety. However, like E-beams, the machine can be switched on and off, and no radioactive substances are involved. Four commercial X-ray irradiation units have been built throughout the world since 1996.



A typical gamma irradiation facitity: JS-8900 Unit Carrier Irradiation

➢ **Gamma rays** with specific energies normally come from the spontaneous disintegration of radionuclides. Naturally occurring and man-made radionuclides, also called radioactive isotopes or radioisotopes, are unstable, and emit radiation as they spontaneously disintegrate, or decay, to a stable state. The radionuclide used almost always for the irradiation of food by gamma rays is cobalt-60. It is produced by neutron bombardment in a nuclear reactor of the metal cobalt-59, then doubly encapsulated in stainless steel “pencils” to prevent any leakage during its use in a radiation plant. Cobalt-60 has a half-life of 5.3 years. This technology has been used routinely for more than thirty years to sterilize medical, dental and household products, and it is also used for radiation treatment of cancer. Radioactive substances emit gamma rays all the time. When not in use, the gamma ray “source” is stored in a pool of water which absorbs the radiation harmlessly and completely. To irradiate food or some other product, the source is pulled out of the water into a chamber with massive concrete walls that keep any rays from escaping. Medical products or foods to be irradiated are brought into the chamber, and are exposed to the rays for a defined period of time. After it is used, the source is returned to the water tank.

Only certain radiation sources can be used in food irradiation. These are the radionuclides cobalt-60 or cesium-137 (used very rarely); X-ray machines having a maximum energy of five million electron volts (MeV); or electron machines having a maximum energy of 10 MeV. Energies from these radiation sources are too low to induce radioactivity in any material, including food.

Radiation dose is the quantity of radiation energy absorbed by the food as it passes through the radiation field during processing. It is measured in Gray (Gy) [one Gray equals one Joule of energy absorbed per kilogram of food being irradiated] or in rad (1 Gy = 100 rads). International health and safety authorities have endorsed the safety of irradiation for all foods up to a dose level of 10,000 Gy (10 kGy).

How much does a typical food irradiation facility cost?

The cost to build a commercial food irradiation plant is in the range of US $3 million to $5 million, depending on its size, processing capacity, and other factors. This is within the range of plant costs for other food technologies. For example, a moderately-sized, ultra-high temperature plant for sterilizing milk, fruit juices, and other liquids costs about US $2 million. A small vapor-heat treatment plant for disinfestation of fruits costs about US $1 million.