# RADIATION DISINFESTATION AND FUMIGANT REPLACEMENT, A TECHNOLOGY WHOSE TIME IS NOW

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## SUMMARY

### Introduction

The process of treating food with radiant energy is not new. The sun's energy has been used for centuries to preserve meat, fruits, vegetables and fish. Lately, infrared and microwave radiation have been introduced for heating food. Microwave ovens are now commonplace in both domestic and commercial kitchens. Today, intense radiant energy, known as ionizing radiation, is the basis of a significant food processing technology.

### Regulatory Developments

On a global basis, laws and regulations specifically focused on protecting indigenous crops from foreign or exotic insect pests go back at least to the nineteenth century. The United States enacted a quarantine law in August of 1912 with the passage of the US Plant Protection and Quarantine Act. USDA regulations promulgated to implement the Act and amended many times over the years are among the most extensive and rigorous in existence.

### NAPPO's International Role

The North American Plant Protection Organization (NAPPO) representing Canada, Mexico and the United States participates in the International Plant Protection Convention (IPPC). A new NAPPO Standard for Phytosanitary measures called "Guidelines for the Use of Irradiation as a Phytosanitary Treatment" was first drafted in July 1996 and finally approved in April 1997.

### Ionizing energy

Gamma rays, X-rays, and accelerated electrons are known as ionizing radiation because as they pass through food, they interact with the molecules to form positively and negatively charged ions. These unstable particles change rapidly into highly reactive free radicals, which in turn react with each other and with unchanged molecules. The effect of these reactions in the molecules of plant material brings about effects such as the inhibition of sprouting and the retardation of ripening. Large molecules such as deoxyribonucleic acid (DNA) are particularly susceptible to being broken into smaller molecules. This chemical change causes damage to the DNA, which prevents living cells from dividing, thus causing the sterility or death of contaminating organisms such as parasites, insects, larvae, bacteria, mould spores and viruses. The simpler the organism, the higher the radiation dose needed to kill it.

## Cobalt-60

Cobalt-60 is the primary source of ionizing energy that is used in gamma radiation processing facilities. Deliberately produced Cobalt-60 is an isotope of Cobalt-59, a non-radioactive metal which is mined from ore deposits.

## Gamma Irradiation Equipment for Agricultural Commodities

Irradiation facilities are characterized by the type of irradiator mechanism used. For simplicity, we have selected the following typical examples of four basic irradiator designs, which are generally suitable for the irradiation treatment of fruits and vegetables:

(1) Tote box concept
(2) Carrier concept
(3) Pallet carrier concept
(4) Pallet conveyor concept

In the tote box concept, the product is packed in metal or fibreglass boxes called totes. A tote has typically a volume of approximately 0.75 $m^3$ and can accommodate a multitude of product boxes. Actual sizes vary to accommodate users' specific needs. Most tote box irradiators are designed with 'overlapping product' source configuration. This configuration offers superior cobalt utilization efficiency.

The carrier concept uses tall (approximately 3 meters high) aluminum carriers. The carriers are suspended; they move through the irradiation chamber and around the cobalt source on an overhead monorail system, moved by pneumatic or hydraulic cylinders.

The pallet irradiator is similar to a carrier, but larger. Similar to carrier irradiators, the pallet irradiators are usually configured with overlapping sources.

The pallet conveyor system is an adaptation of the basic tote box irradiator. It combines the simplicity of a tote box irradiator with the efficiency of the pallet irradiator.

A new concept meat and poultry gamma irradiator with a horizontal source rack and refrigerated irradiation room has recently been introduced. It is not discussed in this paper, as this type of a facility is not intended for the treatment of fruits and vegetables.

## Electron Accelerators

The other source of ionizing energy is high-speed electrons, produced from devices called accelerators that combine electricity and magnetism to accelerate electrons to the desired energy level. Because the accelerator directs the electrons into a tight beam, this source is referred to as an electron beam

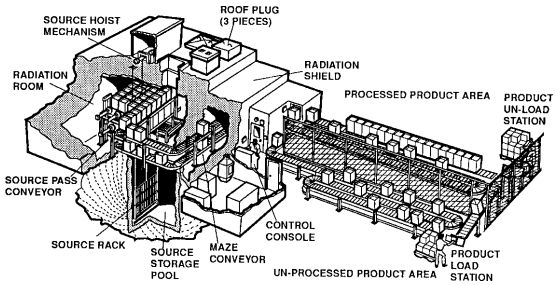
## Economics of Gamma Food Irradiation

At the cost of 1 –3 cents per lb, gamma irradiation disinfestation of foods is economically competitive, in spite of the relatively high capital requirements. Often, the nominal unit processing costs are even further offset by reduction of spoilage and improved product quality.

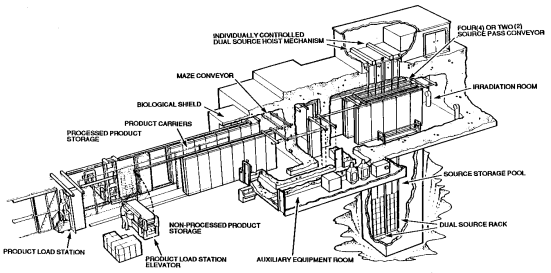
## Conclusion

Interest in, and use of, irradiation technology as a fumigant replacement and for disinfestation is growing. Increased regulatory requirements are driving producers to examine alternative technologies and consumer concerns about food safety and the environment are resulting in increased opportunities for irradiation.

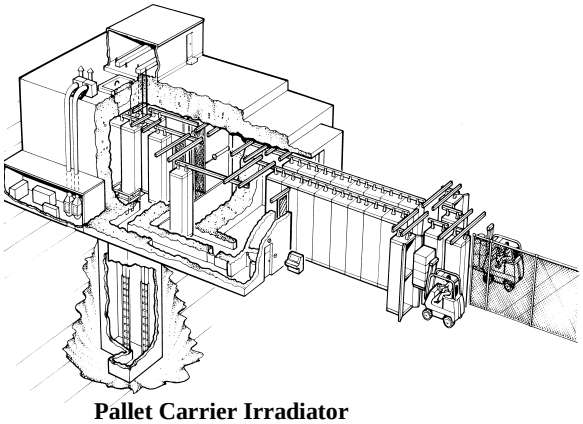
The range of agricultural, food and other products that can benefit from safe and effective treatment by irradiation is also growing. Increased use of this proven technology, as a replacement to chemicals will help producers as well as the environment. Irradiation is an economically viable alternative whose time is now.



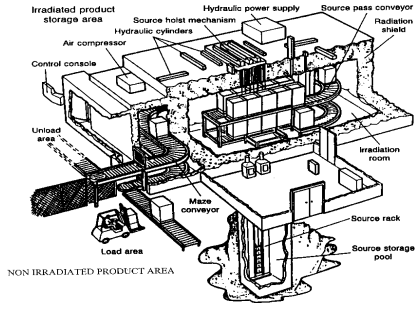

**Tote Box Irradiator**



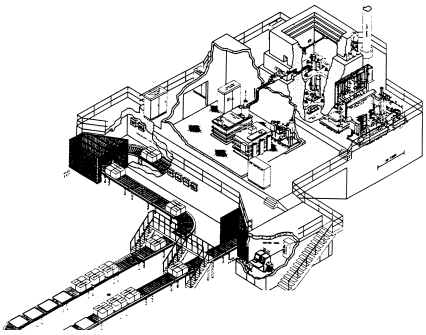

**Carrier Irradiator**



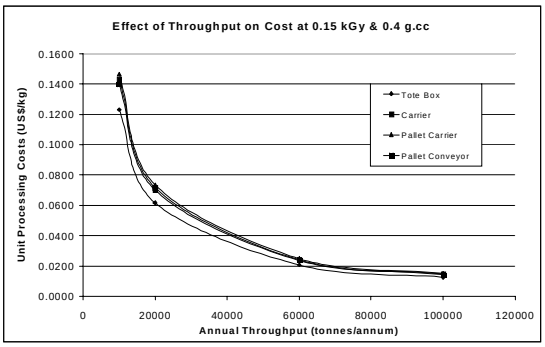
**Pallet Carrier Irradiator**




**Pallet Conveyor Irradiator**



**Electron Accelerator**
**(Courtesy AECL)**




**Economics of Gamma Irradiation**