White paper


X-ray inspection

# X-ray inspection of food products: the safety facts you need to know

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## Introduction

Over the past couple of decades, food processors increasingly have come to rely on X-ray inspection equipment to detect physical contaminants during production. This is not surprising because X-ray inspection equipment has become more sensitive, more affordable, and more reliable. X-ray systems can also be very intuitive and easy to use.

Still, some food manufacturers have lingering worries about the safety of X-ray technology – both for those operating the equipment and the food products the machines inspect.

The bottom line: X-ray inspection of packaged and bulk food product is proven to be extremely safe. There is no documented evidence of adverse health effects of X-rays on equipment operators, the food products that travel through the equipment, and ultimately the consumer of those products. To understand why this is true, let's take a close look at how today's X-ray inspection equipment works and correct any misconceptions associated with this commonly used technology.

## X-ray technology is pervasive

Many of the items we use or consume daily – food, beverages, medicine, and cosmetics – are scanned with X-ray systems at some point during their manufacturing, so we are all exposed to products that have been irradiated in the course of our everyday lives. According to the U.S. Food and Drug Administration, there are no known adverse effects from using products irradiated by these "cabinet-type" X-ray systems.

Food X-ray inspection systems do not use potentially unsafe radioactive materials to generate the X-ray images either. Rather, they rely on tubes that electrically generate the X-ray beam. The beam is directed at the object it is inspecting and a digital detector on the other side of that object creates an image for analysis. One of the advantages of this system, as opposed to one using a radioactive source, is that the X-ray energy stops immediately once the tube is turned off.

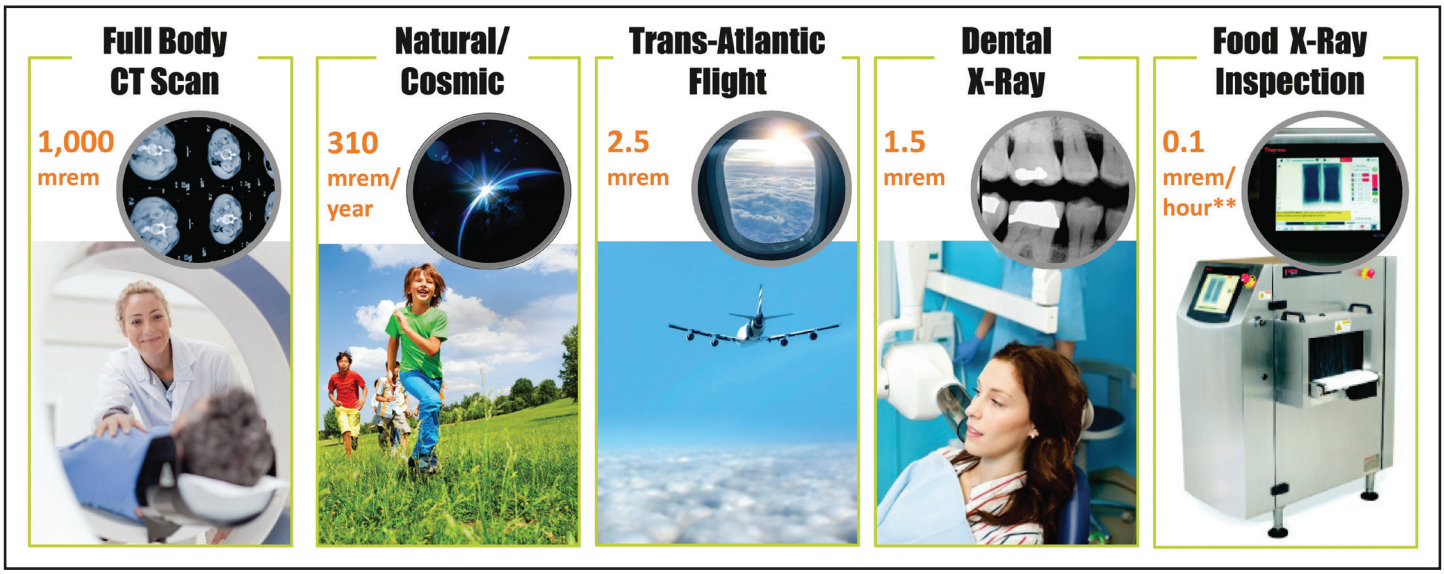
With that said, food X-ray systems do generate ionizing radiation so it is important to understand what levels are considered safe, what regulations might apply, what safety devices are used to meet these regulations, and what we do during manufacturing and installation to assure complete safety in all regards.

## We are all exposed to radiation

In the course of our daily lives we all are subject to naturally occurring background radiation. In fact, natural radiation constitutes about half of the 620 millirems (mrems) of radiation an average person experiences annually, according to the United States Nuclear Regulatory Commission. The International Commission on Radiological Protection also states people can absorb 5,000 mrems annually (8X the natural dose) before radiation poses a health risk.

Although food X-ray systems generate radiation during their normal use, a worker standing at the control panel of an X-ray food inspection machine will likely not receive any radiation from the machine due to shielding. In fact, these machines emit 0.1 mrems per hour or less and that emission is typically at the inlet or outlet where workers are not present. Multiplying 0.1 mrems per hour over the course of a 40-hour work week and a 50-week work year would imply a worker could be exposed to a total of 200 additional mrems per year in the worst case – significantly below the guideline for maximum exposure.

To put X-ray exposure during food production into perspective, here is the average radiation dose people receive from some common life experiences.




**When in operation, food inspection systems can emit this maximum level of radiation per hour, typically very close to the input/output of the aperture only. Because human operators spend limited time in this location they would receive a much less (usually zero) radiation dose in an average work shift.

## The trend toward lower X-ray power and emissions

Since the introduction of food X-ray systems several decades ago, technological improvements have significantly reduced the X-ray power needed to inspect food items. Tubes are more efficient and detectors are more sensitive. This means X-ray "scatter" inside the machine has also decreased, making it easier to shield users from radiation leakage.

Specifically, X-ray equipment 10 years ago operated in the 300 to 500 watt range, while equipment on the market today generates the same or better performance from 70 to 150 watts – a 70% reduction in power and thus emissions. The power required for food inspection is expected to drop even further as new detector technology is developed.

## Ensuring X-ray equipment is safe

Countries around the world have regulatory standards to ensure X-ray safety. These regulations are in place to make sure that the X-ray equipment can be used by technicians and operators in all possible conditions. Thermo Scientific™ X-ray inspection machines are always certified to these standards before selling and installing systems in these regions. Some examples of key regulations by country are shown here.

| Country | Regulatory standard |
|---|---|
| United States | Code of Federal Regulations<br>21 Part 1020.40 (cabinet X-rays) |
| Canada | RED (Radiation Emitting Devices) Act |
| United Kingdom | IRR 1999 |
| France | NCF-74-100 |
| Spain | UNE 73-302 |
| China | GB18871-2002 |

**Below are some of the most important design and manufacturing guidelines we follow stemming from these regulations.**

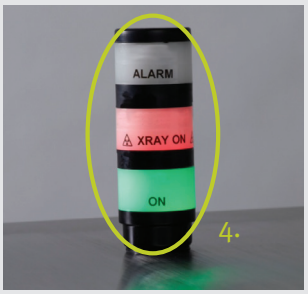
- No more than 1.0 microsievert of radiation can escape from the system at a minimum distance of 5 cm from the machine. Note the U.S. FDA limit is 5 microsieverts (.5 Mrem/hr) at 5 cm; the UK IRR 1999 is 1 microsievert at 10 cm, so this test is a worst case combination of the two standards.
- To meet the radiation leakage standard, interior shielding is used such as stainless steel or lead.
- Multiple layers of radiation-blocking curtains are used where products enter and exit the system.
- Access panels require a tool to open and feature an electronic interlock. When a panel is opened for cleaning or maintenance, the X-ray source and conveyor immediately shut off.
- When a conveyor belt is stopped to remove a jam, or if there is some other production issue, the X-ray must immediately turn off.
- An X-ray lockout key switch is included should a problem be identified to assure the system cannot be turned on prior to repair.
- Warning signs are applied to the in-feed and out-feed apertures to prevent an operator from reaching into the machine while the X-rays are on.
- A warning light tower is included and indicates when the X-ray source is on. If the warning light becomes non-functional, the system will not allow the X-ray source to be turned on.
- Country-specific labeling in the local language is applied to the machine when required.
- Every machine is radiation tested after manufacturing before shipment and additional testing is done at the customer once installed.
- All radiation survey records are kept on file at Thermo Fisher Scientific.


**Multiple safety features are designed into every system.**

**1.** Access panel requires tool for entry

**2.** X-ray lockout key switch


**3.** Multiple layers of radiation blocking curtains




**4.** Warning light tower

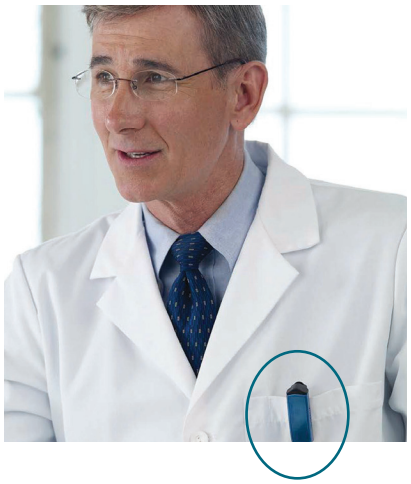
**Thermo Scientific™**
**X-ray radiation meter**

## Local regulations and best practices

Although we do everything possible to design, build, and install systems that meet a high safety standard, there may be other things you will want to do to comply with local regulations or to assure employee safety.

For instance, some U.S. states and other countries require an annual radiation survey. Or, you may be required to register X-ray equipment with the appropriate local authority by notifying them of the installation location and date. In the United States, the unit's placement is also registered with the Food and Drug Administration. Local governing bodies can also audit equipment performance whenever they deem necessary.

As a customer, you can purchase an X-ray meter and perform your own X-ray survey and record the results. Alternatively, our service professionals can conduct and document a periodic survey for you. For food processors who want the added assurance of additional shielding (or are concerned about specific operator risks) custom designs are available.



Finally, our employees who manufacture X-ray machines always wear a dosimeter for added safety. This is a device that measures exposure to ionizing radiation. Because you cannot see or smell radiation, a dosimeter ensures that the equipment is always functioning in the way it was intended. Dosimeters can be ordered and used by employees at food production facilities as an added precaution, too.

## Thermo Fisher installation safety checklist

When our field service technicians are called on to install an X-ray inspection system they will perform an on-site radiation survey and record the results. They also will review the topics below with the customer and provide help/answers when needed.

### During installation a service technician should verify the following:

| | |
|---|---|
| ✓ | The facility or company has a radiation safety officer |
| ✓ | There is a plan or process to do radiation surveys at specified time intervals |
| ✓ | Employees have an understanding/knowledge of radiation safety |
| ✓ | Signage is installed properly on and near X-ray equipment |
| ✓ | Emergency medical procedures are posted in the area and are understood |
| ✓ | If dosimeters are requested, employees are wearing them |
| ✓ | Equipment is registered with the state, province, or other local authority |

### Typical registration documentation requirements include:

| | |
|---|---|
| ✓ | Equipment type, model, and specification as a cabinet device per FDA CFR 21 1020.40 |
| ✓ | Maximum X-ray voltage and current |
| ✓ | Number of X-ray tubes |
| ✓ | Building location |

## Conclusion

X-ray inspection of food products is proven safe. Protocols are in place to ensure that the equipment performs safely upon commissioning and it is easy to confirm safe operation at any time to meet plant or regulatory requirements. For many food applications, X-ray inspection provides superior detection and is easier to use than metal detection technology. The only risk is not considering how X-ray inspection could enhance your product inspection practices.

Learn more at **thermofisher.com/xrayinspection**