

X-Ray Machine Safety Fact Sheet

HS05-035B (09-24)

Radiation exposure poses an invisible threat in the workplace that can lead to severe health problems without proper safety protocols. X-ray technicians and other workers using similar equipment face risks ranging from skin conditions such as dermatitis and erythema to more serious issues such as bone marrow suppression and cancer.

As an employer, you are required by the Occupational Safety and Health Administration (OSHA) Standard ([1910.1096](#)) to implement procedures that protect your employees from radiation hazards. This fact sheet aims to clarify your responsibilities in ensuring a safe working environment for employees operating X-ray machines.



Industrial Use

The OSHA Standard applies to all industries that use X-ray machines including fixed and portable systems. They may include, but are not limited to, the following industries:

Medical and Health Care

The most well-known use of X-rays is in medical imaging for diagnosing injuries and diseases. X-rays are commonly used in:

- Hospitals.
- Dental offices.
- Orthopedic clinics.
- Urgent care centers.
- Veterinary practices.

Security and Defense

X-ray machines are used to inspect luggage, cargo, vehicles, and other items for potential threats. They play a crucial role in security screening at:

- Airports.
- Shipping ports.
- Border crossings.
- Government buildings.

Food and Beverage Industry

X-ray inspections are widely used for:

- Detecting foreign objects and contaminants in food products.
- Checking fill levels.
- Inspecting packaging integrity.

Manufacturing and Industrial Applications

Many manufacturing industries, such as aerospace, automotive, electronics, and heavy industry, use X-ray technology for:

- Non-destructive testing of parts and components.
- Weld inspections.
- Quality control checks.
- Measuring product density or thickness.

Oil and Gas

The oil and gas industry uses industrial radiography for:

- Inspecting pipelines.
- Examining welds.
- Checking equipment integrity.

Pharmaceutical Industry

X-rays are used to:

- Inspect blister packs, vials, and syringes.
- Check for missing or broken components.
- Verify proper assembly of medical devices.

Agriculture

X-ray technology is used in large industrial agricultural plants for:

- Quality control of produce.
- Detecting foreign objects.
- Sorting and grading agricultural products.

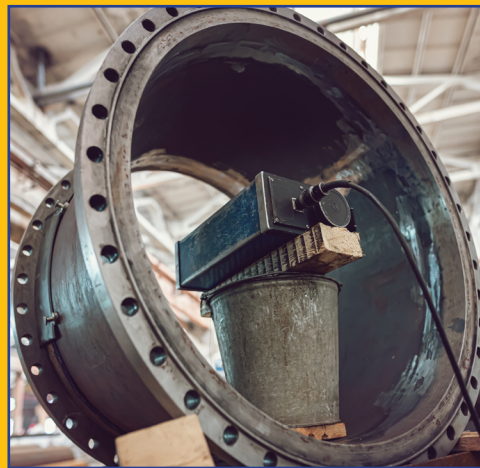
X-ray equipment is also used extensively in scientific research, biofuel sorting and grading, timber inspections for sawmills, wind turbine blade inspections, and more.

X-ray Use in Industry



← Digital X-ray machine in a clinic.

↓ An X-ray machine at airport security.



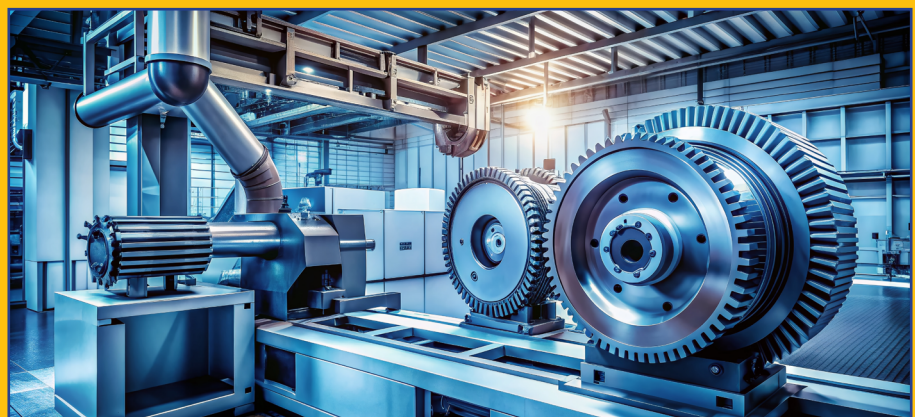
↑ X-ray used to inspect the welds on a heat exchanger element.



→ Chicken meat passing through an X-ray inspection machine.



↓ Heavy industrial X-ray machine inspecting gears.



Exposure Limits and Monitoring

Employers must ensure that employees are not exposed to radiation levels exceeding OSHA's established limits. OSHA's exposure limits of ionizing radiation are:

- Whole body: 1.25 Roentgen Equivalent Man (rem) per calendar quarter.
- Hands, forearms, feet and ankles: 18.75 rem per calendar quarter.
- Skin: 7.5 rem per calendar quarter.

Employers can permit higher doses to the whole body in certain circumstances, but all of the following conditions must be met:

- The dose of the whole body cannot exceed 3 rem in a calendar quarter.
- The dose to the whole body, plus the accumulated occupational dose cannot exceed $5(N-18)$ rem. (N is the individual's age in years at their last birthday.)
- The employer keeps adequate records of past and current exposure.
- Employees under 18 cannot receive more than 10% of the limits specified above in any calendar year.

To achieve this, a comprehensive monitoring program is essential. The program should include regular readings and proper use of personal monitoring badges (dosimeters). Employers must:

- Develop and implement procedures to monitor employee radiation exposure specific to your facility.
- Provide dosimeters to all employees who might receive a dose above 25% of the quarterly limit.

- Require employees to wear these devices at all times in radiation areas.
- Check dosimeter readings at least quarterly.

Monitoring Badges (Dosimeters)



Personal radiation monitoring is essential for any radiation safety program. Dosimeters, or radiation monitoring badges, are crucial tools for measuring individual exposure to ionizing radiation. These devices help ensure worker safety and compliance with OSHA regulations. Ensure employees follow these key guidelines for using monitoring badges:

- Wear monitoring badges at neck level or on the upper torso.
- When wearing a protective (lead) apron, wear the monitoring badge at the collar outside the apron.
- For pregnant employees, wear an additional monitoring badge at the waist under any protective apron.
- Review and acknowledge receipt of monitor reports.
- Retain exposure records, even after employee departure.
- Provide employees with a final monitoring report upon leaving the job.

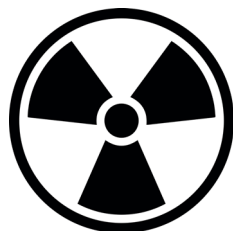
- Store monitoring badges away from radiation sources when not in use.
- Never wear another person's monitoring badge.
- Report lost or damaged monitoring badges immediately.
- Avoid exposing monitoring badges to high temperatures.
- Do not tamper with monitoring badges.
- Report exposures from all jobs if working in multiple facilities.

Radiation Surveys

A radiation survey is designed to detect the presence of radioactive contamination. These surveys help you comply with OSHA standards and protect workers from unnecessary exposure. To conduct a survey:

- Scan the work area, instruments, and surfaces with a radiation survey meter to identify any potential leaks or other radiation hazards.
- Keep records of these surveys for inspection by OSHA.
- Perform surveys at least quarterly, or whenever there are changes in production, process, or control that might increase radiation levels.

Signage and Labeling



Employers are also responsible for proper signage and labeling to alert workers and visitors to the presence of radiation hazards.

Clear, visible warnings help prevent accidental exposure and ensure that everyone in the area is aware of the potential risks.

- Post a "CAUTION: X-RAY EQUIPMENT" sign at the entrance to any room containing X-ray equipment.
- Ensure all X-ray equipment is labeled with "CAUTION: THIS EQUIPMENT PRODUCES X-RAYS WHEN ENERGIZED."
- Use the universal symbol for radiation – the trefoil, a three-bladed symbol that represents a radiation source -- on all signs and labels.
- Properly identify and label all sources of radiation.
- Set up barriers to prevent public access to radiation work areas.
- Place a barrier between the "Radiation Area" and the "Restricted Area."

Equipment Maintenance and Controls

A well-maintained X-ray machine with easily accessible controls is required to minimize risks to both operators and those around them.

- Establish and follow a regular maintenance schedule for all X-ray equipment.
- Ensure all equipment controls are clearly labeled and easily accessible.
- Install emergency shut-off switches in easily reachable locations.
- Ensure X-ray machines emit an audible signal when exposure ends and the timer resets automatically.
- Keep maintenance, repair, and modification records for each X-ray machine for three years.



Shielding and Protection

Proper structural shielding and protective measures are needed to minimize radiation exposure to workers and others.

- Install lead shielding in walls, floors, and ceilings in rooms with X-ray equipment as recommended by the [National Council on Radiation Protection and Measurements \(NCRP\)](#).
- Provide lead aprons, thyroid shields, and lead gloves for employees who must be in the room during X-ray operations.
- Use protective barriers or enclosures for X-ray equipment whenever possible.
- Test all lead aprons and gloves on receipt and at 12-to-18-month intervals for shielding integrity.

Personal Protective Equipment

PPE is a critical component of radiation safety. Proper selection, use, and maintenance of PPE can reduce the risk of radiation exposure and chemical contact. The minimum PPE requirements are:

- Neoprene or nitrile gloves.
- Safety glasses.
- Vinyl rubber apron.

Additional precautions may be necessary depending on your specific industry and work environment. Other PPE that may be required are:

- Lead aprons.
 - Thyroid shields.
 - Dosimeters.
 - Leaded gloves.
 - Leaded eyewear.
 - Face shields.
- All PPE should be used and maintained properly:
- Inspect PPE regularly for damage or defects.
 - Test lead aprons and gloves for shielding integrity every 12-18 months.
 - Store PPE properly to prevent damage and maintain effectiveness.

Film Processing and Chemical Exposure

While most X-ray machines are now digital, some locations or industries still choose to use traditional film radiography. When film processing is used, it is vital to use proper processing procedures not only to produce high-quality images but also to maintain a safe working environment. These procedures help minimize chemical exposure and ensure the integrity of radiation shielding.

- Handle chemical solutions carefully to avoid splashing.

- Make Safety Data Sheets available for all chemicals.
- Use appropriate PPE.
- Clean up chemical spills or splashes immediately.
- Use covers on processing equipment and chemical storage tanks.
- Install proper ventilation in darkrooms.
- Maintain appropriate temperature and cleanliness in darkrooms.
- Follow the manufacturer's instructions.

Training Requirements

Comprehensive training is essential for employees who operate X-ray machines to ensure the safety of both operators and those in the vicinity. This training should include a broad range of safe work practices and proper equipment operation techniques. While the scope of training may vary, it is crucial to tailor the training program to address safety protocols specific to your industry and the particular tasks involved.



X-raying a pipeline's weld joints.

Training Schedule and Documentation

Employers should implement a robust training program that includes:

- Initial training during employee orientation.
- Annual refresher courses for all employees working with or around X-ray equipment.
- Detailed record-keeping of all training sessions, including dates and topics covered.

Core Training Components

At a minimum, the training curriculum, as applicable to your industry, should address the following key areas:

- **Radiation safety fundamentals.**
 - Health risks of radiation exposure (e.g., erythema, dermatitis, skin cancer, bone marrow suppression).
 - Recognition and interpretation of radiation caution and warning symbols.
- **Techniques to minimize exposure.**
 - Principles of ALARA, an acronym for "as low as reasonably achievable" to reduce radiation exposure.
 - Efficient work practices to reduce X-ray system usage time.
 - Proper use of technique charts (tables of exposure settings for X-ray machines) and their locations at control panels or exposure switches.
 - Optimize film speed and exposure time.
 - Use the correct technique to avoid repeat X-rays.

- **Protective equipment and practices.**
 - Proper use of dosimeters for personal radiation monitoring.
 - Correct use of protective devices (lead aprons, thyroid shields, lead screens).
- **Operational safety.**
 - Maintain safe distances (minimum 6 feet/2 meters) from radiation sources.
 - Proper positioning to avoid direct X-ray beam exposure.
 - Safe handling of X-ray tube housing during procedures.
 - Limiting equipment access to trained personnel only.
- **Equipment-specific training.**
 - Proper operation of specific X-ray machines in use.
 - Emergency procedures for equipment malfunctions.
 - Safe handling and storage of X-ray equipment.
- **Film processing and chemical safety.**
 - Safe handling of chemicals, if applicable.
 - Proper film processing procedures and quality control, if applicable.
- **Special accommodations.**
 - Protocols for pregnant employees to limit occupational exposure.
- **Emergency response and reporting.**
 - Steps to take in case of accidental exposure.
 - Procedures for reporting incidents or safety concerns.

- Incident reporting and documentation procedures.
- **Industry-specific considerations**
 - **Health care.**
 - Use digital radiographic equipment when possible to reduce radiation exposure.
 - Take extra precautions with high-dose procedures like CT scans and fluoroscopy.
 - In dental settings, position operators safely relative to X-ray equipment.
 - **Manufacturing and construction.**
 - Use X-ray fluorescence (XRF) devices safely when inspecting materials.
 - Follow proper procedures for industrial radiography in construction and quality control.
 - **Security operations.**
 - Adhere to guidelines for security screening using X-ray systems.
 - Follow American National Standards Institute N43.17-2009 standards for personnel security screening systems.
 - **Food industry.**
 - Comply with the Food and Drug Administration regulations for food irradiation.
 - Protect workers from exposure during food irradiation processes.

By following these comprehensive guidelines, you can ensure a safe working environment when using X-ray machines and comply with OSHA standards across various industries.



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