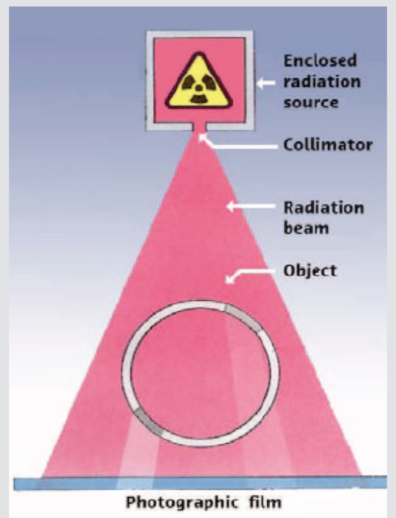
RADIATION PROTECTION OF WORKERS
Industrial Radiography

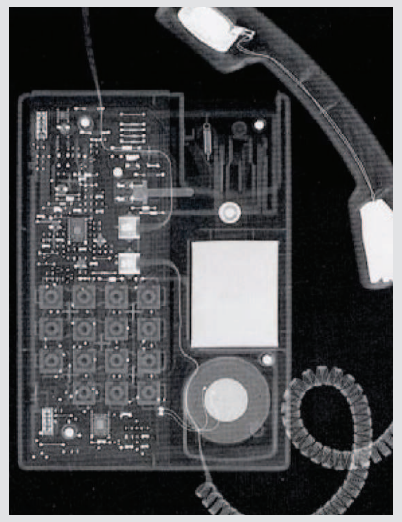
IAEA

RADIATION AND RADIOGRAPHS

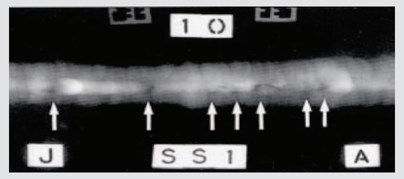
Ionizing radiation can penetrate objects and create images on photographic film. The technique is called radiography and the processed films are called radiographs.

Materials of higher density absorb more radiation. The metal components are revealed inside this telephone because they have absorbed more radiation than the surrounding plastic.





Industrial radiography requires penetrating X or gamma rays to reveal hidden flaws in metal objects such as pipe welds. The terms X radiography and gamma radiography indicate the radiation in use.



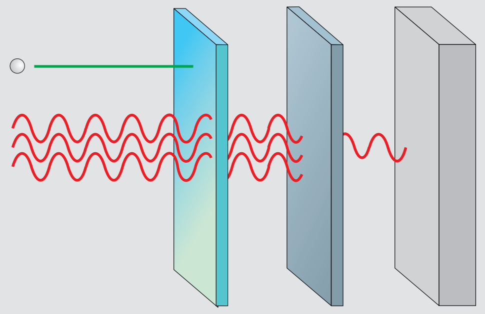
The arrows on this radiograph of a weld indicate defects.

RADIATION PROTECTION

Shielding

1 cm of plastic will totally shield all beta radiation.

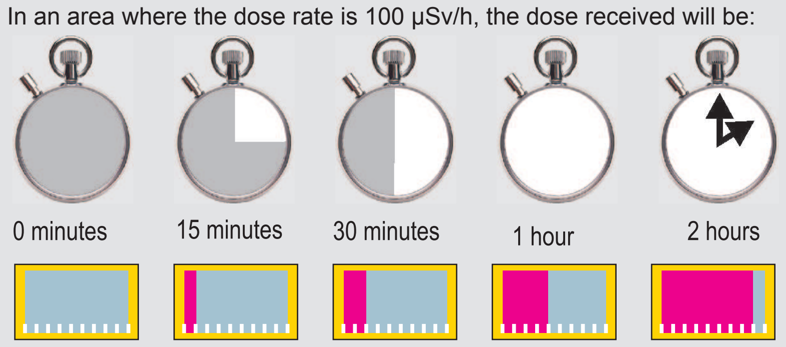
Lead and concrete can be used to shield against gamma and X radiations.



Time

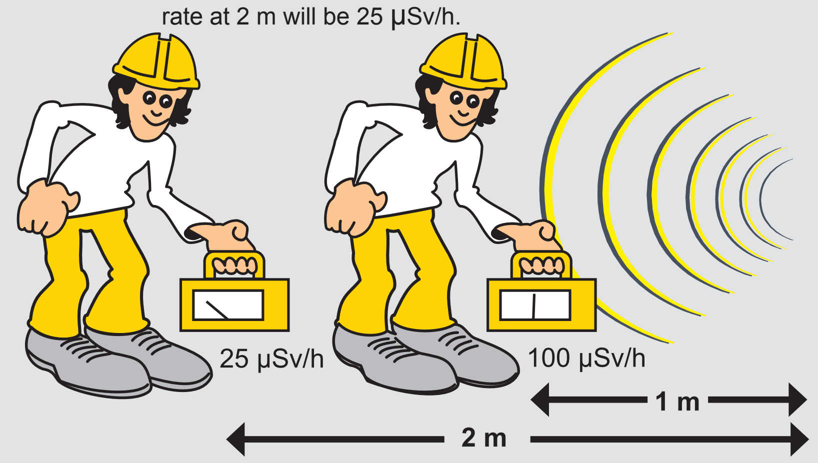
To reduce radiation doses, the time spent in radiation areas must be kept as short as possible. The longer the time spent in an area, the higher the dose received.

In an area where the dose rate is 100 µSv/h, the dose received will be:



Distance

If the dose rate at 1 m from a source is 100 µSv/h the dose rate at 2 m will be 25 µSv/h.

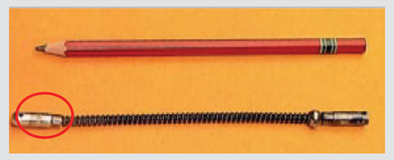


RADIOACTIVE SOURCES

Sealed sources are small in size and contain material which emits penetrating radiation continuously. Special containers made of dense metal shielding are necessary to store, move and manipulate these sources. Due to their small size and manoeuvrability, sealed sources can be used in confined spaces.

Portable and mobile radiographic containers.

Iridium-192 is a common radioactive source used in gamma radiography. Other radioisotopes can be used depending on the density of material to be radiographed.



Radiography sources are typically incorporated into 'pigtails'. The pigtail may be about the same size as a pencil but the actual source (circled, above) is physically smaller.

X RAY MACHINES

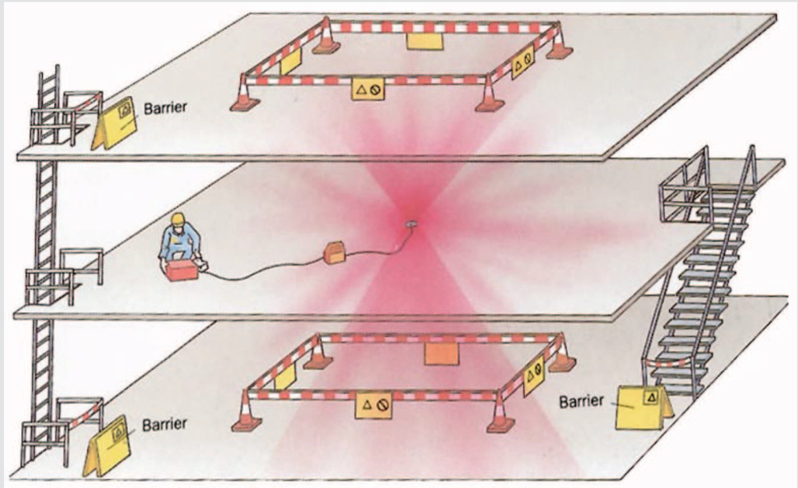
Industrial X ray machines typically operate at more than 100 000 volts. Without electrical power, the machine does not produce radiation and it is safe for the radiographer to handle the equipment.

A radiographer positioning the object and X ray machine.

ENCLOSURES AND SITE RADIOGRAPHY

A radiography enclosure is a special room constructed to shield others working outside. Warning signs AND devices fitted to the doors prevent accidental entry whilst radiation is in use. In addition to this, procedures for work are followed.

Radiography is also carried out on-site, where objects cannot be easily moved or an enclosure is not practicable. Provisions should be implemented to ensure that people are not present in the areas with a radiation hazard.



Barriers are placed at access points above and below the location of the work.

PROCEDURES

Safe storage

Radioactive sources should be kept in a secure, fire resistant and adequately shielded storage location when not in use, and should be kept separate from other materials. The storage location for X ray machines that are not in use is not required to be shielded.

Removal and return of sources to a storage location must be recorded. Records on the location of the sources must be kept and updated each working day.

Cooperation with other workers

The radiographer needs the cooperation of others to ensure safety during the work and the site management's permission to work. He/she must give advance notice to the local managers, foremen and workers.

A radiographer and foreman discussing procedures for work. Note the symbols in use, including the radiation trefoil and legends.

Warning notices and signals

Notices are displayed at the barriers to explain access restrictions and the meaning of warning signals.

Controlled area: Radiation

No unauthorized entry

Routine checks

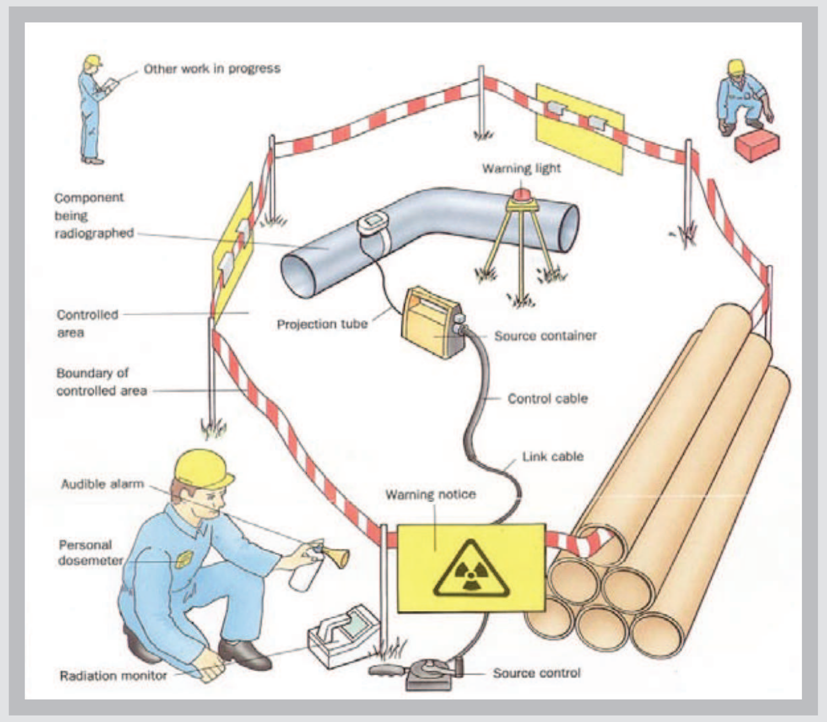
The radiographer should use the survey meter to check:

- ☑ That the source is in its container before work begins.
- ☑ That the barriers are correctly positioned, or exposure rates around an enclosure are low.
- ☑ That a gamma source has retracted into the container at the end of a gamma radiography exposure.
- ☑ That the area is clear at the end of site gamma radiography.
- ☑ That X rays are no longer being generated at the end of an X radiography exposure.

The radiographer should also check:

- ☑ That all equipment is in good condition before starting work.
- ☑ That warning signals and other safety features are working.
- ☑ That emergency equipment is available and in good condition.

Precautions



The radiographer should confirm that people are excluded from the areas where there is a radiation hazard, then signal audibly when the source is about to be exposed. A different signal, often a beacon, should indicate the exposed radiation source position or, for X radiography, that X rays are being generated.

Radiographed objects do not retain any radiation and they do not become radioactive. They are immediately safe to handle when the test is completed.

Setting up X radiography.

Allow the radiographer time to check that the source is safe or that X rays are no longer being generated before you enter the area. Radiation does not need time to disperse and the area is safe to enter immediately when barriers are down.

A radiographer checking that the radioactive source is safe.

Failure to confirm that a gamma source has retracted to the safe position or X rays are not being generated can result in accidental exposure.

RADIOGRAPHERS

- ☑ DO follow the procedures.
- ☑ DO use the appropriate equipment, including collimators.
- ☑ DO confirm that there are no other people working in the area of radiography.
- ☑ DO use clear working signs and signals.
- ☑ DO set up the controlled area and the necessary barriers.
- ☑ DO confirm the location of the source, or that X rays are not being generated, by use of a survey meter.
- ☑ DO secure and store the source or X ray machine when not in use.
- ☑ DO wear your personal dosimeter.

OTHER WORKERS

- ☑ DO observe the access restrictions, however remote it may seem from the location of the source.
- ☑ DO familiarize yourself with all the warning signs and signals the radiographers use.
- ☑ DO report any safety concerns to the Radiation Protection Officer.
- ☑ DO NOT tamper with or remove radiographic equipment.

DOSE AND EFFECTS

Units of dose

The unit of absorbed dose is the gray (Gy).

The unit used to quantify the dose in radiation protection is the sievert (Sv).

One millisievert (mSv) is 1/1000 of a sievert.

► Annual doses from natural background radiation vary on average between 1 mSv and 5 mSv worldwide.

One microsievert (µSv) is 1/1000 of a millisievert.

► The typical dose from a chest X ray is 20 µSv.

Dose rate

Dose rate is the dose received in a given time. The unit used is microsieverts per hour (µSv/h).

►If a person spends two hours in an area where the dose rate is 10 µSv/h, then they will receive a dose of 20 µSv.

Health effects of radiation exposure

If radiation doses are very high, the effect on the body will appear relatively soon after the exposure. These acute injuries will occur if the absorbed dose is higher than a threshold value; the sources and equipment used in industrial radiography are capable of delivering such doses. It is therefore essential that procedures for work are followed.

Even if the dose is not high enough to cause serious injury, there is still the possibility of incurring other health effects. These effects, e.g. radiation induced cancer, are risk based, i.e. the higher the dose received, the greater the likelihood of developing the effect. To reduce the possibility of developing these effects, radiation doses must be kept:

AS LOW AS REASONABLY ACHIEVABLE (ALARA)