NON DESTRUCTIVE TESTING: FLAW DETECTION WITH IRIDIUM AND SELENIUM

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WHAT IS NDT?

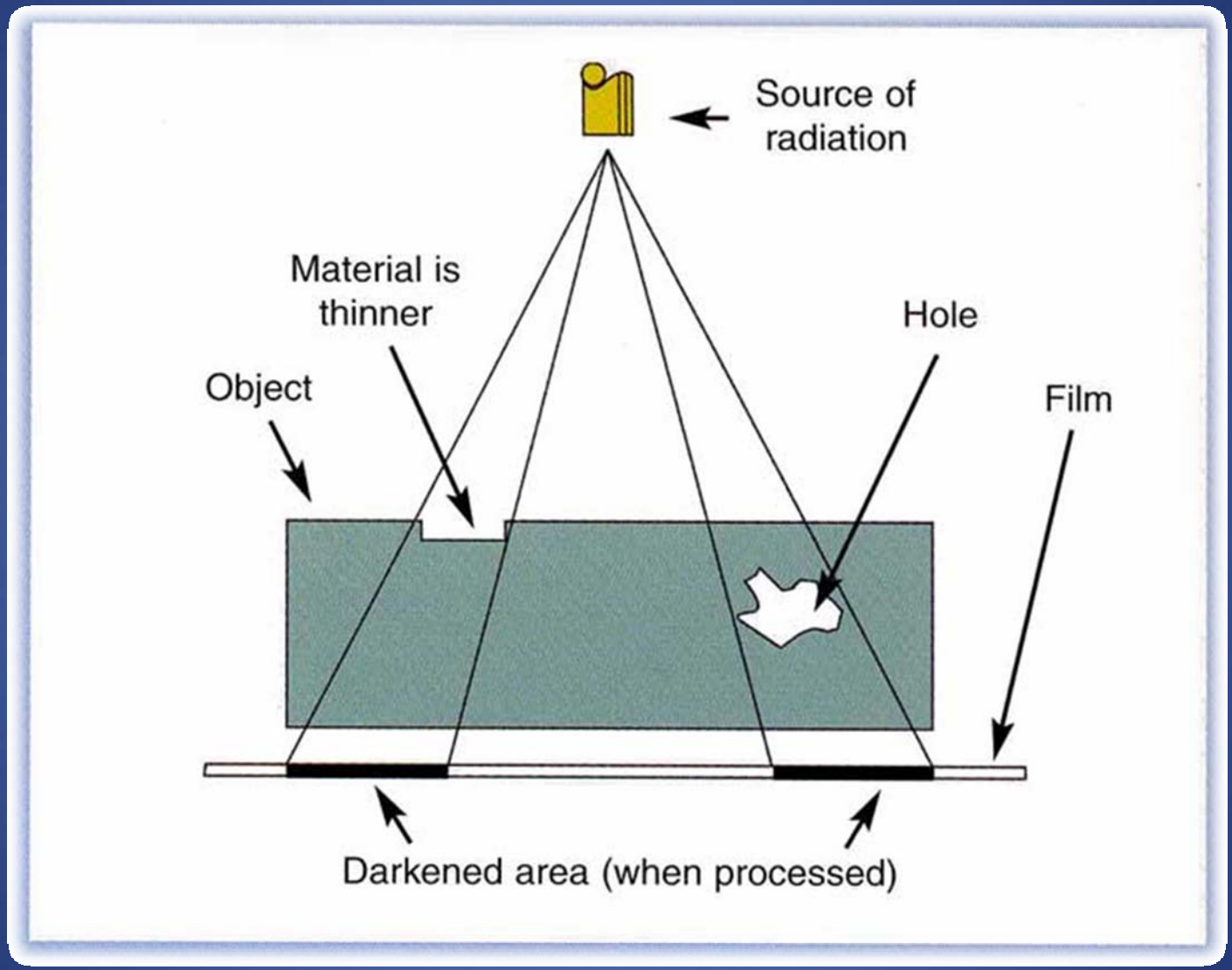
- A technique of checking flaws in materials, components, structures without altering their property or affecting their serviceability .

- Includes ultrasonic, eddy currents, liquid penetrant, magnetic particle and radiography. Flaw detection with Iridium and Selenium falls under Radiography.

WHY RADIOGRAPHY?

Radiography is well suited for detection of volume type flaws such as gas porosity and slag inclusions. Since the radiation beams are directed through the entire volume of the suspected defect area, flaws such as lack of fusion, cracks and crack like planar flaw oriented in the direction of the radiation beam will be highlighted. Radioisotopes are employed in gamma radiography.

Radiography NDT method of flaw detection offers a quick and compact means of detecting flaws with immediate results. It is based on the way materials absorb penetrating radiation. Its independence from a power source enables it to be employed in the field and resulting detection films can be easily processed, analyzed and interpreted.



source: *http://www.ndt-ed.org*

WHAT ARE RADIOISOTOPES?

- Isotopes are different forms of an element that have the same number of protons in the nucleus but a different number of neutrons. In the neutral state, the number of external electrons also equals the atomic number. These electrons determine the chemistry of the atom. The atomic mass is the sum of the protons and neutrons.
- When a combination of neutrons and protons, which does not already exist in nature, is produced artificially, the atom will be unstable and is called a radioactive isotope or radioisotope. This instability causes the isotope to produce some form of radiation (gamma rays) employed in the radiography industry.

IRIDIUM AND SELENIUM

- Iridium is a silvery white metal named after the Latin word for rainbow because its salts are highly colored. Iridium is hard and brittle with low ductility, which makes it very difficult to machine and form. It is quite dense, about twice as dense as lead, and occurs in nature as two stable isotopes. Iridium-193 is the most prevalent form of its isotopes, comprising about 63% of natural iridium, with iridium-191 accounting for the rest. Iridium-192 has the highest gamma radiation energy of 0.82meV and is the isotope of most concern based on general availability; it is used in a number of industrial and medical applications .

- Selenium is a non-metallic mineral that resembles sulfur and can exist as a gray crystal, red powder, or vitreous black form. It occurs in nature as six stable isotopes. Selenium-80 is the most prevalent, comprising about half of natural selenium. The other five stable isotopes and their relative abundances are selenium-74 (0.9%), selenium-76 (9.4%), selenium-77 (7.6%), selenium-78 (24%), and selenium-82 (8.7%). The half-life of Selenium-75 is 120 days.

source: *wikipedia*

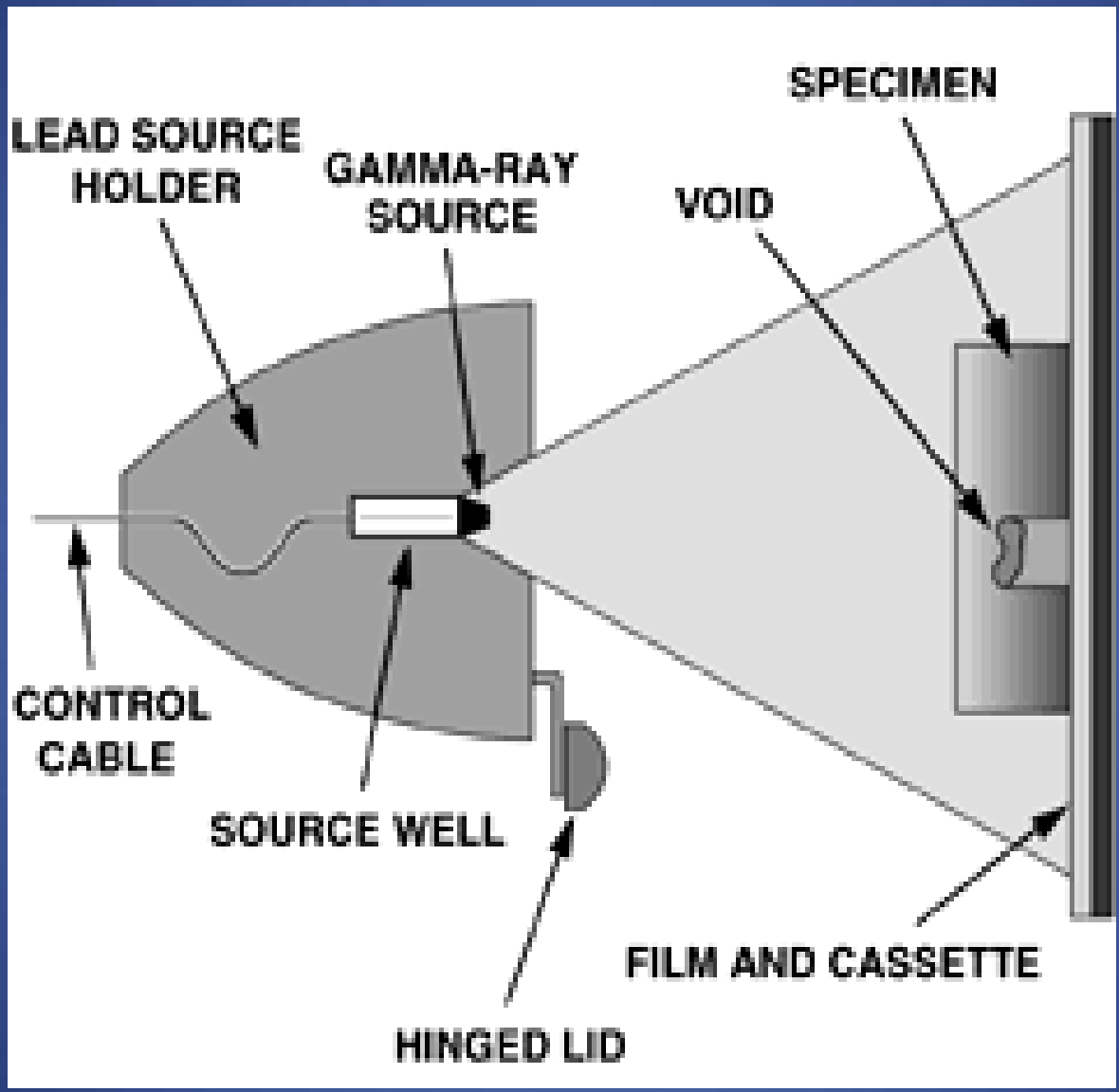
RADIOGRAPHIC TECHNIQUE

- Gamma Radiography works in much the same way as x-rays screen luggage at airports. Instead of the bulky machine needed to produce x-rays, all that is needed to produce effective gamma rays is a small pellet of radioactive material in a sealed titanium capsule.

source: *http://www.ndt-ed.org*

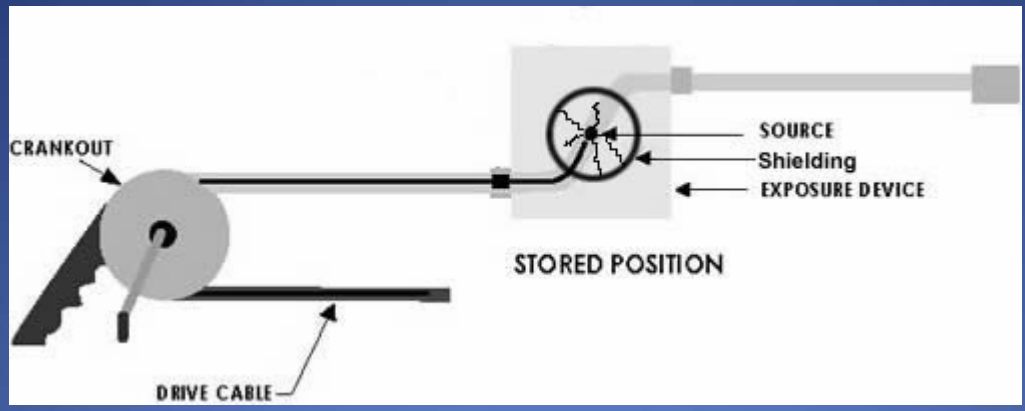
- The capsule is placed on one side of the object being screened, and some photographic film is placed on the other side. The gamma rays, like x-rays, pass through the object and create an image on the film. Just as x-rays show a break in a bone, gamma rays show flaws in metal castings or welded joints.

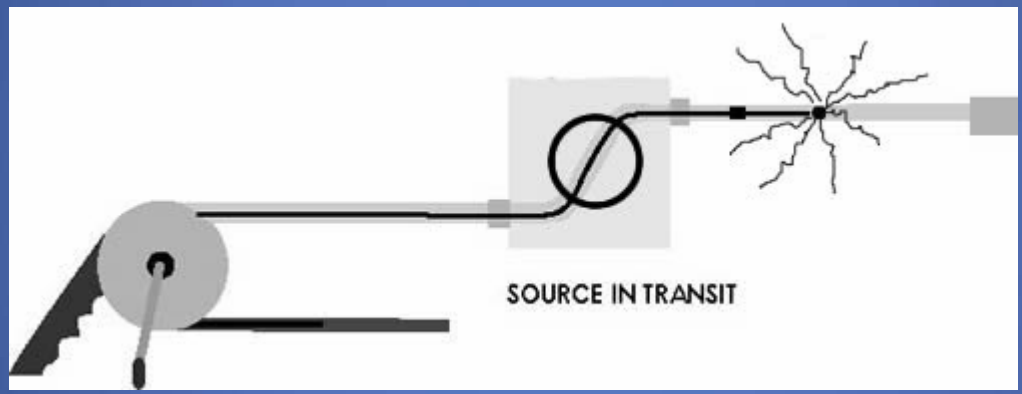
- This technique allows critical components to be inspected for internal defects without damage which is the primary objective of NDT.

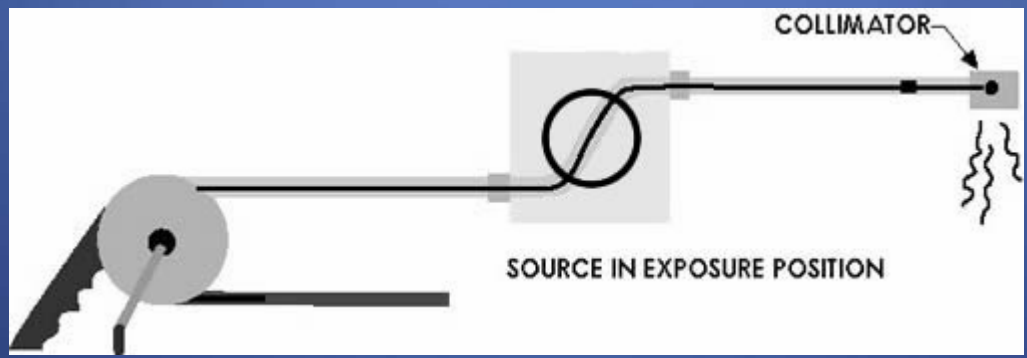


source: *http://www.ndt-ed.org*

- Gamma sources are normally more portable than x-ray equipment so have a clear advantage in certain applications, such as in remote areas. For remote area applications, the radiation source (Ir-192 or Se-75 in this case) is cranked into position and exposed to the area being tested.

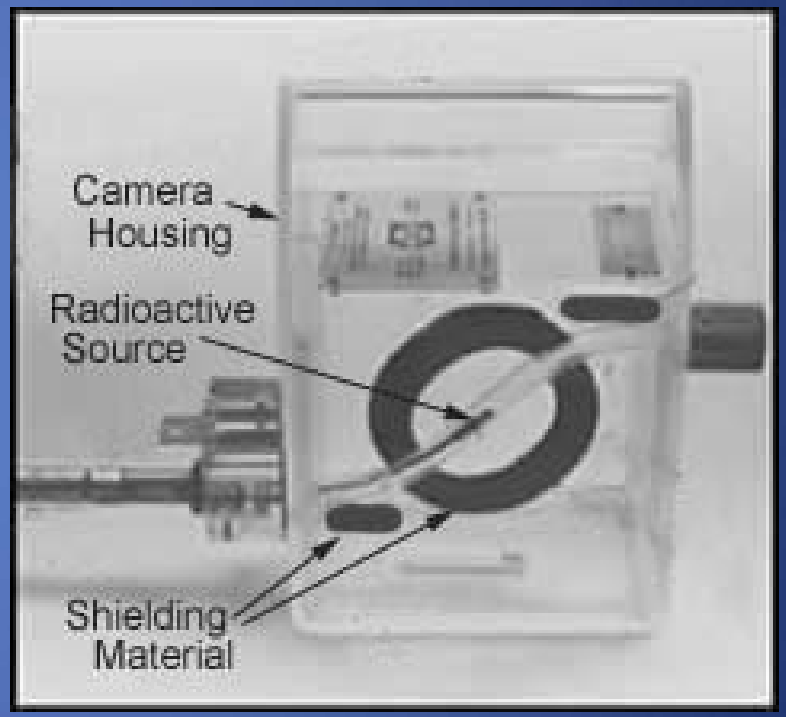






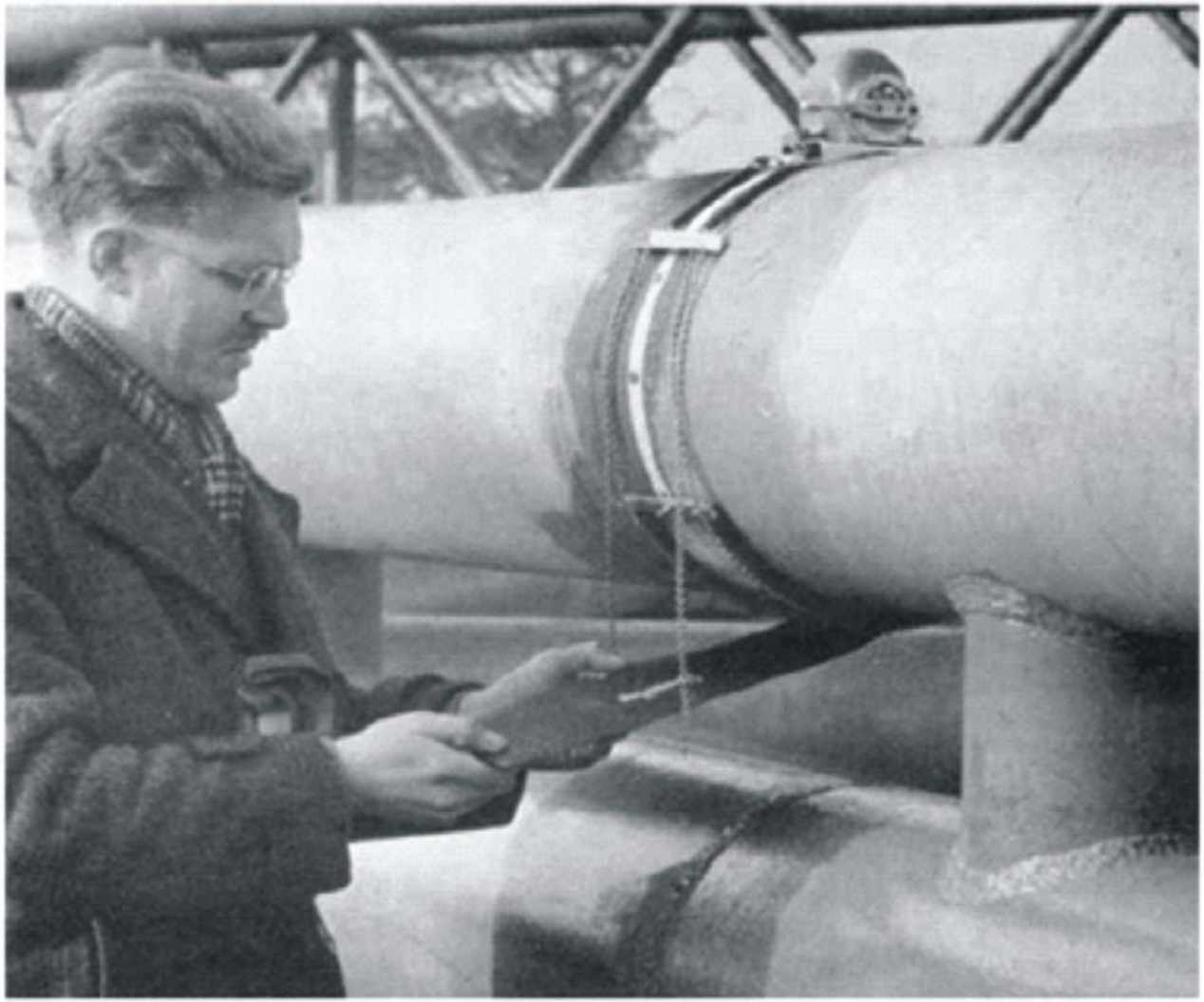
source: *http://www.ndt-ed.org*

VERY PORTABLE TOO!!!



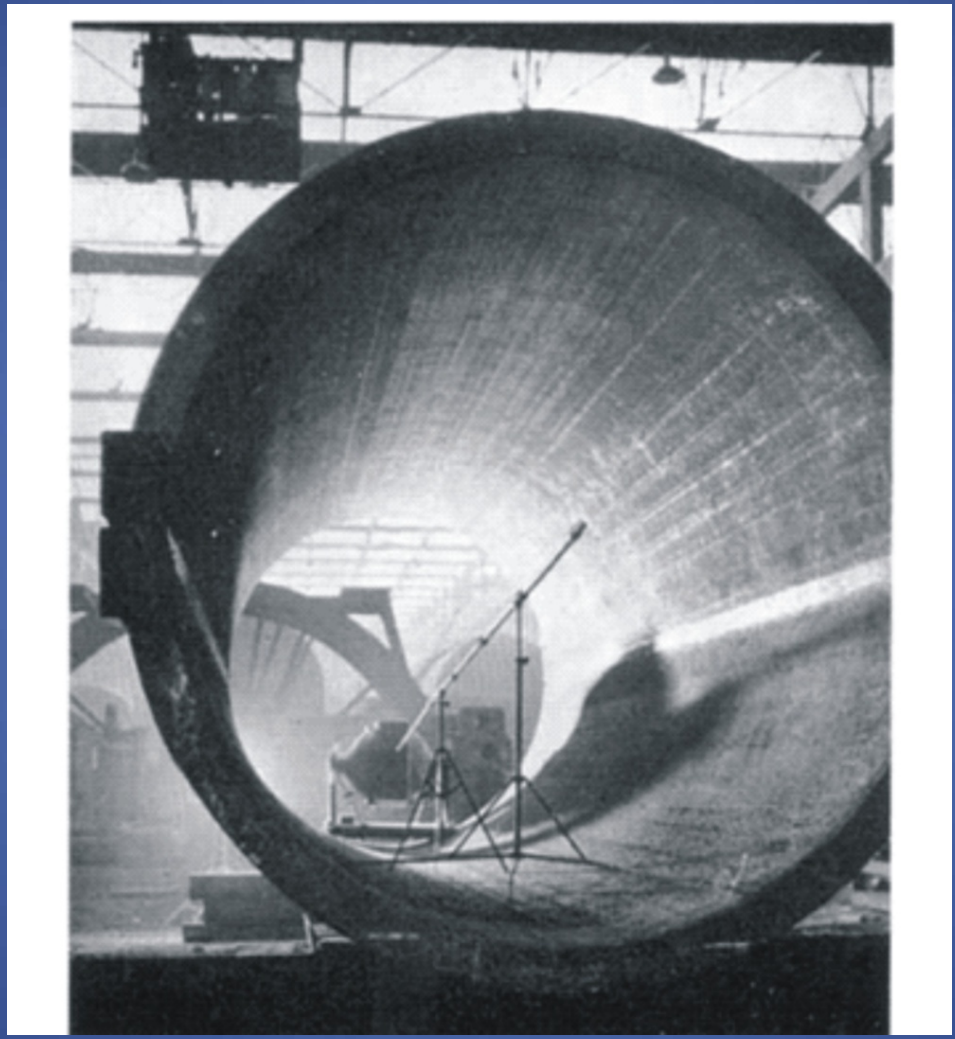
source: *http://www.ndt-ed.org*

- Where a weld has been made in an oil or gas pipeline, special film is taped over the weld around the outside of the pipe. A machine called a "pipe crawler" carries a shielded radioactive source down the inside of the pipe to the position of the weld. There, the radioactive source is remotely exposed and a radiographic image of the weld is produced on the film. This film is later developed and examined for signs of flaws in the weld.



Source: http://www.platinummetalsreview.com

SUITABLE FOR EXTREME APPLICATIONS



An iridium-192 source in use for the non-destructive testing of a welded steel shell at the works of G. A. Harvey & Go. (London) Ltd.
Source: http://www.platinummetalsreview.com

IMAGING

- A very important aspect of Radiography in NDT is the film deployed to capture the image projected by the flaw. Films for general radiography consist of an emulsion-gelatin containing radiation sensitive silver halide crystals, such as silver bromide or silver chloride, and a flexible, transparent, blue-tinted base.

- When gamma rays, or light strike the grains of the sensitive silver halide in the emulsion, some of the Br^- ions are liberated and captured by the Ag^+ ions.

- Defects appear as dark or abhorrent striations compared to the rest of the film.

FILM SELECTION CONSIDERATION

- Composition, shape, and size of the part being examined and, in some cases, its weight and location.
- Type of radiation used, whether x-rays from an x-ray generator or gamma rays from a radioactive source.
- The intensity/quality of the gamma radiation (Ir-192 or Se-75).
- Relative importance of high radiographic detail or quick and economical results.

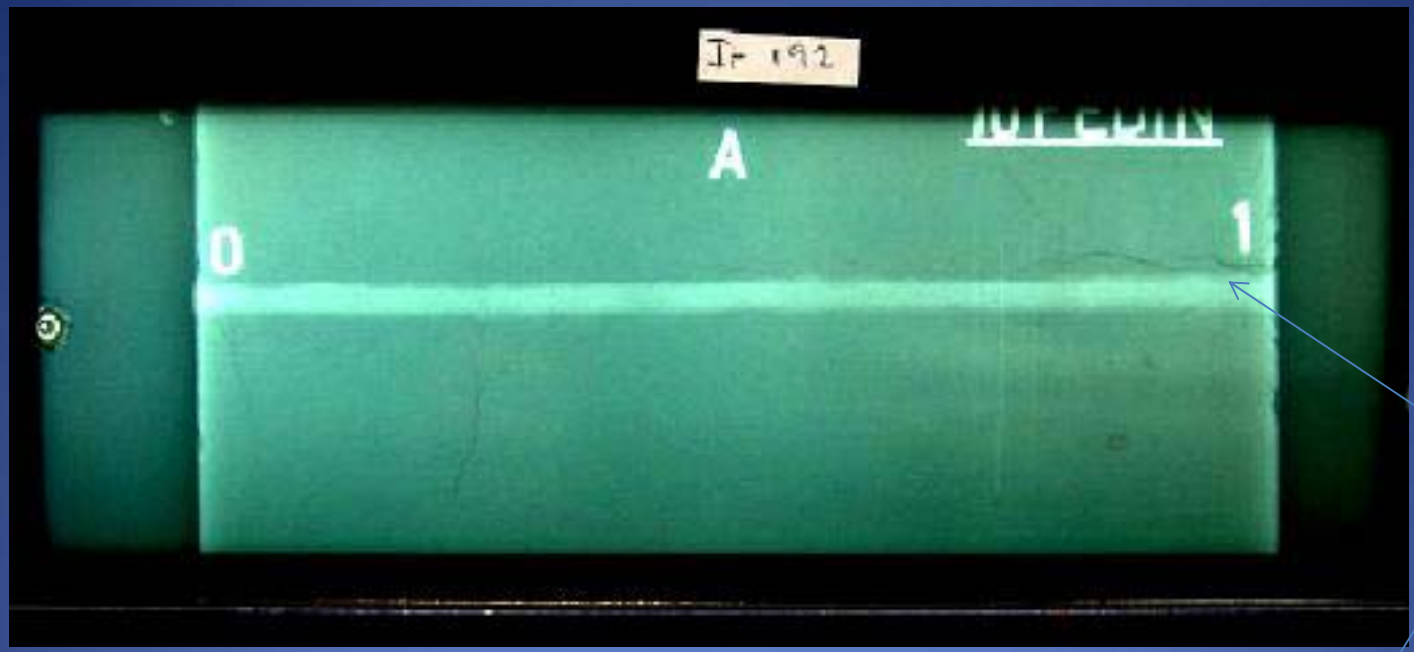
The selection of the correct film will greatly enhance the image results obtained when the films are processed.

IRIDIUM vs SELENIUM

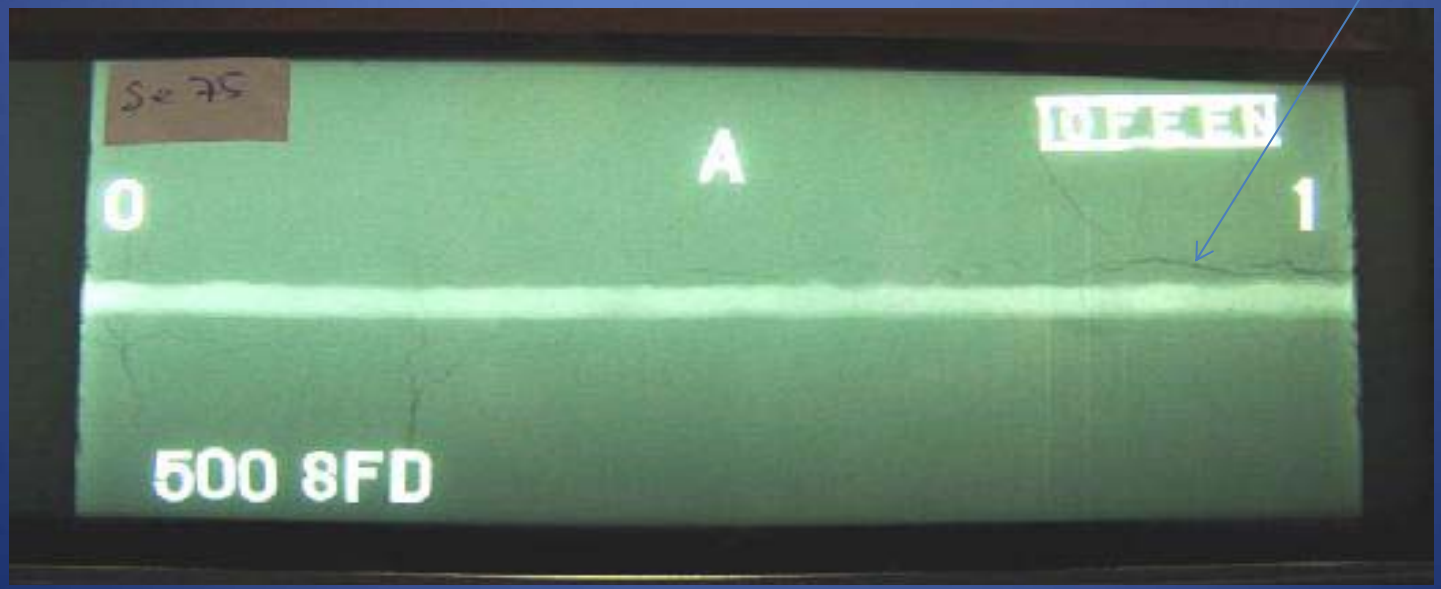
- Se-75 can provide the same contrast at lower wall thicknesses when compared to Ir-192, or provide improved values for the same material thickness.

- A reduced contrast has been accepted for the use of Ir-192 when isotopes are used for low wall thicknesses.

  Results of images obtained when Ir-192 and Se-75 were employed as gamma ray source in NDT of same specimen of steel plates which contained typical weld flaws is presented below:



flaws



Source: http://www.platinummetalsreview.com

From the image results, the following were deduced:

- Flaw detection using Se-75 is improved compared to Ir-192 for radiography of thin (5mm) materials.

- There is an increased contrast of the Se 75 image compared to that of Ir-192. Therefore the application and use of Se 75 for industrial radiography is better suited for steel thicknesses over 5mm.

- Technicians have also been able to note the reduction in radiation area when using Se-75 compared to Ir-192.

Radiation Safety

Usual precautions taken while handling radioactive materials be observed in performing NDT with Ir-192 and Se-75. These include:

- Checking on the amount of radiation received by carrying film badges or radiation detectors such as dosimeters.

- Practically, it is not feasible to provide safety from gamma rays solely by means of a protective barrier. Therefore, distance or a combination of distance and protective material is usually required.

- When not in use, radiation source should be stored securely. protection is usually obtained by keeping them in thick lead containers, because in this case the total amount of lead needed is not great.

Distance is the most economical method of protection while the source is in use. A danger zone should be roped off around the location of the radioactive material, and personnel should be forbidden to enter this zone except to put the source in position or return it to its safe. Suitable conspicuous signs should be provided to warn away the casual passersby.

CONCLUSION

- Increased contrast of the Se-75 image compared to that of Ir-192. Thus Se-75 can be utilized for thicker materials.
- Reduction in radiation area when using Se-75 compared to Ir-192.
- Selenium-75 provides advantages of longer half-life, improved operator safety, smaller exclusion zone and high image quality. Can be used in remote geographical regions and most particularly in offshore applications.
- NDT is suitable for extreme applications.
- Of course, Radiation safety is paramount.

SUGGESTIONS

- ✓ Techniques that will allow Gamma radiography to be fully automated reducing the need for human proximity to radiation source.
- ✓ Investigation of means to obtain clearer images by a unique combination of distance of source, exposure time and film considerations.
- ✓ Possibilities of using NDT on detection of flaw in composites and non-metals as well.

THANK YOU FOR LISTENING