



Industrial radiography: hand injury from exposure to X-ray beam

Description of the incident

A Company carried out industrial radiography (X-ray and gamma) in its own radiography enclosures, and also at other locations using mobile equipment (site radiography).

Prior to this incident, there was a fault with the portable X-ray warning signals, which prevented site radiography work being carried out as planned. Consequently, managers instructed that this equipment should be pre-tested in the radiography enclosure. A method for this was devised, which involved connecting the mobile warning systems into one of the radiography enclosure systems. Using this method, the enclosure safety and warning systems (door interlock, audible pre-warning and exposure warning lights) were disabled, but the X-ray set could still be operated.

On the day of the incident, two radiographers were carrying out X-ray radiography in an enclosure. They went for a break, but left the operating key in the X-ray control panel. A different employee noticed the enclosure was empty, and decided to test the mobile safety systems using the above method for the first time.

The radiographers returned to set up the next exposure in the enclosure, unaware that the safety systems had been disconnected. They did not see their colleague testing the mobile systems and he did not see them enter the enclosure. While one of the radiographers was moving the X-ray tube, the employee testing the mobile systems started an exposure. The radiographer's fingers on his right hand were directly over the beam port of the x-ray set: fortunately, the beam was not directed at his body. The radiographers noticed a "radiation" warning light (from a separate detection system installed for gamma radiography) and left the enclosure immediately.

No immediate investigation was carried out: the incident was reported 3 weeks later when the radiographer informed the Company of radiation burns on the ends of his fingers (see photograph below).



Radiological consequences

It was estimated that the exposure to the radiographer's fingers was approximately 23 Sv (based on a 2 second exposure to the beam).

The radiographer suffered severe tissue damage to fingers on his right hand (see photograph). He did have surgery, but his fingers remain numb, with occasional tingling, although he has now been able to return to work.

The Company was prosecuted by the national regulatory authority, and received a fine equivalent to approximately €40,000.

Lessons to be learned

This incident could easily have been prevented and radiation exposures could have been much higher. Specific lessons learned from this incident include:

- Industrial radiography uses high output sources. Even very short exposures to the main X-ray beam can produce radiation injuries. Safety and warning systems should never be disconnected or overridden unless other precautions can be put in place to maintain the same overall level of radiation safety.
- Industrial radiography safety systems should be regularly tested; however the testing methods should be subject to a proper risk assessment process, in consultation with a Radiation Protection Expert (RPE). Such an assessment would have highlighted the potential dangers of disconnecting the installed safety systems. In this case, it would have been relatively simple to arrange for alternative safety systems to prevent access to the enclosure during testing.

- Key-controlled X-ray control panels are an important safety feature. In this case, the key was left unattended in the control panel, even though the working instructions required it to be removed. In the subsequent investigation this was found to be a common practice.
- A separate independent safety system (in this case, an installed “gamma alarm” radiation detector) prevented the dose from being much higher. Personal electronic alarms/dosemeters provide a similar function, and should be considered for all industrial radiographers.
- There were no specific safe working procedures for testing the mobile safety systems, and there were no provisions for ensuring that this task was properly supervised.