



Report from a UK incident

Overexposure of welders due to temporary loss of ytterbium-169 (Yb-169) source

Description of the incident

A metal fabrication company was undertaking gamma radiography in a radiography enclosure using an ytterbium-169 (Yb-169) source. The enclosure and radiography equipment was owned by the Company; however the radiography was undertaken by sub-contractors.

There were some specific features of the radiography work:

- Very tight bends were needed in the source guide tube to expose the source in the correct position. Consequently, a special guide tube was fabricated in-house; however the extra force needed to drive the source along this tube was too high for the automatic exposure system. Instead, the radiographers exposed the source manually which negated many of the installed safety systems in the radiography enclosure.
- The source capsule was attached to the source holder by a screw thread, which was glued together.
- The gamma radiation energy and the gamma dose rates from Yb-169 are relatively low: the dose rate at the surface of the shielded (depleted uranium - DU) source container was the same whether or not the source was present. Also, to obtain high quality radiographs the end of guide tube was modified to allow the source capsule to protrude out of the end.
- There was an installed gamma alarm in the radiography enclosure, but this had to be switched on manually and was not always used by the radiographers. In addition, the gamma alarm did not sound when the source was inside the component being examined.

On the day of the incident the glue securing the threaded joint failed allowing the source capsule to unscrew. When the source was driven around the tight bends in the guide tube, the rotational forces were sufficient to unscrew the source from its holder.

Following the last radiograph, the radiographer retracted the source holder, but the source capsule fell out of the open end of the guide tube into the component being examined. The radiographer measured the dose rate at the source container: he believed that the source was inside despite this being the normal reading for an empty DU container, and returned the container to the store. He noted that the safety indicator on the container had changed from red to green; however this is triggered by the source holder (not the capsule) returning to the source container. At no time did the radiographer use his dose rate monitor to check around the enclosure.

The component was then moved to the welding facility. At the end of the shift, the welders checked inside the component to check for any metal debris and noticed the

source capsule (it looked like a small screw). The welders passed it amongst themselves trying to identify where it had come from (they were completely unaware that it was a radioactive source).

The radiographers returned later and, on entering the welding facility, some of their personal alarm dosimeters were activated; however the alarms were assumed to be faulty, and this was ignored. Some of the radiographers also handled the source in an attempt to identify it. Eventually a radiation monitor was used, which revealed that it was a radioactive source. At this point the room was cleared and the source recovered without further incident.

Radiological consequences

The incident was investigated by the national regulatory authorities. Initial estimates indicated hand doses of up to 16 Sv, and whole body doses of 5 mSv. No tissue reactions were subsequently observed, and the hand doses were later re-estimated as being up to 2 Sv.

The investigation concluded that the radiation doses could have been much higher. The welders were intending to take the source capsule out of the facility and show it to other workers to help identify it. If this had occurred, many more persons could have been exposed.

The welders were not radiation workers and were not trained in radiation protection; many were very worried about the incident.

Lessons to be learned

The Company was prosecuted for not having a suitable and sufficient radiation risk assessment for the radiography work. Such a risk assessment should have identified that:

- The bends on the specially-made guide tube were outside the manufacturers' specification; the effects of having to manually force the source holder round these tight bends had not been considered.
- Using a manual exposure system would defeat many of the installed safety systems.
- The source becoming detached was reasonably foreseeable, and the use of open-ended guide tubes was not appropriate.
- The gamma alarm system was not sufficient to detect a detached Yb-169 source, due to the shielding provided by the component being tested.
- Monitoring the DU source container would not provide a positive indication that the source was present.

Another lesson can be learned from the fact that the radiographers did not immediately recognise the source capsule when it was presented to them, even though the Company did have a dummy source capsules for demonstration purposes. All gamma radiographers should know what the source capsule looks like, and consideration

should also be given to sharing this information with other relevant workers such as welders.

The prosecution resulted in a very large fine - equivalent to almost 0.5 million euros (including legal costs).