Protective gloves against ionising radiation and contamination

As the use of radiation increases in the healthcare industry, the need for adequate protection for health workers is becoming more important. One of the most common items of personal protective equipment (PPE) in this field of work is the glove. In Europe, the performance standard covering these is EN 421:2010 – ‘Protective gloves against ionising radiation and radioactive contamination’. This article describes the general requirements for gloves protecting against radioactive contamination and ionising radiation, and includes the types installed in permanent containment enclosures.

Background radiation comes from many sources, and includes naturally occurring radioactive materials found in soil, water and air. An example is radon – a gas that emanates from some rocks and soil. Radionuclides (radioactive particles) from air, food and water are ingested by people every day. Human exposure to radiation also comes from man-made sources, such as nuclear power and medical diagnosis or treatment. The most common of these are X-ray machines and other medical devices, and it is these that this type of PPE is designed to protect against.

A vital piece of protection
The dangers involved in not using the correct protective equipment in this area are serious and, while the risk of contracting cancer from such scattered radiation is low, this type of exposure can lead to dermal atrophy and damage to the vascular tissue. It should never be forgotten that radiation is invisible, odourless and cannot be felt. In addition, while we live with background traces every day, the statement that all radiation protection specialists live by – ‘as low as reasonably possible’ – ALARP should be remembered in order to keep any accidental or increased exposure to a minimum.

It is also important to remember that with regard to the healthcare industry, any radiation-resistant gloves are not designed for use in the primary X-ray beam. They are intended to reduce the scattered radiation to which the surgeon’s or other health practitioner’s hands may be exposed. As such, they should be considered a piece of safety equipment to help reduce radiation exposures and risks.

Testing regimes
EN 421 requires that gloves for protection against radioactive contamination are tested to EN 374-1:2003 – ‘Protective gloves against chemicals and microorganisms. Terminology and performance requirements’ (clause 5.2) for resistance to penetration (figure 1), EN 388:2003 – ‘Protective gloves against mechanical risks’ for mechanical performance, and EN 420:2003+A1:2009...
an X-ray tube generates four narrow beam ‘qualities’ (the energy of the beam at the target area), shown in figure 2. These are of different voltages and filtration thicknesses, as given in clause 5.1.3 of EN 421. Copper filtration is used to attenuate the beam to specific wavelengths. This ensures that only the primary radiation source is measured, thus avoiding anomalous readings due to radiation from a secondary source being detected. In general use, copper or aluminium filtration is used to ensure the exposure to the patient is kept to a minimum, so the filtration used in EN 61331-1 tests replicates this.

The detection method used can be X-ray film, numeric film or an ionising chamber, the latter being used most often due to the lack of availability of X-ray films and the recent technological advances in the development of ionisation chambers. The beam is measured by one of these detection methods after passing through samples of the glove. These are taken from four places across the surface of the glove, and then compared to the strength of the beam passing through various thicknesses of lead.

The results are measured as an ‘air kerma’ (kinetic energy released per unit mass) rate in grays (Gy) or milligrays (mGy), and are then interpolated from this comparison as an equivalent thickness in millimetres. A ‘grey’ is a measurement equal to a joule per kilogram and reflects the sum of the initial kinetic energies of all of the charged particles liberated by uncharged ionising radiation.

Before submitting gloves to this highly specialised, complex and precise procedure, SATRA is able to offer a simple comparative screening test using recently purchased X-ray equipment. This enables glove manufacturers to have a quick check test performed on their gloves before deciding whether or not to proceed with EN 421 testing (see figure 3). Please email research@satra.com for more information.

Besides attenuation properties, consideration should be given to the flexibility of the gloves and the sensitivity to touch they allow. These parameters are much improved, with the introduction of other heavy elements replacing lead in the construction of the gloves. Many now use bismuth, tungsten or titanium as an alternative shielding element. In addition, the newer glove designs have the advantage of not needing to be disposed of as hazardous waste in the way that lead must be.

Other PPE

The testing in EN 61331-3 covers protective clothing, eyewear and protective patient shields, and uses the same lead equivalency test as in EN 421 to ensure the risks are kept to a minimum over the rest of the body. All this protective gear should be used in association with, and as part of, a structured set of local rules governing who has access to the relevant equipment and what safety measures should be in place.

In general, any organisation that works with a radioactive source must be licenced and regulated by the relevant authorities. In the UK, these are the Environment Agency and the Health and Safety Executive, who ensure that workers and members of the public are not harmed by the activities associated with the source. Similar organisations with the remit to oversee the safe use of radioactive materials exist in other parts of the world. Their work includes reviewing risk assessments which should include the use of PPE as a control measure.

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Figure 1: Testing a glove to EN 374-1:2003 (clause 5.2)

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Figure 2: An example of narrow beam geometry

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Figure 3: A glove that fails the EN 421 clause 5.1 test (on left), compared to a glove that passes (on right)