Shielding against radiation

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Bhaskar Balakrishnan

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The recent radioactive material incident at Mayapuri in Delhi has thrown up certain basic issues involving safety of the public against radiation exposure in various contexts. Most of the radiation safety practices are familiar to personnel working in specialised institutions using X-rays or radioisotopes for medical, industrial, or research purposes. Public awareness of such issues is low.

The release of radioactive substances and their dispersal can occur due to several reasons. One is disposal of scrap containing radioactive material as happened in Mayapuri. Another is the accidental release of radioactive substances from installations such as nuclear power plants and waste repositories. Yet another possibility is the use of nuclear weapons in the event of a conflict, which requires adequate civil defence measures. In addition, exposure can occur during medical diagnostic tests, such as X-rays and CT scans, and because of background radiation, which is always present at varying levels.

EXPOSURE LIMITS

Certain amount of radiation exposure is inevitable due to the natural background radiation that exists, arising from cosmic rays, natural minerals, etc. The level of this is around 1-6 milli Severts per year (mSv/yr, the unit of radiation dosage).

Where radioactive minerals such as thorium and uranium are present, the natural dosage may be higher — for example, in Kerala, the additional dosage is 4 mSv/yr. Over time, humans have developed a certain level of tolerance for this radiation. Medical X-rays, on the average, account for another 2 mSv/yr in developed countries; in India it may be lower. A single CT abdomen scan, for example, can result in a dosage of 30 mSv.

Among the types of radiation emitted by radioactive substances, the alpha and beta rays can easily be stopped by heavy clothing, and absorption even in air. Such radiation can be a problem if the active substances are ingested into or deposited on the human body. The gamma rays, on the other hand, are intensely penetrating and require the substantial thickness of lead, steel or concrete to attenuate them. It is this form of radiation similar to X-rays that poses the most danger.

To prevent accidental release of radioactive substances in scrap metal, it is essential to have a system of screening of consignments for radiation at the port of entry. And prior to processing, any suspicious package or component must be isolated in a properly shielded zone, and subjected to detailed examination. A scrap market should have access to a trained safety officer and supporting infrastructure as is the requirement in many establishments. Any suspicious incident should be promptly notified. The residents of scrap markets should be encouraged to put in place such measures to avoid a repetition of the Mayapuri incident.

HEALTH HAZARDS

Unlike chemical poisoning, radiation exposure does not produce immediate symptoms. The effects become apparent only after some time, depending on the dosage and location in the body. Some organs are more sensitive to radiation, such as the reproductive organs, bone marrow, etc. Damaged cells may get repaired, or die, or worse, develop into cancers. In embryos, damaged cells may result in deformations and abortion of the foetus.

Small doses of radiation may not produce immediate effects, but may have effects that last over many years. Large doses (2-5 Sv) may result in "radiation sickness" — with symptoms such as skin burns, diarrhoea, vomiting, and changes in blood profile — first seen in the wake of the nuclear bombing of Hiroshima and Nagasaki.

As cases of exposure to radiation are relatively rare, ordinary medical personnel may not be able to diagnose this condition unless a clue emerges as part of the case history. Training of medical personnel to recognise and treat radiation injury is, therefore, important.

NUCLEAR PLANTS

Nuclear power plants are a source of concern to those living nearby. In addition to the reactor itself, these plants house radioactive substances in the spent fuel, cooling water, and contaminated equipment and supplies, which must be properly handled and disposed.

However, the plants are built and operated under exacting safety regimes, and radiation levels are monitored regularly and the discharges of radioactive materials into the atmosphere and water are kept well below permissible limits. Their safety record over many cumulative years of operation has been quite exemplary.

The Atomic Energy Regulatory Board's prescribed limit of exposure for the general public is 1 mSv/yr, based on the ICRP-60 international standard. The AERB has also fixed limits for discharges of radioactive substances from nuclear power plants. According to the AERB, the effective dose for the public arising from nuclear power plants at a distance of 1.6 km was only 2.3 per cent of the maximum permissible limit for Tarapur, and much lower for the other plants.

However, while everything possible is done to ensure safety, incidents can and do occur. Any incident that has the potential to harm the public must be promptly, automatically and fully disclosed to the public by the operator of the installation. The local population must be regularly briefed on the risks and the action to be taken in the event of any incident. These measures must be made mandatory. The operator should consider the local population as a partner and not an adversary. Unfortunately, this has not always been done in the past where unnecessary secrecy has aroused suspicions. With the anticipated growth of the Indian nuclear power industry, such matters will assume greater importance.

In the area of civil defence and preparedness for nuclear attacks and emergencies, India needs to do much more. In view of such a threat from Pakistan and China, and the expected growth of the nuclear industry, the subject should be given more priority.

The capacity of institutions such as the National Civil Defence College, Nagpur should be strengthened.

While every effort should be made to avoid a nuclear attack, if it does occur, it would undoubtedly cause huge damage and casualties. However, it is the duty of the state to achieve the best possible preparedness to deal with such a situation and reduce human suffering. A basic booklet should be issued for public guidance on preparedness for nuclear emergencies.

(The author is former Ambassador to Cuba and Greece. blfeedback@thehindu.co.in)