IN THE SPOTLIGHT: Radiation protection
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Radiation protection for people and the environment

The purpose of radiation protection is to shield people and the environment from the harmful effects of exposure to ionising and non-ionising radiation. Radiation protection measures are implemented in a range of areas, from workplace health and safety, e.g. in X-ray departments, to managing the legacy of decades of nuclear power generation.

Ionising radiation is extremely high in energy and can therefore cause significant damage to living tissue. Ionising radiation occurs as a product of radioactive decay or can be generated artificially, as with X-radiation, which is used in radiology. Non-ionising radiation is emitted in high-frequency electromagnetic fields (telecoms) and extremely low-frequency electric and magnetic fields (power lines), for example, and also occurs as ultraviolet (UV) radiation from the sun.

The public is also exposed to radiation from natural sources. Radon, a noble gas that is present in the air, breaks down into radioactive decay products which enter the human body when inhaled. Natural radionuclides are ingested with food. Cosmic radiation and terrestrial radiation are further sources of exposure. In Germany, the annual effective dose from this natural radiation exposure amounts to 2.1 millisieverts on average, albeit with marked regional variation.

Protection from technological impacts

The potential damage to people and the environment varies, depending on radiation intensity. It is therefore important not only to manage current radiation exposure but also to take responsibility for past and future exposure. Various radiation protection measures are required in this context, including:

- Management of current radiation exposure: this includes measures to limit and minimise risks associated with the operation of nuclear plants, medical applications, low- and high-frequency fields and exposure to natural radiation (particularly radon).
- Legacies of the past: this involves the removal or minimisation of the impacts of earlier human activities, such as the uranium ore mining previously carried out by the Wismut mining company in eastern Germany; and
- Safe storage of high-level radioactive substances from German nuclear power plants for the future: this involves the planning of repositories. These final storage facilities minimise the risks associated with existing stocks of radioactive waste.

Radiation protection from a scientific perspective

Radiation protection is a field where new challenges continuously arise and require interdisciplinary scientific solutions. Key issues currently on the agenda include:

- Radioecology: This branch of science analyses and models the transport of radioactive substances in the environment and the exposure of humans, flora and fauna to radiation, with a view to providing optimal protection. A further objective is to determine whether current standards and limit values can continue to be met in the long term.
- Disaster management and radiation protection: When serious accidents occur in nuclear power plants, particularly those involving core meltdowns, appropriate measures must be taken to minimise the radiological impacts in the short and long term. For example, any radioactive substances released into the environment must be measured, monitored and evaluated in terms of possible impacts.
- Management of contaminated sites: This involves examining whether remediation is necessary, how it can be carried out and how sites can be monitored in future.
- Risk communication: This is highly relevant to many of these issues, including the impacts of low- and high-frequency fields and the dismantling of nuclear power plants. A key issue currently on the agenda is the final storage of radioactive waste; here, the general public is involved in delivering a solution.

The Oeko-Institut’s role: the scientific basis for the protection of humankind

The Oeko-Institut has a long tradition of conducting research on radiation protection issues. Its office in Darmstadt has contributed substantially to the development of new approaches for mitigating existing radiological impacts and possible accident-related risks.

Major milestones: Oeko-Institut experts provided answers to wide-ranging questions from the general public and various governmental and non-governmental organisations on the impacts of the Chernobyl and Fukushima reactor disasters. They conducted analyses of the potential impacts of accidents at nuclear reactors located in Germany itself or close to its borders and have been involved in the remediation of contamination resulting from uranium ore mining.

At present, the Oeko-Institut’s researchers are working on topics which are, and will continue to be, of particular importance after Germany’s phase-out of nuclear power. The greatest challenge is selecting a suitable site for the final storage of nuclear waste. Radiation protection principles must be upheld in the dismantling of Germany’s nuclear power plants – another area of intensive engagement by the Oeko-Institut.

It is essential that measures to protect people and the environment are incorporated into relevant legislation and continuously updated on the basis of scientific knowledge. The Oeko-Institut’s staff provide research-based consultancy to institutions responsible for these issues at the local and national level and are members of bodies such as the German Commission on Radiological Protection, the German Reactor Safety Commission and the German Nuclear Waste Management Commission.

Study: Impacts of a major nuclear accident on the drinking water supply

Switzerland's Leibstadt nuclear power plant is sited directly adjacent to the River Rhine close to the German border. How would a nuclear accident on the scale of the Fukushima disaster impact on the drinking water supply for the city of Basel downstream? Would it be feasible to source an alternative water supply from the River Wiese, a tributary which flows towards the Rhine from the German side of the border? How would radionuclides released into the air disperse in various weather scenarios – and when, where and how would they enter the Wiese river system?

To answer these questions, scientists from the Oeko-Institut modelled the behaviour of radionuclides in the environment in order to analyse the expected contamination of the River Wiese. The study was commissioned by IWB Industrielle Werke Basel – the city of Basel's water utility – and the Trinational Nuclear Protection Association (TRAS).

Radioactive contamination would enter the river via a cascade of reservoirs of various types, including areas of vegetation, sealed surfaces, soil and groundwater. The calculations showed that within a matter of hours, the river system would become so heavily contaminated that the water would no longer be of a suitable quality for infiltration into the drinking water supply.

However, the modelling also showed that after just 14 days, radionuclide levels in the River Wiese would decrease to the point where the water was usable once more. A 14-day interruption of infiltration would not pose any risk to Basel's drinking water supply, so in the event of a nuclear accident, a replacement supply of raw water from the River Wiese would be a feasible option.

https://www.iwb.ch/Fuer-Unternehmen/Wasser/Trinkwasser-Versorgung.html

Studies on the clearance of radioactive substances

When granting clearance for radioactive waste from nuclear power plants, which factors must be considered in order to provide optimal protection for waste management staff and local residents? Which limit values should apply? The Oeko-Institut's researchers have conducted various studies and produced a number of expert opinions on the exposure of the general public and workers to radiation.

For example, the Oeko-Institut was commissioned by the waste management operator in the district of Neu-Ulm to investigate whether the Weissenhorn waste-fired power plant was suitable to burn clearance waste from the Gundremmingen nuclear power plant. The Oeko-Institut's researchers calculated radiation exposures for employees and the general public. The German Radiation Protection Ordinance (Strahlenschutzverordnung – StrlSchV) states that radioactive waste may be cleared only if the additional exposure for the public will not exceed 10 microsieverts per year.

The Oeko-Institut's team of experts looked at various exposure pathways and concluded that in all cases, doses are well below the limit values. Even in a hypothetical scenario in which local residents only consume agricultural products from fields directly adjacent to the incineration plant, the doses fell short of the limit value by a factor of 5,000. The highest radionuclide dose was found in waste transportation employees. While this dose is substantially lower than the dose criterion set out in the Ordinance, the expert opinion included a number of recommendations on how it could be further reduced.

Further information

Opinion on conceptual issues of clearance for disposal at a landfill in decommissioning and dismantling of the Obrigheim nuclear power plant (KWO), by the Oeko-Institut on behalf of Abfallwirtschaftsgesellschaft des Neckar-Odenwald-Kreises mbH (AWN)

Oeko-Institut Annual Report 2016: Provision of nuclear advice to Abfallverwertungsgesellschaft des Landkreises Ludwigsburg (AVL) GmbH

Potential radiological consequences of clearance for disposal according to § 29 StrlSchV in the subsequent use of a landfill during post closure care and in the period afterwards: study by the Oeko-Institut on behalf of Baden-Württemberg's Ministry of the Environment, Climate Protection and the Energy Sector

Vortrag „Mögliche Folgen der Ablagerung freigemessener nicht-radioaktiver Abfälle bei der Nachnutzung von Deponien" beim 28. Karlsruher Deponie-und Altlastenseminar 2018 (= Possible consequences of depositing cleared non-radioactive waste in the subsequent use of landfills: lecture at the 28th Karlsruhe Seminar on Landfills and Contaminated Sites, 2018)

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