

THE FATE OF RADIOACTIVITY IN SEWERS

The Environment Agencies authorise and monitor the disposal of low-level radioactive waste to sewers. Such discharges originate from non-nuclear sites such as hospitals, universities and research centres. Discharges are strictly controlled through authorisations, which place conditions and limits on the disposer. We commissioned the work summarised within this leaflet to reassess the fate of these radioactive discharges and to ensure that this practice remains acceptable and is still the best option for disposal. In all cases the study found assessed radiation doses (associated with these discharges) to be a small fraction of the public dose limit. The Environment Agencies conclude from this study that the disposal of radioactive waste to sewers remains the best option available to ensure the safety of the public (including sewer workers) and to protect the environment.

Approach

The application of radioactivity in medicine, for the treatment of cancer and the diagnosis of disease, is an essential part of modern living. The Agencies recognise that the use of radioactivity by small users, such as cancer therapy units and research institutes, is justified and authorises them to dispose of their low-level radioactive waste to sewers. The Agencies consider this to be a safe practice, but to confirm this we instigated a research study to reassess the potential doses to workers and members of the public that result from these discharges.

The Beckton and Knostrop sewage treatment works (in London and Leeds respectively) and their associated sewer systems were chosen for the study. This was due to their size and complexity, in particular because discharges may enter these systems from many different sites. A computer programme was developed to model the fate and behaviour of radioactive discharges right through the sewer system and sewage treatment works to the liquid disposals from the sewage treatment works. Field measurements were made to validate the model.

The computer programme assessed the radiological impact on two levels: predicting doses based on actual discharges made in 1997; and doses that would result if discharges were made at the authorised limits. Radiation doses have been estimated to people working in sewers and at the sewage treatment works, and for members of the general public. In all cases the doses calculated are for workers and members of the public who are most exposed to the radioactive discharges due to the nature of their job, the location in which they live or their life style. The results are summarised in the next section. It should be noted that the radiation dose figures given are over-estimates, as they are based on authorised discharge limits rather than actual discharges. Generally actual discharges are much less than the authorised limits. For 1997, estimates of the dose to sewer workers based on actual discharges were at least 3 times lower and estimates of the doses to the public were at least 10 times lower. These findings are supported by actual measurements made at the sewage treatment works.

The doses given in the following section may be compared to the annual dose limit for members of the general public of 1000 uSv (the range across the United Kingdom being 1000 - 100,000 uSv), while the same individual might receive 10 uSv during a two hour airline flight or 20 uSv during a chest x-ray. A comparison of these radiation doses is shown in the graph.

Exposure of workers

Drains and sewers - Maintenance workers, undertaking controlled operations to clear blocked pipes in a hospital for example, could encounter radioactive waste. The dose to a worker spending two hours un-blocking a small pipe has been assessed as 110 uSv, or less. This is a small fraction (11 percent) of the annual dose limit. As the waste enters the large-bore main sewer system it becomes significantly diluted and it has been assessed that a worker spending an entire year maintaining large sewers would receive a dose of less than 12 uSv. This is an even smaller fraction of the annual dose limit.

Sewer treatment works - On entering the treatment works, radioactivity may stay in solution and pass through the process unaffected or become attached to sewage sludge and concentrate as the sludge is processed. Doses to workers involved in different parts of the sewage treatment process have been assessed. It is concluded that worker doses are 238 uSv, or less, in all situations. These doses are well below (less than 25 percent of) the annual dose limit. Estimates based on actual discharges made in 1997 are at least 3 times lower.

Exposure of the public (from the sewage treatment works)

Discharges to rivers - Following appropriate treatment, discharges are made from sewage treatment works to rivers. Here there is further dilution of any radioactivity that has passed through the sewage treatment process. Potential doses to the public from these discharges (people who might eat significant amounts of fish caught downstream of discharges) have been assessed to be 180 uSv, or less. This is a small fraction (18 percent) of the annual dose limit. Estimates based on actual discharges made in 1997 are 10 times lower.

Some types of radioactivity tend to concentrate in sewage sludge. The dose to members of the public resulting from its disposal has been assessed. There are three main disposal routes for sludge: incineration, landfill and spreading on land. Each route is discussed below:

Incineration - The vast majority of sludge produced at large urban sewage treatment sites is now incinerated. Some types of radioactivity contained in sewage sludge are released into the atmosphere when sludge is incinerated. The maximum dose to a member of the public as a result of breathing in a small amount of radioactivity is assessed to be 2 uSv/y or less. This represents a tiny fraction of the annual dose limit.

Landfill - The incinerator ash is generally disposed of to landfill. A very small fraction of the total radioactivity so disposed could escape in the form of a leachate or a gas. It has been assessed that the dose to a member of the public from this route would also be minute (2 uSv/y or less). Far less frequently sewage sludge is disposed of directly to landfill (during incinerator shutdown). If it assumed that this disposal route is used all the time it has been assessed that the resulting dose to a member of the public could be 150 uSv/y. A more realistic estimate based on actual discharges in 1997 is at least 1000 times lower.

Spreading to land - Treated sewage sludge has been used for many years as a fertiliser on agricultural land following appropriate treatment. There are restrictions that dictate how often sludge can be applied and the type of land on which it can be used. The sewage treatment works considered in this study do not currently dispose of sewage sludge to land. However, other work including a recent Environment Agency study, in East Anglia, has estimated that the dose from this pathway is a small fraction of the dose limit.

Disposal to sea - This practice ceased at the end of 1998 in line with the EC directive on urban wastewater treatment and has, in most cases, been replaced by incineration. Earlier work, for example a study by the National Radiological Protection Board in 1996, has estimated that the dose from this pathway was a small fraction of the dose limit.

Doses from radioactive discharges to sewers

This R&D technical summary relates to information from project P3-036 contained in the following output:

R&D Technical Report P288: Investigation of the sources and fate of radioactive discharges to public sewers.

Internal status: Released to regions.

External status: Released to public domain.

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Copies of the technical report are available internally from each regional information centre (library) or the National Information Centre in Bristol, and externally from the Environment Agency R&D dissemination Centre, c/o WRc, Frankland Road, Blagrove, Swindon, Wiltshire SN5 8YF, Tel: 01793 865138, Fax: 01793 513562.

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