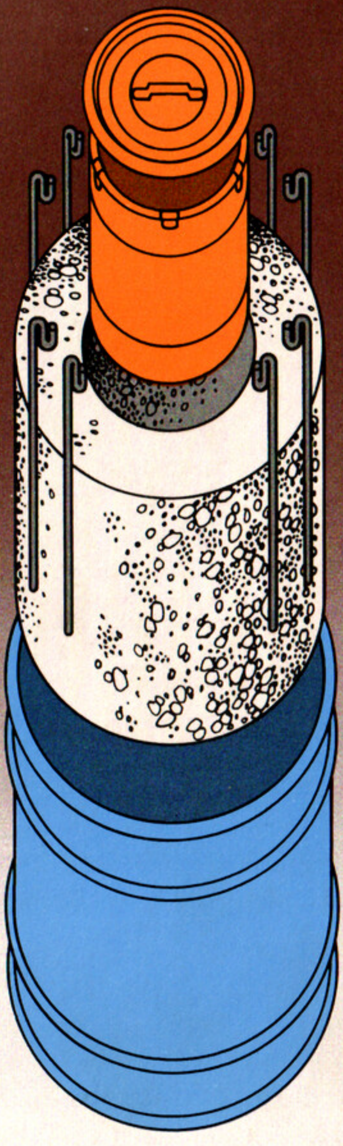
Nuclear waste management



More than 20 years ago, Britain began using nuclear power to generate electricity. Today about 12% of our electricity comes from this source and the figure will rise to about 20% when stations now under construction are completed.

All industrial processes give rise to waste products and some of these have not always been satisfactorily dealt with in the past. In the nuclear industry the potential hazards of radioactive wastes were appreciated from the outset and the careful management of waste has always had a high priority.

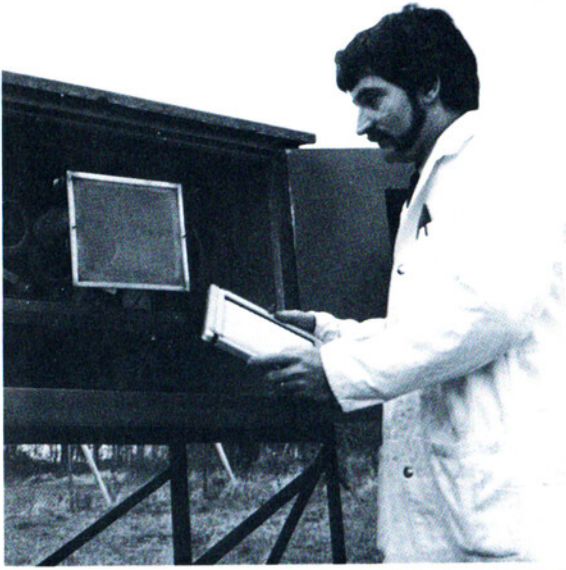
Radiation

Strictly speaking, radiation includes radio-waves, light and heat. In the nuclear context however, the term is used for high-energy radiation which can cause changes in the atoms of material it strikes.

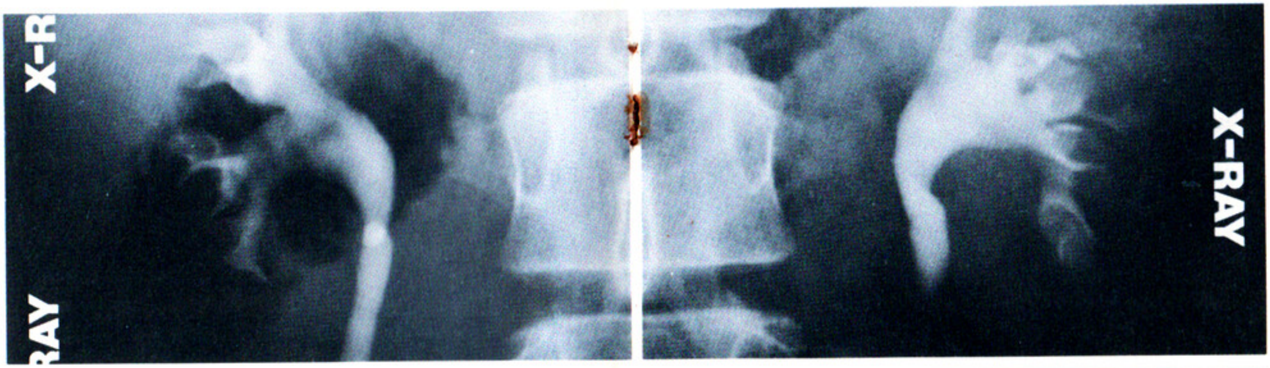
This type of radiation has always been part of the environment, coming from the earth, outer space, and our own bodies. It also comes from medical diagnosis and treatment, and TV sets.

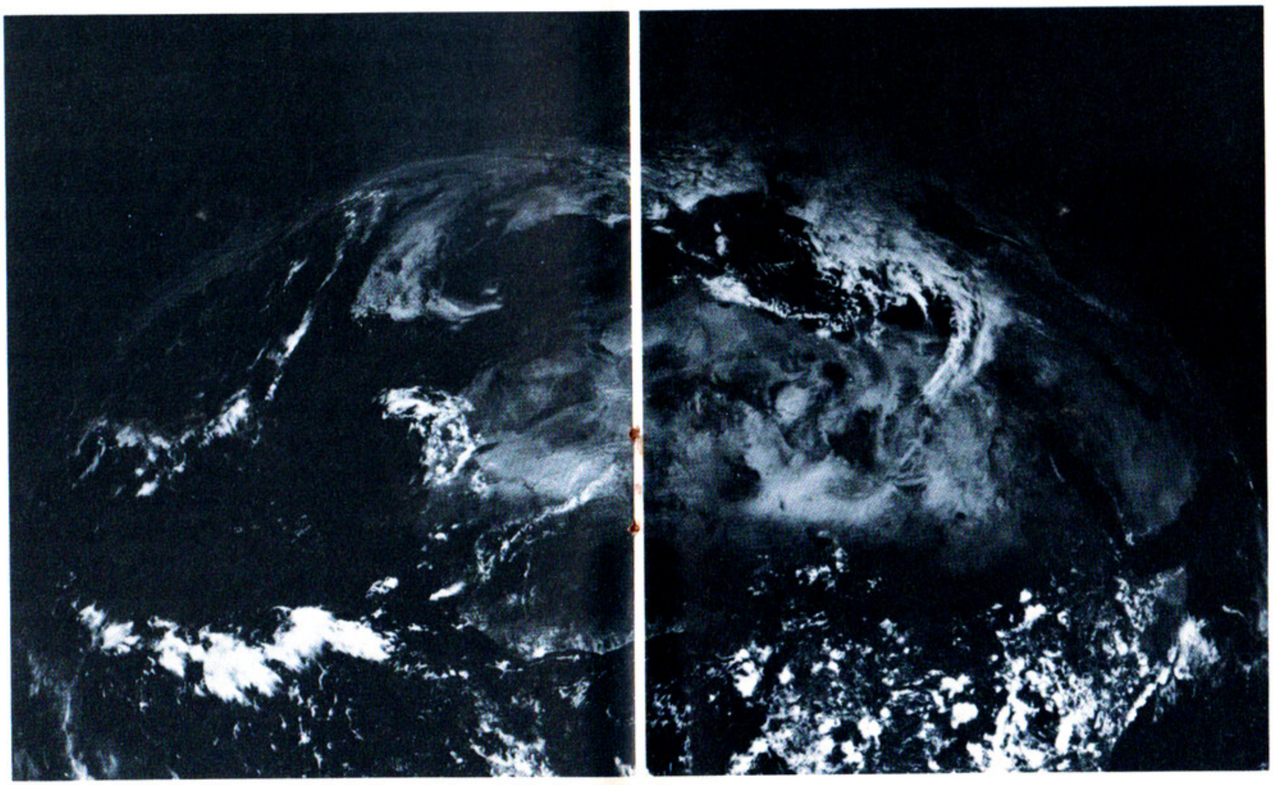
The nuclear power industry contributes less than one-fifth of one per cent of the average radiation to which members of the public are exposed. About two thirds of the total amount comes from our surroundings – the buildings we live in, the ground we walk on – cosmic radiation from space, and from our own bodies. Most of the remaining one-third comes from medical sources like 'X' rays. *The variation* in the natural background radiation between different areas of Britain far exceeds the average contribution from nuclear power. The permitted level of discharges is based on the amount of radioactivity likely to be received by the most exposed groups. A small number of people are more exposed to radioactive discharges than the average but regular environmental monitoring ensures that the greatest potential exposure would be less than 25% of the limit recommended by the

Above: A dust collecting filter is removed from an airborne particles monitor. The radioactivity of the filter is measured and analysed. Below: Radiation on the surface of the ground is measured with a gamma spectrometer.



Two-thirds of the radiation to which the British public is exposed is from the natural background. The great majority of the remainder comes from medical applications, mainly X-rays. Occupational exposure, weapons test fallout and miscellaneous sources such as jet travel and TV sets account for less than two per cent. This leaves just 0.15 per cent resulting from nuclear industry activities.





Drums packed with low active waste and fitted with concrete caps are disposed of in the deep ocean. They must be strong enough to reach the sea bed intact. The inner drum is encapsulated in concrete – 90 per cent of the gross weight is packaging.

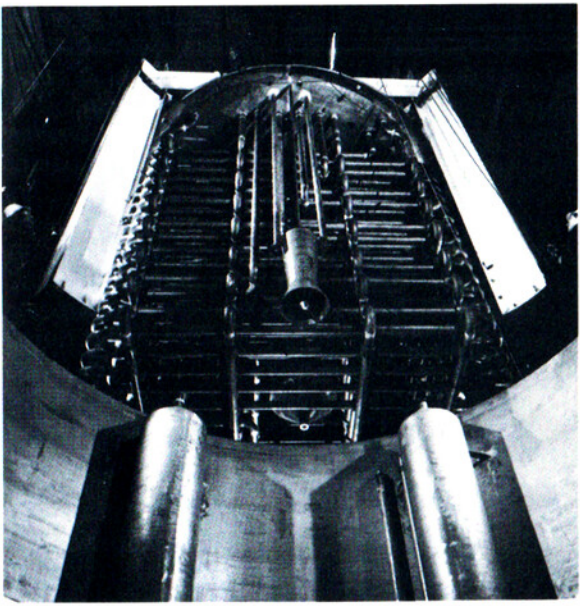
International Commission on Radiological Protection for members of the public.

Unlike hazards from chemical waste products, hazards from radioactive waste decline. The intensity of radiation from a radioactive element falls with time and the more radioactive an element the quicker the decline. The half-life – the time in which the radioactivity falls to half the original value – varies, ranging from less than a second for some elements to billions of years for others. Since in twenty half-lives the radioactivity has fallen to one-millionth of its original value, some radioactive elements virtually disappear almost as soon as they are formed. On the other hand, uranium itself exists in large quantities because it has a half-life equal to the age of the earth.

Origins of the waste

Some radioactive wastes arise from the use of

Cooling coils are inserted in storage tanks for highly radioactive fission product waste at Windscale. These tanks are double-walled and located in concrete vaults lined with stainless steel.



radioactive materials in industry and medicine, but most originate from the nuclear power fuel cycle.

Irradiated nuclear fuel consists typically of at least 96 per cent 'unburnt' uranium, up to two to three per cent fission products (various elements created by splitting the uranium atoms), and up to one per cent of heavy elements (actinides) produced from the uranium by the capture of neutrons. The best known of these is plutonium.

Since most of the fission products have very short half-lives the fuel rods are highly radioactive and physically hot from the energy released as the radiation is emitted. Spent fuel, when removed from a reactor, is placed in cooling ponds for several months to allow the fission products with very short half-lives to die away.

After cooling, the spent fuel is transported in special massive 'flasks' to British Nuclear Fuels' works at Windscale in Cumbria for reprocessing.

There the spent fuel is dissolved in acid and the valuable plutonium and uranium separated for re-use. The remaining liquid, containing fission products and a small amount of actinides, is concentrated and stored in stainless steel tanks surrounded by concrete and cooled with water.
There are several kinds of waste:–
Gaseous (mainly low activity). Gases are produced during reprocessing for example.
Liquid (low activity). Treated water from plant drainage, laundries and cooling ponds.
Liquid (high activity). Concentrated liquor containing fission products.
Solid (intermediate to low activity). Filters, contaminated instruments, paper tissues, protective clothing.
Solid (high activity). Fuel cladding.
Procedures for the management of all these wastes types are well established. Disposal is subject to Government authorisation.

Dealing with waste
Wastes can be stored, or released to the environment where they disperse and become greatly diluted. Government authorisation and monitoring policies are designed to ensure that no one is exposed to a dangerous level at any time. Low activity gaseous and liquid wastes are released directly to the air, rivers and the sea. Some low-level solid waste such as contaminated trash from production and laboratory areas is buried at specially designated sites. Some is incinerated, and some packaged and disposed of in the deep ocean. Most of the intermediate and all high level waste is at present stored.

All these practices are subject to statutory authorisation, inspection and, in the case of the deep sea disposal, international controls and surveillance. To ensure radiation exposure is kept well within internationally agreed limits, air, milk, water, fish, seaweed, grass, soil and other

If all the electricity, domestic and industrial, used by one person in a lifetime, were generated by nuclear power, the resultant long-lived radioactive wastes could be incorporated in a piece of glass this size:

samples are collected and analysed regularly, and the results published.

The first annual report of the independent Radioactive Waste Management Advisory Committee stated: 'Current disposal practices for low and intermediate level solid wastes and for liquid and gaseous wastes are generally satisfactory: they are based on sound radiological principles and should not give rise to public concern. We endorse the United Kingdom's use of deep sea disposal for low and intermediate level wastes; we think this could be somewhat increased'.

A significant factor about nuclear waste is the relatively small amount produced. For a given output of electricity the input of nuclear fuel for thermal reactors is between 10,000 and 20,000 times *less* than for a coal fired power station. If all the electricity an individual uses in his life-time were generated by coal-fired power stations 30 tonnes of ash would be produced. If it were generated by nuclear power less than a kilogramme of highly active waste and a few kilogrammes of fuel cladding would be produced. For each tonne of spent nuclear fuel that is reprocessed about a twentieth of a cubic metre of concentrated highly-active liquid is produced. The concentrated liquid waste from the entire British nuclear programme over the last quarter of a century is equivalent in volume to two three-bedroomed houses.

High level waste

The present method of storing liquid highly-active waste in water-cooled tanks has proved very safe over the last 25 years. However, there are advantages in solidifying the waste by incorporating it into glass blocks in corrosion-resistant canisters.

Turning the waste into solid blocks further reduces the volume and simplifies the management of the waste. The blocks can be stored for very long periods, cooled by water or air. All the highly-active waste produced by the projected UK nuclear programme up to the year 2000 could be stored in this form on an area not larger than two football pitches. In France vitrification is already carried out on a semi-industrial scale.

The glass blocks will be placed in a surface store for a long period. After they have cooled sufficiently they could be consigned to a final depository beneath land or sea. Glass compositions have been developed which are very resistant to the effects of heat or radiation. Experiments have shown that radiation equivalent to that accumulated in the waste in about 100,000 years causes only minimal changes in the physical properties of the glass.

The glass blocks will be encased in steel cylinders which would be covered with corrosion-resistant metal before emplacement in a depository. For underground disposal further barriers to the migration of water or activity could be introduced by packing absorbent material around the containers. The migration of radioactivity from the wastes would be retarded for periods of thousands of years. If disposed of on or under the sea bed any radioactivity migrating into the sea would be diluted to harmless levels.

Studies are now being made in the UK and other countries to assess the feasibility of the ultimate disposal of the glass blocks deep underground or on or under the ocean bed. In the UK a programme of test borings is being undertaken to examine fully the properties and characteristics of different geological formations in relation to their suitability for the containment of the glassified wastes. There is no proposal at present to carry out experiments with radioactive wastes.

The Government expect to have obtained sufficient information in about ten years time to enable decisions to be taken about the development of a demonstration disposal depository. For a land site, access shafts would have to be constructed deep into the selected formations. Any proposals for the demonstration disposal of radioactive waste deep underground would be subject to planning procedures and would also need to be evaluated side by side with the alternatives of disposal on or under the ocean bed which are also being studied. Decisions could then be taken by the Government of the day about a full-scale disposal operation in the next century.

Further information on atomic energy and its applications can be obtained from:

Information Services Branch
UK Atomic Energy Authority
11 Charles II Street
LONDON SW1Y 4QP

Information Services Department
British Nuclear Fuels Limited
Risley
WARRINGTON WA3 6AS

Press and Publicity Office
Central Electricity Generating Board
Sudbury House
15 Newgate Street
LONDON EC1A 7AU

Public Relations Department
The Electricity Council
30 Millbank
LONDON SW1P 4RO

British Nuclear Forum
1 St. Albans Street
LONDON SW1 YSL

Information Services
National Nuclear Corporation Limited
Whetstone
LEICESTER LE8 3LH

Public Relations Department
South of Scotland Electricity Board
Cathcart House
GLASGOW G44 4BE

Published as a contribution to the wider understanding of nuclear power by Information Services Branch, United Kingdom Atomic Energy Authority, 11 Charles II Street, London SW1Y 4QP. January [illegible]
Designed by [illegible]
Printed by Eyre & Spottiswoode Limited at Grosvenor Press Portsmouth