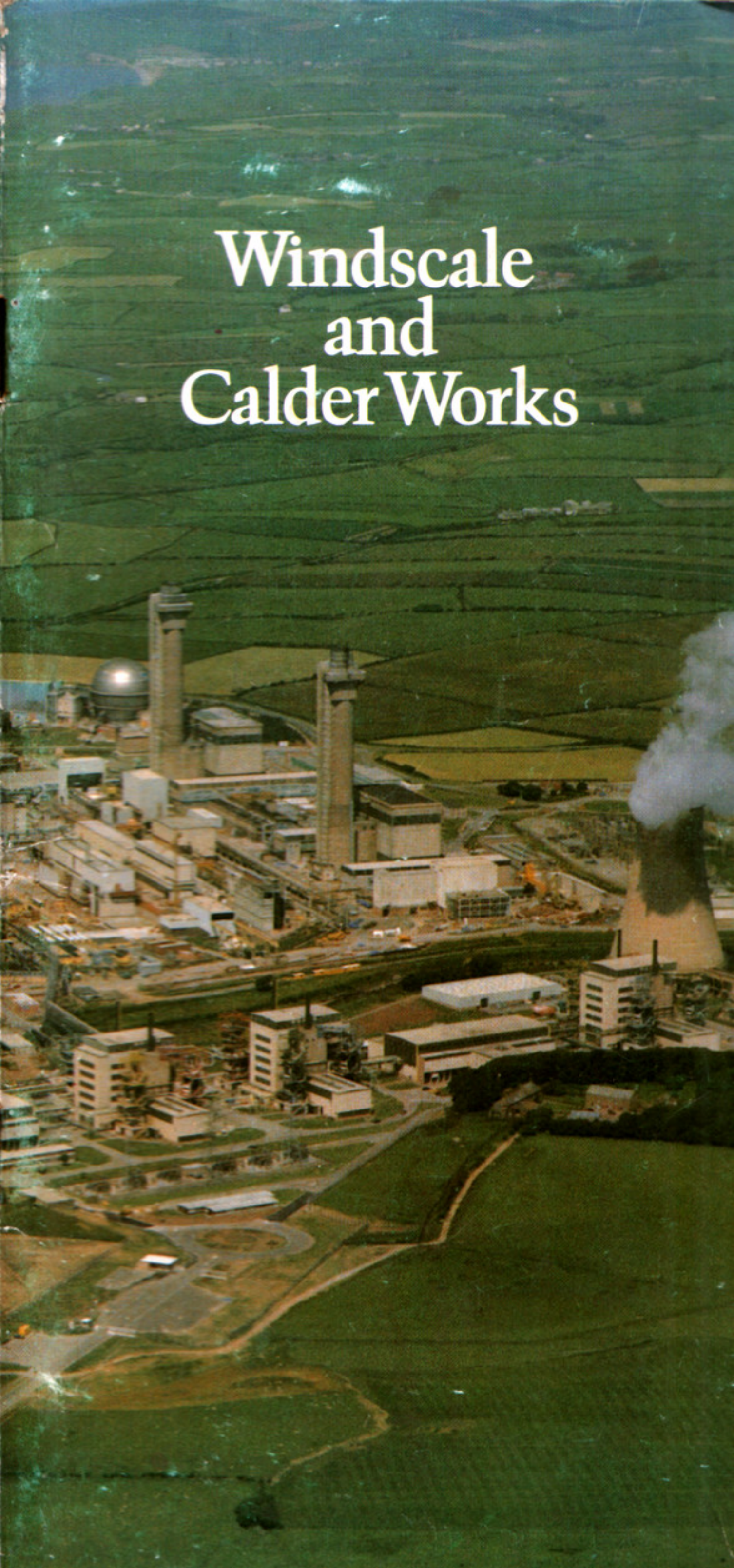
Windscale and Calder Works



Windscale

Windscale has been reprocessing nuclear fuel since 1952 and brought its present reprocessing plant on stream in 1964 to meet the expanding Magnox reactor programme– the first generation of nuclear power stations.

Development of the Thermal Oxide Reprocessing Plant (THORP), the subject of the 1977 Windscale Inquiry, will enable the reprocessing of fuel from the UK's second generation of nuclear power stations– Advanced Gas-cooled Reactors (AGRs), as well as oxide fuel from overseas.

We need to reprocess nuclear fuel to:–

Recover for re-use the valuable uranium and plutonium in irradiated fuel.

Separate radioactive waste from the irradiated fuel so that this can be stored safely for eventual disposal.

Irradiated or spent Magnox and oxide fuels both contain at least 96% unused uranium as well as small amounts (less than 1%) of plutonium. A single recycle of these materials increases by 30 to 40% the electricity which can be produced from a given quantity of uranium ore. This is economically advantageous and a responsible use of finite world resources of uranium.

Main administration block, Windscale

Magnox Reprocessing

Burning fuel in a reactor

Electricity is generated by turbo-generators driven by steam, which is produced by heat. In a nuclear power station heat is produced in a reactor by the fission, or splitting, of uranium atoms. Energy from the atom in this way means that uranium fuel has the potential to produce two million times the energy content of an equal weight of coal.

Nuclear fuel remains in the reactor for several years, during which time atoms in the fuel continue to fission, producing neutrons on which the fission process relies and radioactive waste fission products. The fission products absorb neutrons, causing the reactor to operate less efficiently.

Consequently, fuel elements must be periodically removed and replaced with new fuel elements. After a period of storage at the power station, the spent fuel is sent to Windscale for reprocessing to reclaim uranium and plutonium and to remove the waste fission products.

One of the reactors at Calder Hall

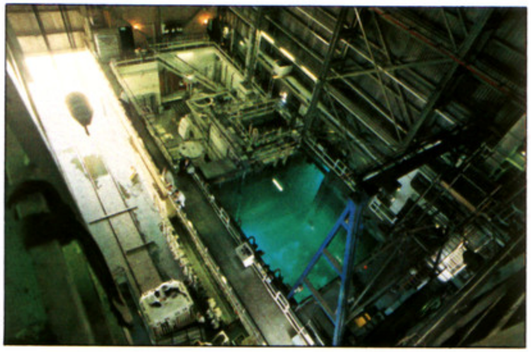
Transport of fuel

Spent fuel has been safely transported to Windscale for reprocessing from nuclear power stations within the UK, Europe and the Far East for the past 20 years. In that time there have been over 7,000 flask journeys in the UK and overseas.

Flasks for the transport of spent fuel are constructed of extremely strong thick-walled steel or steel and lead of high integrity. These flasks are designed and tested to stringent international standards so that they will retain their integrity under arduous and unlikely accident conditions.

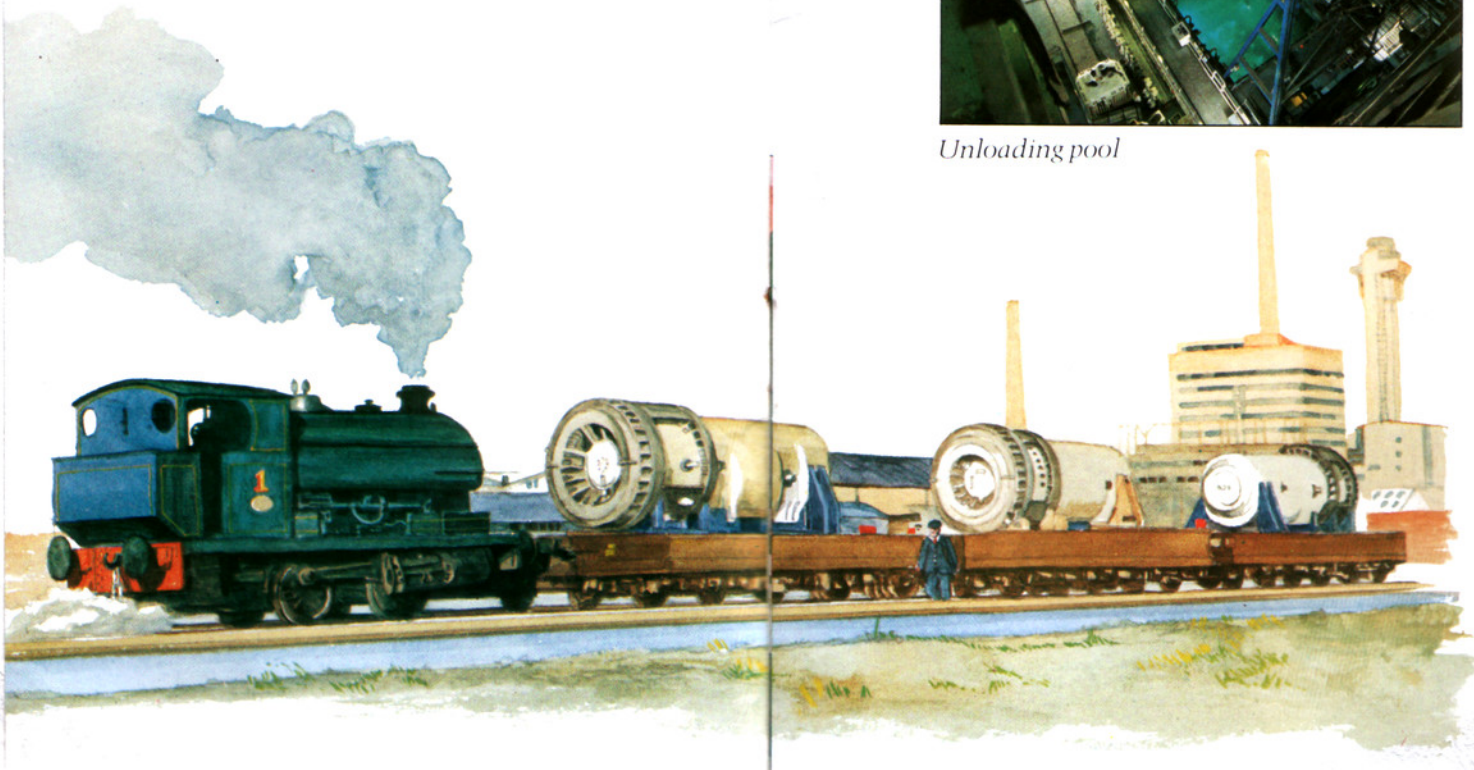
Spent fuel stored in ponds

On arrival at Windscale the fuel elements are removed from the transport flasks under water into "cooling ponds" to await reprocessing. The spent fuel is highly radioactive and continues to generate heat as the fission products decay. The water provides the required degree of cooling to absorb this heat and shields the operators from radiation emitted by the fuel. Storage of fuel for prescribed periods also allows short lived radioactivity to die away before the fuel is reprocessed.



Unloading pool

Moving flasks at Windscale



Decanning

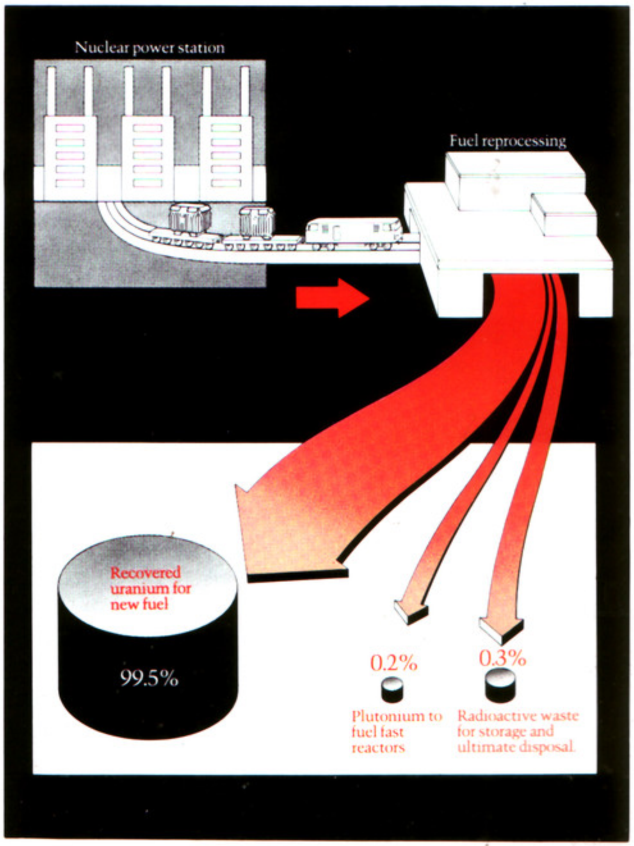
The magnesium alloy casing around the Magnox fuel element must be removed so that the spent uranium fuel rod inside can be reprocessed. Decanning is carried out in shielded cells using remotely controlled equipment. The canning material remaining after the separation process is transferred to shielded storage silos, where it is stored under water.

Separation process

After decanning, the uranium fuel rods are transferred to the reprocessing plant. They are fed into a continuous dissolver where they are dissolved in nitric acid. Waste fission products are removed from the solution produced and the remaining uranium and plutonium are chemically separated.
The uranium is either returned to the customer or sent to BNFL's Springfields Works near Preston for re-use and storage.
The plutonium is either fabricated into fuel at Windscale for use in the UKAEA's Prototype Fast Breeder Reactor at Dounreay in Scotland, or stored.

Decanning

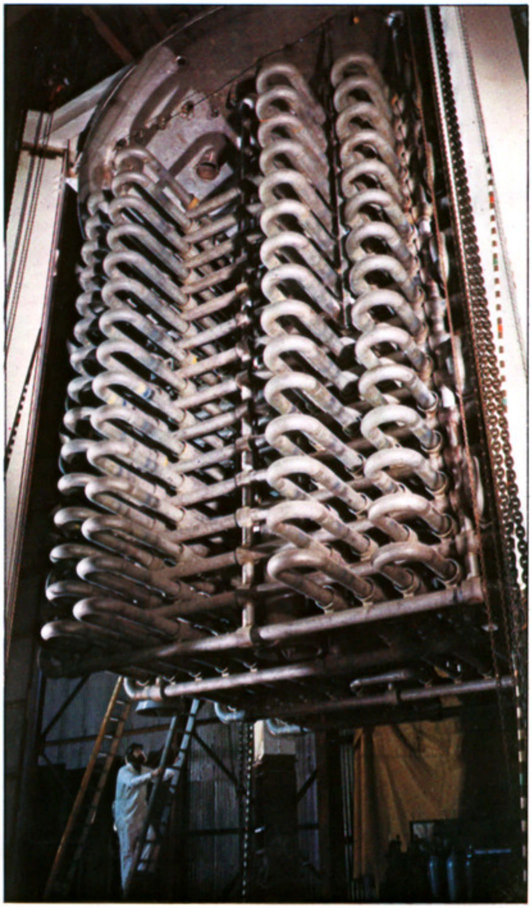
Reprocessing of Irradiated Magnox Fuel.



Highly-active storage tanks

During reprocessing, fission product waste is separated from the fuel and is then concentrated for further treatment and subsequent storage. The concentrated high-level fission product waste extracted during reprocessing is at present stored in high integrity stainless steel tanks, double-clad and located in concrete vaults, which are themselves clad in stainless steel. In the past 25 years 900 cubic metres of highly active waste has been produced as the result of reprocessing.

Cooling coils for highly-active waste storage tanks.



Vitrification

A process to convert the highly-active waste to a solid, glass-like form is being developed and will be installed at Windscale over the next ten years.

The vitrification process involves mixing highly-active waste with glass-making materials to form glass blocks, enclosed in metal containers. These can be stored pending ultimate disposal.

This glass disc simulates the amount of waste produced by one person in a lifetime if all his electricity was produced by nuclear power

Waste Disposal

All industrial processes produce waste, in a variety of physical and chemical forms, each of which needs special consideration. So it is with the nuclear industry. There are only two acceptable ways of dealing with wastes of any kind if they cannot be destroyed or are not worth recycling. They may either be stored or disposed of to the environment. Both storage and disposal are practised in the case of radioactive wastes.

Most of the radioactivity–99.96%–arising from the reprocessing of fuel at Windscale is stored on site.

Low active liquid waste is discharged to the Irish Sea with low active solid waste such as contaminated apparatus, containers and clothing being buried in trenches at the National Disposal Point at Drigg near Windscale.

Discharge of these wastes is carried out under authorisations set by the Department of the Environment and Ministry of Agriculture, Fisheries and Food. Extensive monitoring of the discharges is done by both these Government Departments as well as by BNFL to measure the environmental effects of the discharges and to confirm that any radiation doses to members of the public are well within the dose limits recommended by the International Commission for Radiological Protection.

Collecting plankton samples for analysis

Health and Safety

In all industries dealing with toxic substances, it is essential to set standards of protection to safeguard both workers and the general public.

At Windscale and Calder Works there is a large department dedicated to safety services which is backed up by full-time medical facilities dealing with monitoring the health of workers.

Workers are protected against direct radiation because the majority of handling operations of materials are carried out behind concrete, steel or lead. Routine monitoring is carried out during and after all work with highly active materials.

Access to the Chemical Separation Area, where the reprocessing of used nuclear fuels is carried out, is by changerooms. Here, as the name suggests, the workers and visitors change into appropriate clothing for the area–employees into basic industrial coveralls and visitors into laboratory coats and industrial-type shoes.

On leaving, this clothing and footwear is left in the changeroom and after workers have showered and visitors have washed their hands, monitoring checks are made.

Monitoring hands and clothing

Radiation doses of all workers in the Chemical Separation Area are based on limits recommended by the International Commission for Radiological Protection. If these levels are exceeded the worker is temporarily removed from work in active areas.

Extensive medical records are kept of everyone who has worked at Windscale, including details of exposure to radiation.

An annual check is carried out on plutonium workers through the "Whole Body Counter," which is a very sensitive monitor for discovering levels of radioactivity in the body. This is just one of a series of monitoring facilities used to check the health of workers.

The Whole Body Counter, on a limited scale, has been offered to the public through the Windscale Local Liaison Committee. This committee comprises representatives of BNFL, Government departments involved in the industry, district and county councils as well as local parish councillors, members of the National Farmers Union and area health officials. It meets quarterly to discuss works operations and its meetings are open to the Press and the public.

Whole Body Counter

Future Development

Future investment plans for Windscale include the replacement of existing reprocessing facilities for treating fuel from Magnox stations. Design and development plans are now proceeding on a new Thermal Oxide Reprocessing Plant, known as THORP. This is required to reprocess the irradiated oxide fuel from the UK nuclear programme and from overseas reactors.

Pond 5 construction

Among the many new developments at Windscale connected with the reprocessing plans is the Pond 5 project. This is due to be completed in the early 1980s and will provide replacement receipt, storage and decanning facilities for Magnox fuel and receipt and storage facilities for oxide fuel.

Discharges of low-level radioactive materials from Windscale to the Irish Sea will be reduced significantly when new plant, known as SIXEP (Site Ion Exchange Effluent Plant) comes into operation. This plant is being constructed to treat contaminated water arising from the fuel storage ponds and is expected to be completed in 1983.

Calder Hall

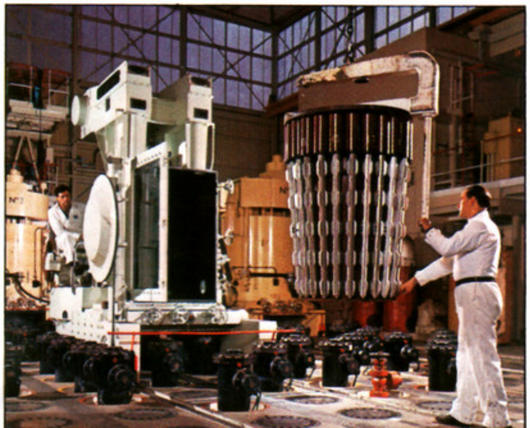
Calder Hall is best known as the world's first commercial nuclear power station and as such paved the way for the whole UK nuclear power programme. It has been operating continuously since October 1956 and is expected to operate into the 1990s.

This type of station is known as a "Magnox" station because the uranium metal rods are contained in a magnesium alloy (Magnox) container or can. In each of the four reactors, 10,176 fuel elements are stacked, six to each channel, one above the other. As the atoms split in the uranium, the fuel in the reactor gets hot. The heat is removed by carbon dioxide gas that flows over the hot fuel transferring the heat from the core of the reactors to the boilers, where water is converted to steam and used to drive turbo-generators–producing electricity.

Nuclear power stations have a first class safety record. The experience with Magnox stations in Britain is now equivalent to over 180 years of reactor operation. During that time no harm has been caused by radiation to any of their workers or to members of the general public.

There are now nine commercial nuclear power stations operating in the UK, each with two reactors, based on the Calder Hall design. They have been so successful and reliable in operation that they have been described as "Britain's nuclear workhorses." Today in Britain more than 13% of our electricity is generated from nuclear power.

Loading reactor at Calder Hall



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