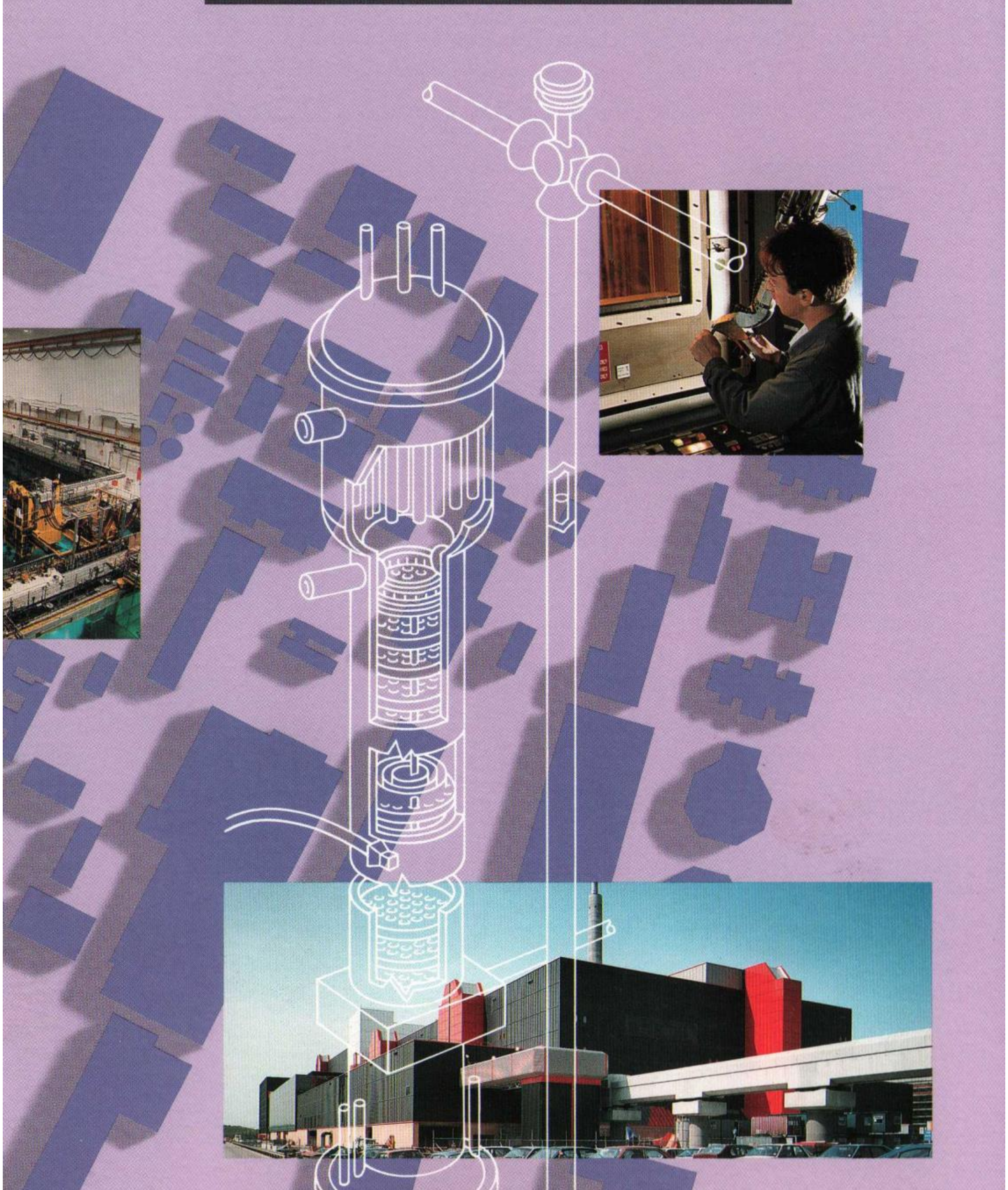
Sellafield



BNFL

British Nuclear Fuels plc

British Nuclear Fuels plc (BNFL) is acknowledged worldwide for providing an efficient nuclear fuel cycle service.

Sellafield (near Seascale, Cumbria) is the largest of BNFL's five UK sites and operates:

- ☐ Calder Hall Magnox Power Station
- ☐ Magnox Reactor Fuel Reprocessing Plant
- ☐ Oxide Fuel Reprocessing Plant (commences operations in 1993 and has been named the Thermal Oxide Reprocessing Plant –THORP)
- ☐ Waste treatment plants and storage facilities

The reprocessing of irradiated fuel from UK and overseas nuclear reactors is the main activity carried out on the Sellafield site.

Irradiated fuel is uranium material which has become highly radioactive because of the formation of waste products within the fuel during its time in the electricity-generating reactor, making the fuel less efficient.

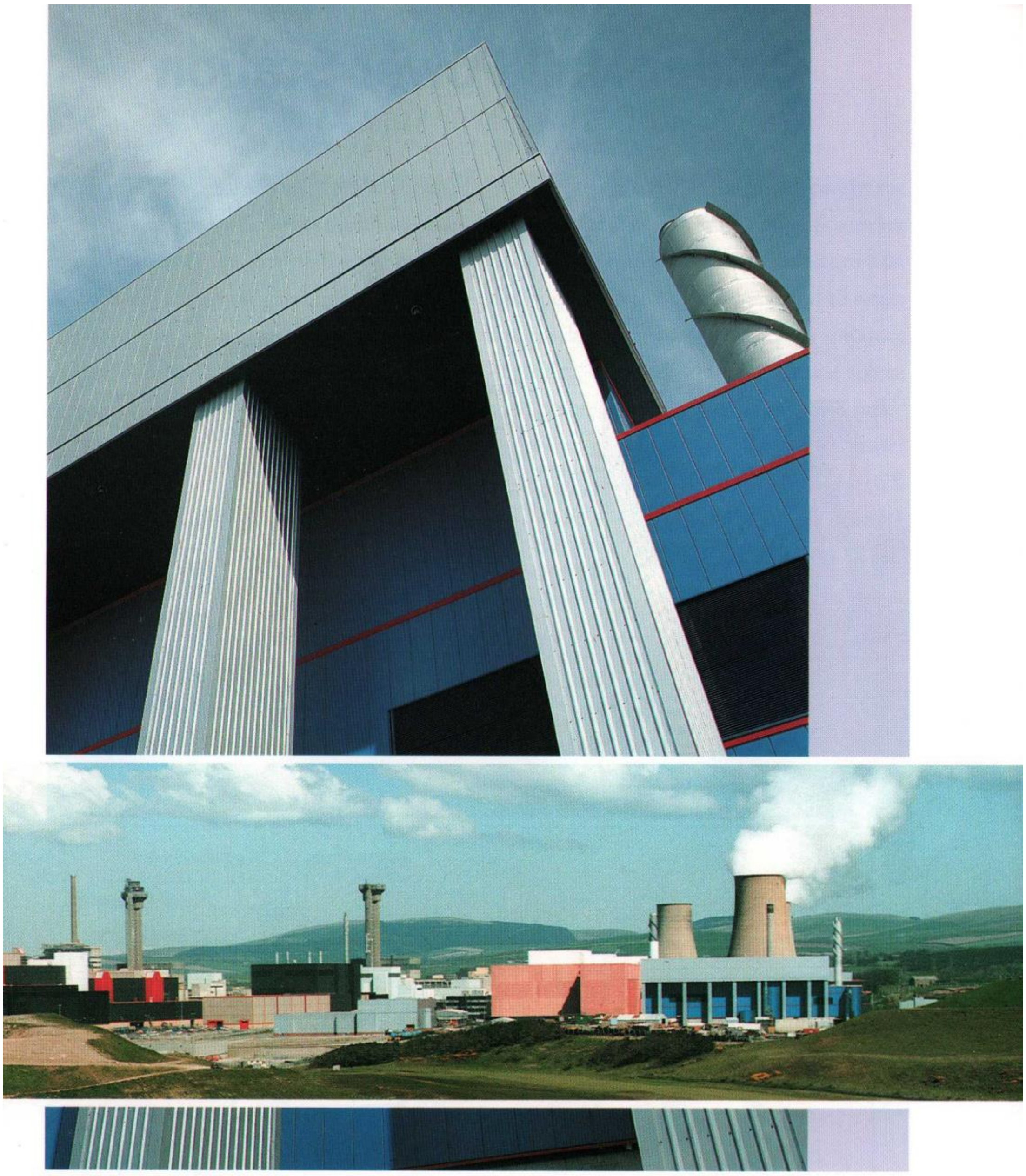
Why reprocess?

Reprocessing enables used fuel to be recycled rather than being disposed of as waste. A solvent extraction process is used to separate the uranium (at least 96%), plutonium (approximately 1%) and highly active waste (approximately 3%).

The uranium can then be treated and manufactured into fuel that can be used in a reactor again. Plutonium can also be used again by mixing it with uranium to produce fuel known as Mixed Oxide fuel (MOX).

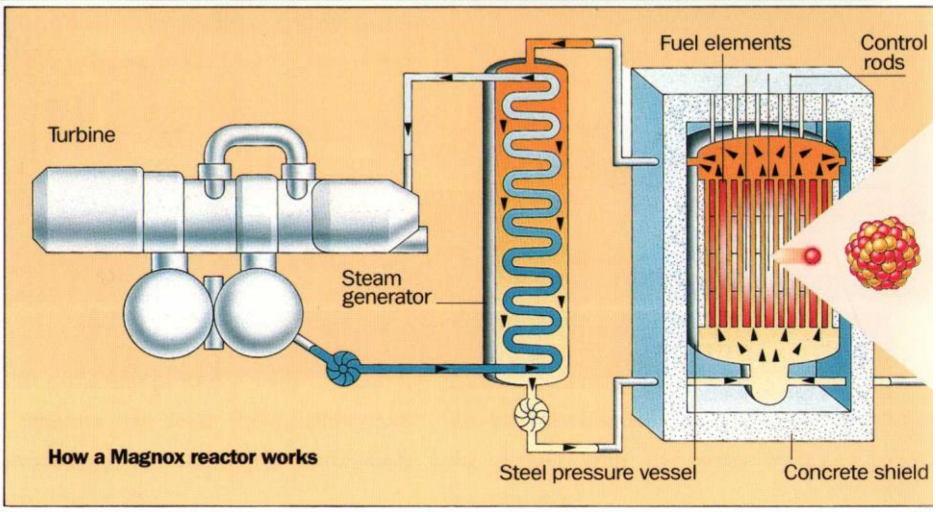
Reprocessing also assists in the management of waste. It allows the waste to be separated and converted into forms which can be disposed of safely. Even if irradiated fuel is

not reprocessed, it still needs to be disposed of and the technology for conditioning irradiated fuel for direct disposal is not as advanced as that for dealing with the waste arising from reprocessing.



One of the new waste treatment plants

Calder Hall Power Station



How a Magnox reactor works

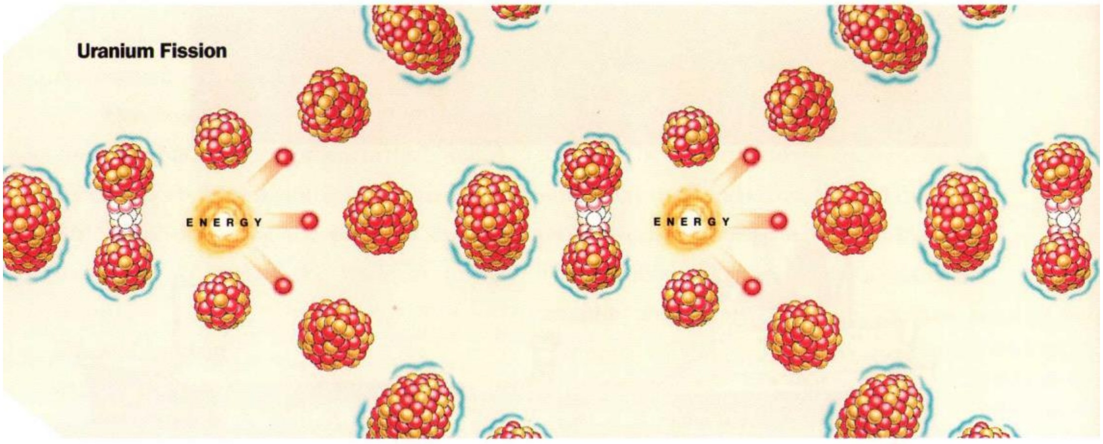
Calder Hall Power Station started operating in 1956 and was the world's first industrial-scale nuclear power station, paving the way for the UK's nuclear energy programme.

The station consists of four Magnox reactors each producing enough heat to give approximately 60 Megawatts of electricity. Each reactor is fuelled with more than 10,000 Magnox fuel elements (uranium metal rod inside a magnesium alloy can) stacked in channels.

Heat is generated in the reactor core by the splitting of uranium atoms. Carbon dioxide gas flows over the fuel and carries the heat to heat exchangers where water is converted to steam which drives turbo-generators to produce electricity. The fuel remains there for several years before being removed as irradiated fuel.

Nine similar commercial nuclear power stations have been constructed in the UK followed by a series of the more efficient Advanced Gas-cooled Reactor stations.

Left: Calder Hall Nuclear Power Station

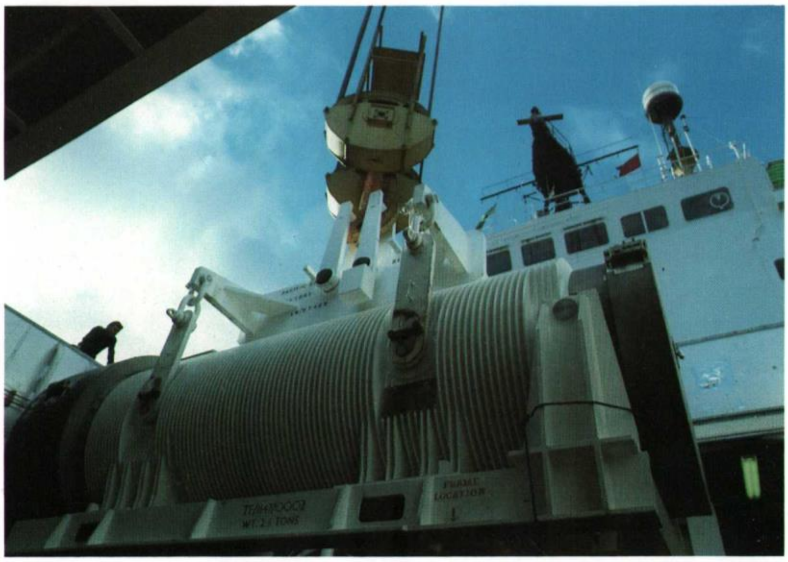


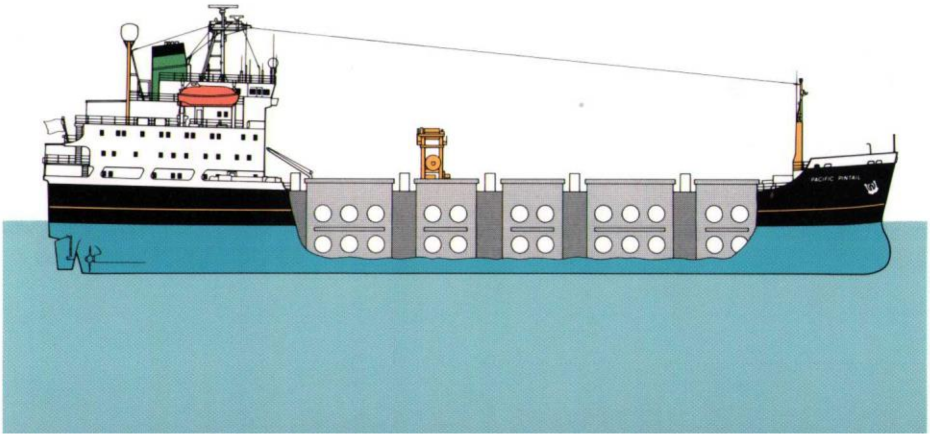
Transport of Fuel

The irradiated fuel is transported from UK and overseas customers to Sellafield in specially designed flasks made from 35cm thick mild steel or steel and lead. The flasks, which weigh between 50 and 100 tonnes, are tested to stringent international standards to withstand a severe transport accident without the release of dangerous amounts of radioactivity.

The larger transport flasks which carry irradiated fuel from overseas customers arrive in purpose-built ships at BNFL's own marine terminal at Barrow-in-Furness and are transported by rail to Sellafield.

Loading fuel flasks into the hold of one of our ships





Magnox Reprocessing

A Magnox fuel element consists of a uranium metal rod approximately one metre long and three centimetres in diameter encased in a magnesium alloy can.

Transport and Storage

On arrival at Sellafield the fuel elements are transferred from the transport flasks into containers which are stored under water in cooling ponds to await reprocessing. The fuel is still highly radioactive and continues to generate heat. The water provides the required degree of cooling to absorb heat and shields the operators from radiation emitted by the fuel. Storing the fuel enables short-lived radioactivity to decay before the fuel is reprocessed.

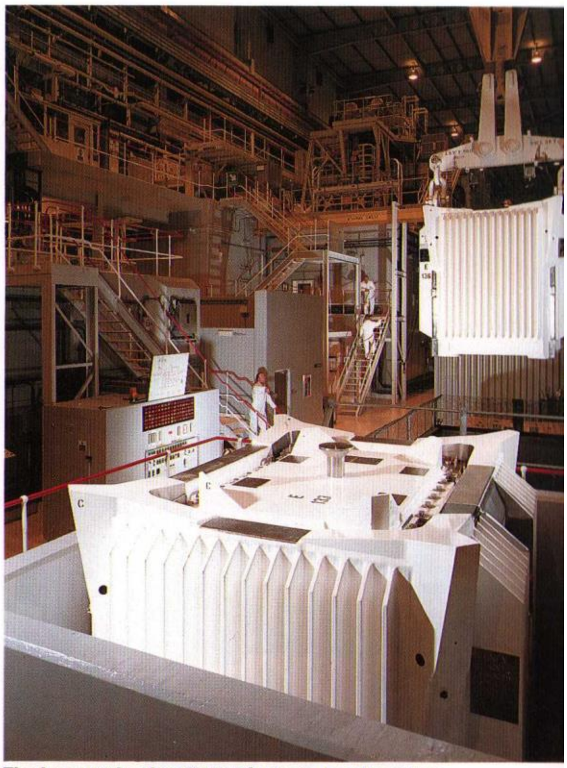
Decanning

The magnesium alloy cladding around the Magnox fuel element must be removed so that the irradiated fuel rod inside is able to be reprocessed.

Decanning is carried out using remote controlled handling equipment in thick-walled cells to absorb the radiation from the irradiated fuel. After decanning the pieces of can are transferred to one of the waste treatment plants.

Reprocessing

The irradiated uranium fuel rods are transferred to the reprocessing plant in shielded containers. They are continuously dissolved in nitric acid and the resulting solution is mixed with a solvent. The solution and solvent separate in a similar way to oil and water. Most of the waste products can be removed in the water-like layer. The remaining solution contains a mixture of uranium and plutonium. This solution is chemically conditioned, causing most of the plutonium to separate out into the water-like layer which can be extracted. The process is repeated for further purity.



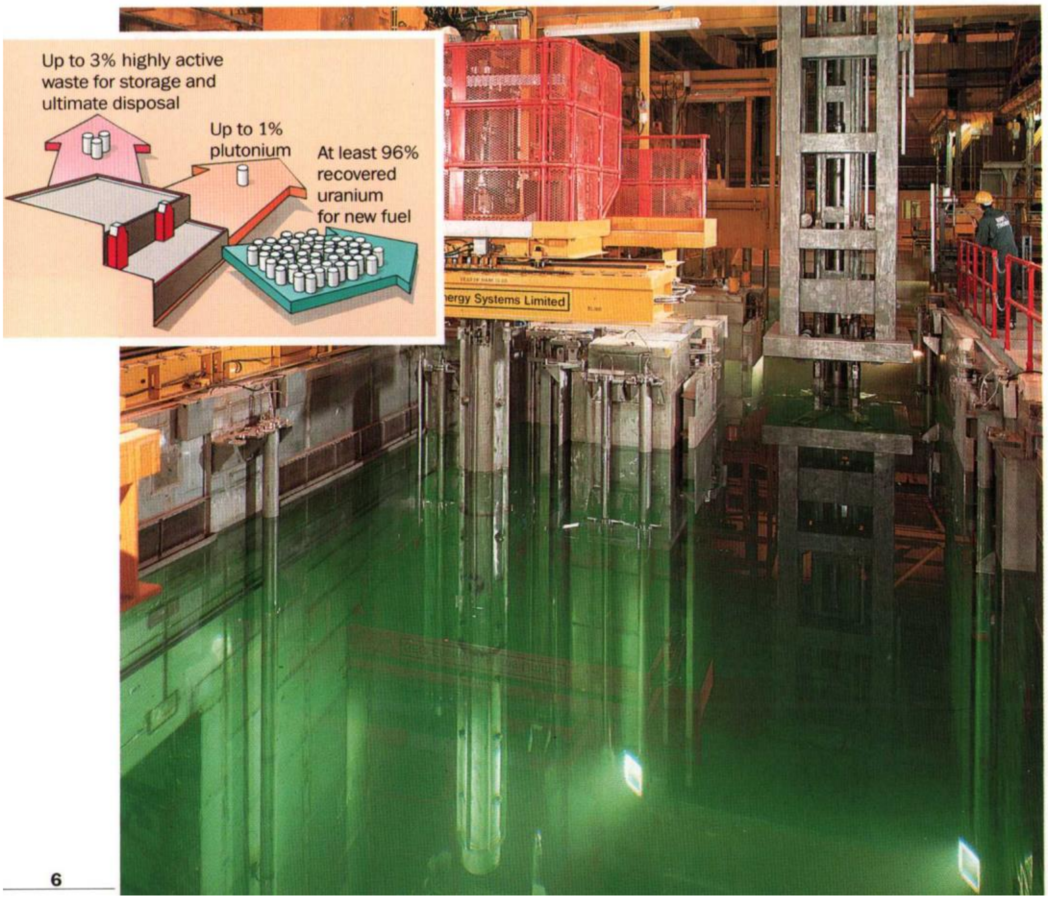
Flasks carrying irradiated fuel are monitored on arrival at Sellafield

Reprocessing Light Water Reactor Fuel

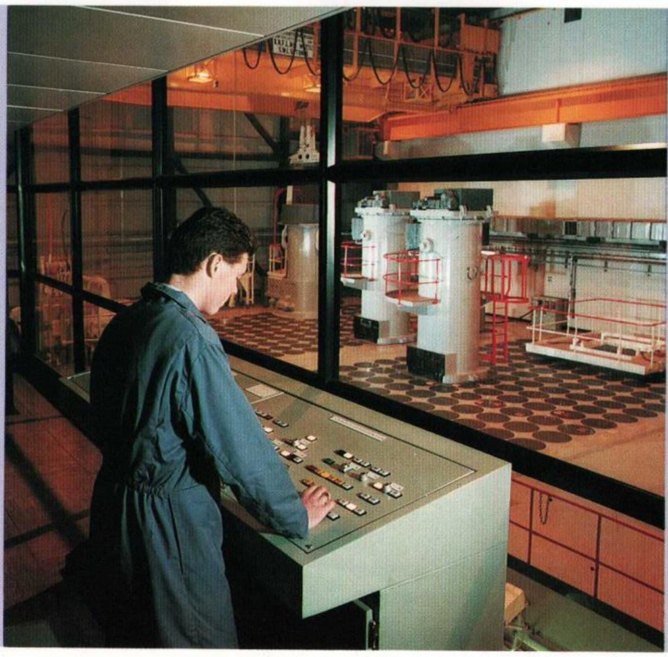
BNFL is set to embark on a new era of reprocessing operations. The £1.85 billion Thermal Oxide Reprocessing Plant (THORP) at Sellafield is designed to reprocess irradiated oxide fuel from the UK's Advanced Gas-cooled Reactors, and from UK and overseas Light Water Reactors.

THORP is one of Europe's most complex engineering projects. It combines all the facilities necessary for reprocessing nuclear fuel under one roof, enabling the irradiated fuel to enter the plant at one end and the separated uranium and plutonium to be taken out at the other. Although the design requirements for reprocessing oxide fuels are different to those of Magnox fuels, the process stages are similar – transportation, storage, fuel assembly dismantling and reprocessing. The plant also has specific routes for transferring each class of waste from THORP to its relevent waste treatment plant.

The Fuel Removal Pond in the Thermal Oxide Reprocessing Plant (THORP)



Radioactive Waste Management



The Vitrified Product Store Control Room

All industrial processes produce waste in a variety of physical and chemical forms, each of which needs special consideration. In the nuclear industry radioactive waste, which may be solid, liquid or gaseous, falls into three categories:

- ☐ High-level
- ☐ Intermediate-level
- ☐ Low-level

Their titles refer to the level of radioactivity each contains, and for each category a specific method of treatment has been developed.

The high-level liquid waste arising from more than 30 years of reprocessing operations has been stored in double-walled high-integrity stainless steel tanks. Although this method of storage has proved safe and reliable, the waste is safer and easier to store as a solid.

The vitrification process, which started operating in 1991, converts the highly-active liquid into a solid glass-like form which is contained within stainless steel flasks.

The full containers are moved remotely to an adjacent air-cooled store where they will remain for at least 50 years before final disposal.

The intermediate-level waste such as fuel cladding materials, sludges, resins and contaminated equipment are treated in one of the encapsulated plants (encapsulated in cement).

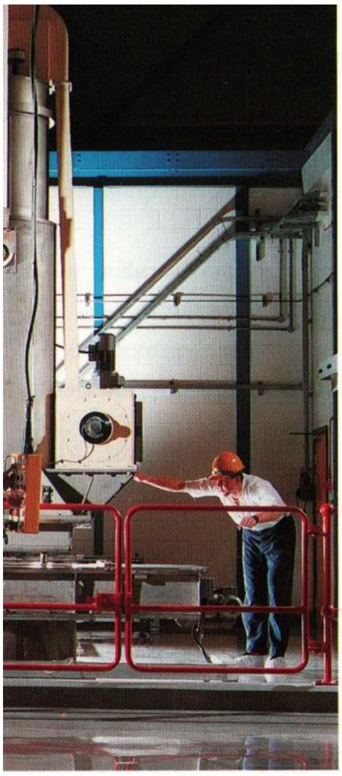
The drums of cemented waste are transferred into purpose-built stores pending permanent disposal.

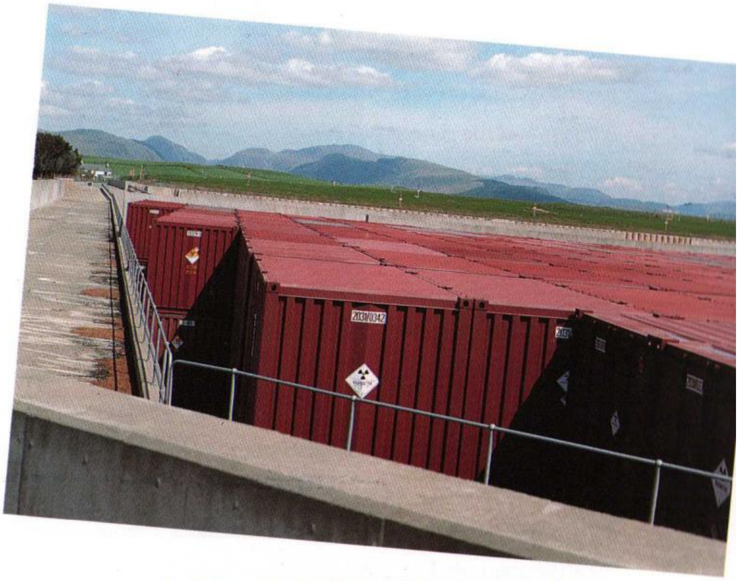
Some categories of intermediate-level waste, such as contaminated building rubble, plant items etc are sent to the Miscellaneous Beta Gamma Waste Store for packaging and storage.

The Government sees the need to locate and develop a permanent disposal facility for the intermediate-level waste, and any low-level waste which cannot be sent to Drigg. It is the role of UK Nirex Ltd, a company founded by the nuclear industry in 1982, to develop a deep repository in line with Government policy. Nirex is concentrating its future investigations on Sellafield.

Low-level liquid waste is treated in the Site Ion Exchange Effluent Plant (SIXEP) before being monitored and discharged to sea. The plant has been designed to remove mainly radioactive caesium and strontium from such effluents as pond waters.

The plant also provides a cooling system for the pond water in the adjacent Fuel





Left: Low-level effluent will be treated in the Enhanced Actinide Removal Plant before being discharged to sea

Centre: Testing operations in the Effluent Plant Maintenance Facility

Above: Solid low-level radioactive waste is stored at Drigg, five kilometres south of Sellafield

Handling Plant. Up to 11,000 cubic metres of pond water per day can be re-circulated in this way.

An additional plant – the new Enhanced Actinide Removal Plant – has been designed to remove further radioactivity from effluents.

The quantity of radioactive material discharge to the Irish Sea has steadily fallen over the years due to the introduction of such plants. The discharges have been cut to one hundredth of the peak levels of the mid 1970s. **Low-level solid waste** such as contaminated equipment, containers and clothing is sent to the Drigg disposal site, five kilometres south of Sellafield. The solids are packed in containers which are placed in a concrete-lined vault. Waste from other industries – hospitals, universities, nuclear power stations and research establishments – is also disposed of at Drigg.

Discharges of low-level waste are carried out under authorisations set by Her Majesty's Inspectorate of Pollution (HMIP) and Ministry of Agriculture, Fisheries and Food (MAFF).

Health and Safety

Throughout industry as a whole, it is essential to set standards of protection to safeguard both workers and the general public.

BNFL has produced a formal Environmental Policy Statement which deals with environmental issues from effluent management, through energy efficiency and waste recycling, to conservation and enhancement of the environment on and around the Company's sites.

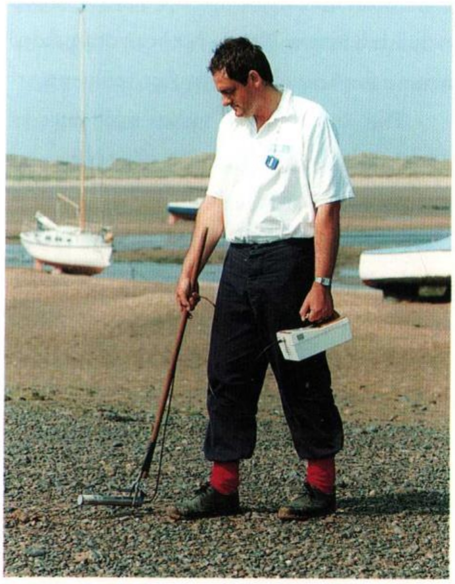
Both BNFL and the relevant Government departments carry out monitoring programmes to assess the environmental effects of the discharges, and to confirm that radiation doses to the public are within the dose limits recommended by the International Commission on Radiological Protection (ICRP).

The Sellafield medical department is equipped with modern facilities for monitoring the health of workers. This includes keeping extensive medical records of everyone who has worked on site, including details of exposure to radiation.

Employees are protected by a combination of safe working procedures, plant design, extensive ventilation systems and the use of remote handling equipment. Their working environment is continuously monitored for radioactive contamination. In addition, special monitoring equipment checks the site for airborne contamination and regular checks are made on the environment in and around the site.

For employees working in the radioactive processing area, special protective clothing is provided before entry via the changerooms. On leaving the process area employees remove this clothing and, after washing, follow a radiation monitoring procedure.

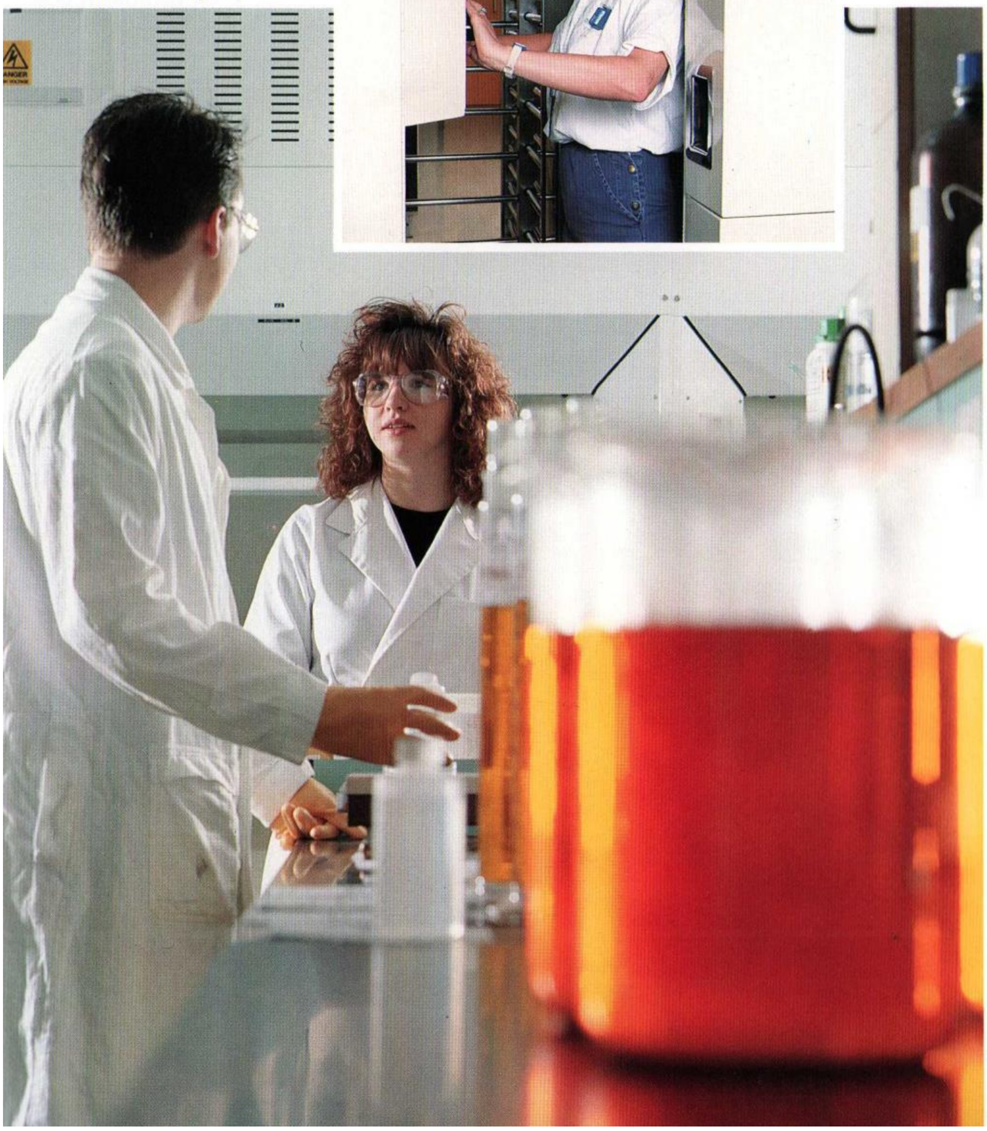
Occasionally some employees undergo tests to detect any radioactive materials which may have entered the body. In some cases regular checks are carried out using the whole-body monitor – a sensitive piece of equipment used to detect radiation given off by small amounts of radioactive substances in body tissues. Members of the public living in the Sellafield area may also use the whole-body monitor.



Monitoring at the Ravenglass Estuary

Monitoring the whole body for radioactive contamination takes only a few seconds

Routine analysis of environmental samples



Future Developments

A major capital investment programme is under way at Sellafield. A small scale demonstration facility to manufacture mixed plutonium/uranium oxide fuel (MOX) is currently undergoing testing. Outline planning permission has also been sought for a commercial scale Sellafield MOX Plant, which will produce MOX fuel for both boiling water and pressurised water reactors, and will enable customers to make use of the valuable plutonium arising from electricity generation in civil reactors.

Construction will soon begin of another reinforced-concrete store for intermediate-level encapsulated waste.

Construction is almost complete of a gas-fired combined heat and power plant which will supply process steam and electricy to the site, ensuring reliable energy supplies for reprocessing and waste management.

Other projects include a Waste-Solvent Treatment Plant, and a facility for compacting low-level solid wastes to one tenth of their original volume. The latter will extend the operating life of Drigg well into the 21st century.

Looking to the future, feasibility studies are being carried out into the possibility of building a new nuclear power station at Sellafield.

The Combined Heat and Power Plant, currently under construction, will provide future energy for the Sellafield site

Training Young People

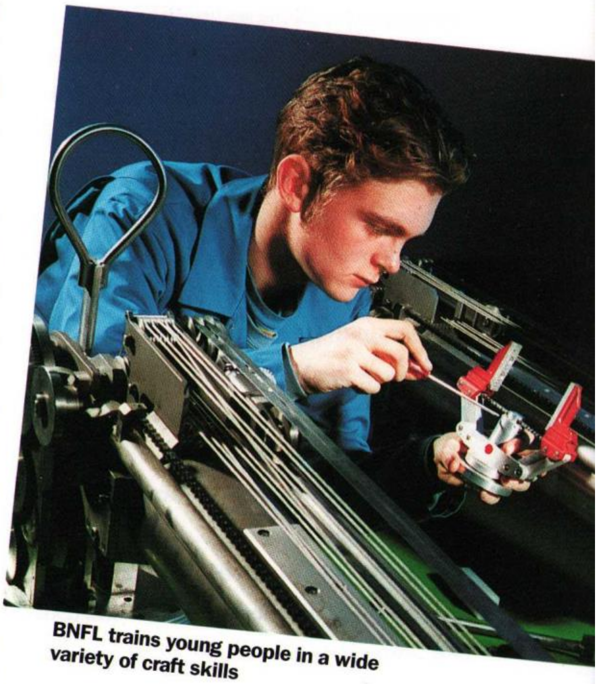
BNFL trains young people in a wide variety of skills to become well qualified craftsmen/women, technicians, process workers, and scientific, administration and computer personnel.

About 500 young adults are trained each year in a purpose-built training centre at Sellafield which includes engineering workshops, laboratories, lecture rooms, a library and gymnasium.

Trainees study for National Vocational Qualifications (NVQ) which emphasise achievement in the workplace and result in skilled youngsters equipped to contribute to the Company's extensive range of activities.

The NVQ programme involves study at local colleges for appropriate Business and Technology Education Council (BTEC) and City and Guilds qualifications. The most capable trainees may be sponsored for degree courses.

Outward Bound courses and activities such as community service and Duke of Edinburgh Award schemes are encouraged. The Sellafield centre's outstanding contribution to this latter scheme led to it becoming an operating Authority able to organise its own training, assess participants and authorise awards. Other schemes include City Challenge, which comprises projects to help the ill, elderly and handicapped, and courses organised by the police and other organisations.



BNFL trains young people in a wide variety of craft skills

BNFL's high standard of training has been officially recognised by the Training, Education and Enterprise Directorate (TEED) and in association with local Training and Enterprise Councils (TECs) has earned the Company Approved Training Organisation status. This will enable BNFL to continue providing work placements and training for youngsters on the two year Youth Training Scheme (YTS).

Community Relations

With the decline of the traditional steel and coal mining industries, Sellafield has become a major employer in West Cumbria. Some 8,000 people are employed by BNFL at Sellafield, and approximately 4,000 contractors work on various construction projects.

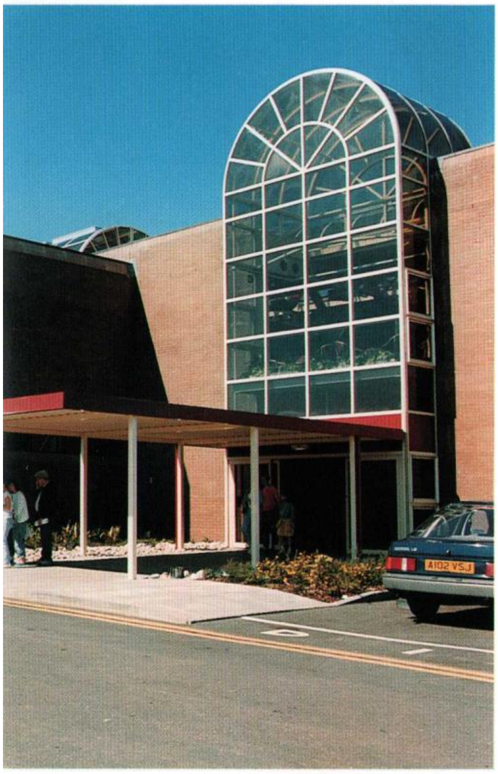
In order to avoid large scale unemployment as major construction projects are completed, BNFL has played a key role in establishing the West Cumbria Development Agency and the West Cumbria Development Fund. This is a joint initiative with local councils and private enterprise to generate new business in West Cumbria.

The Fund is over 85% financed by an annual BNFL donation of £1 million. It has been estimated that around 1,750 jobs have been either created or safeguarded.

The flagship of the Fund is the multi-million pound Westlakes Science and Technology Park, established on a site near to Whitehaven town. Within six weeks of opening the first phase of the Park half the accommodation had been contracted.

Outside the Visitors Centre the public board one of the Sightseer coaches for a tour of the Sellafield site

The Westlakes Science ar

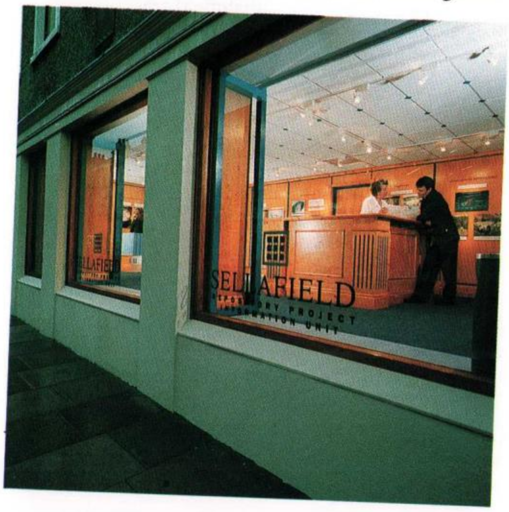


Because BNFL and Nirex recognise the need to keep local people informed, a Sellafield Repository Project Information Unit has opened in Whitehaven town centre.

The Sellafield Local Liaison Committee provides a vital link between BNFL and the community. Drawing together representatives from both local and national organisations, the committee has the knowledge and technical expertise to discuss in depth events which may affect the community and their environment.

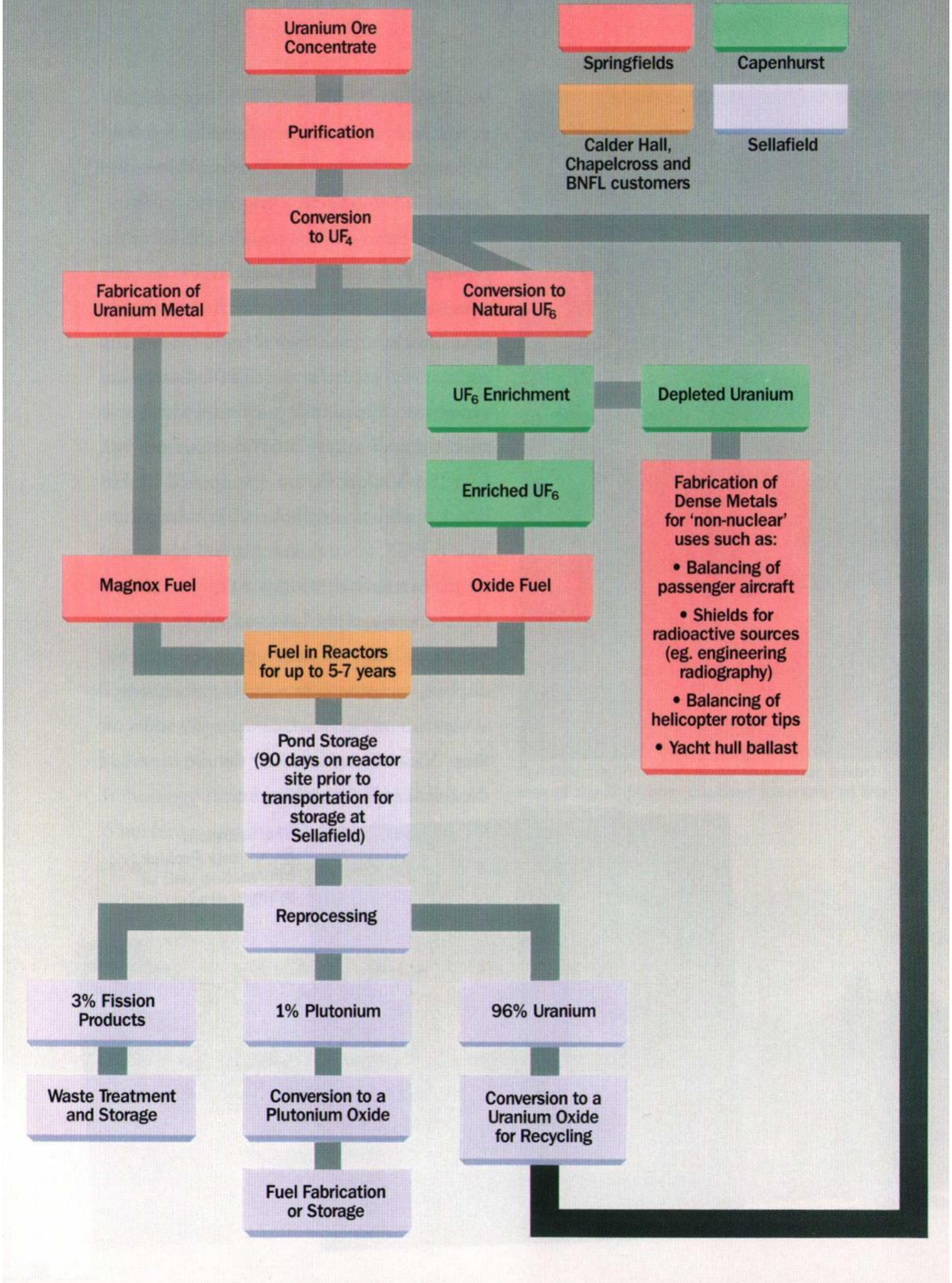
The Visitors Centre was opened by His Royal Highness the Duke of Edinburgh on June 6 1988. Since then it has become one of the major tourist attractions in the North West. Open all year except Christmas Day, the Centre houses an array of exciting life-size models, displays, computer games and literature, as well as a restaurant, lecture facilities and a souvenir shop. Visitors may also tour the site in one of the Sellafield Sightseer coaches.

chnology Park



The Sellafield Repository Project Information Unit at Whitehaven

Nuclear Fuel Cycle



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