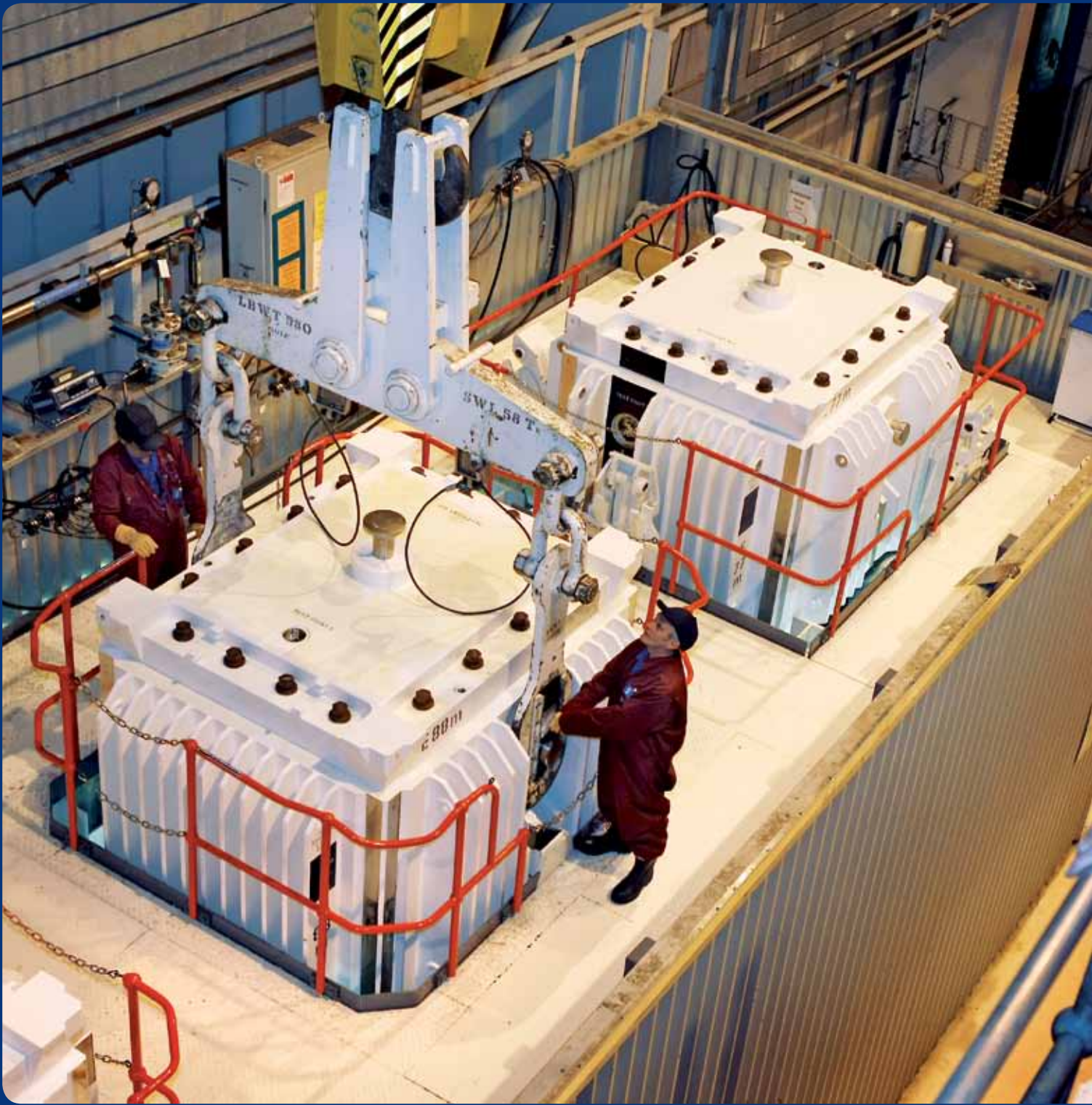


Reprocessing overview

Fuel storage, reprocessing, uranium and plutonium recycling





**Successfully ma
used nuclear fue**



Reprocessing takes used fuel which has been removed from a nuclear reactor to recover the reusable materials. After about four years in a reactor the fuel becomes less efficient. Reprocessing allows 97% of this used fuel to be recycled back into new fuel.



Reprocessing has been carried out at Sellafield for well over five decades and in this time more than 50,000 tonnes of fuel has been safely separated. If all of this used fuel were to be recycled into new fuel, it would generate enough electricity to meet all the UK's electricity needs for over two years.

**more than
50,000 tonnes**

There is a huge amount of reprocessing experience at Sellafield which has been technically proven as the effective way to treat used nuclear fuel.

The very first reprocessing facility was opened in the early 1950s. Then in the 1960s the Magnox reprocessing facility started operating and is still operating to this day. It is regarded as the workhorse having reprocessed over 44,000 tonnes of fuel. The Thorp reprocessing facility began reprocessing back in 1994 and has recently sheared its 6,000th tonne of fuel.

Sellafield reprocesses fuel from nuclear reactors in both the UK and abroad.

naging



The last operating nuclear power station at Sellafield was closed down in 2003 and is now being decommissioned



Sellafield has customers for used fuel services from the UK, Japan, Germany, Netherlands, Sweden, Spain, Italy, Canada, Belgium and Switzerland.

A large industrial facility, likely a nuclear reprocessing plant, with a worker in the foreground. The worker is wearing a white hard hat and a high-visibility vest. The facility has a high ceiling with yellow overhead cranes and various pipes and machinery. A large white cylindrical component is being moved or positioned by a crane. The scene is brightly lit, and the overall atmosphere is industrial and technical.

£1 billion

income was made available from Sellafield's commercial operations including reprocessing in 2008/09 to fund decommissioning and clean up work.

Overseas LWR fuel is transported to Barrow-in-Furness in specially designed nuclear transport ships from where it is brought to Sellafield by rail



The Challenge

"We are committed to the continued operation of our reprocessing plants at Sellafield in order to provide customers a complete nuclear fuel management service. At Sellafield we provide fuel receipt, storage and reprocessing services for used fuel from nuclear reactor customers.

We then manage the products of reprocessing on behalf of our customers, which if recycled would provide as much energy as at least 100,000 barrels of oil from just one tonne of used fuel. Without reprocessing, a lot of this valuable energy would be lost.

The income from these commercial operations is very important as it is used to fund the decommissioning and clean-up work at Sellafield and saves the UK taxpayers a considerable amount of money."

Stuart MacVean, Director of Spent Fuel Management



We have the skills and technology at Sellafield in order to manage existing and future arisings of used nuclear fuel from any programme of UK new reactor build.

The challenge is to manage customers' used nuclear fuel and the options to do this include:

- Reprocessing
- Interim storage
- Direct disposal

Reprocessing the used fuel separates out the uranium and plutonium from the waste. These are then made available for customers to be manufactured into new fuel. The waste is converted into a glass format which is safe for transport back to customers and for very long term storage.

Used nuclear fuel is an asset not a waste and reprocessing is the only way of unlocking this valuable energy source. Reprocessing involves the chemical separation of the 1% plutonium and the 96% uranium, from the 3% waste products.

If used fuel is not reprocessed, the only other short-term option is to keep it in stores above ground. All the fuel rather than just the 3% becomes waste if the fuel is not reprocessed, therefore there will be a greater volume of highly radioactive waste to manage.

Apart from reprocessing, direct disposal is the only other long term solution for spent fuel management. With direct disposal, used nuclear fuel is permanently buried or entombed underground. The used fuel would be conditioned and packaged suitable for direct disposal underground after several decades of cooling – such a repository is unlikely to become available before 2075.

If the used fuel is not either reprocessed or directly disposed of underground, it has to be interim stored in purpose-built dry stores or in fuel storage ponds. It is assumed that interim spent fuel storage at Sellafield can continue in existing fuel storage ponds. Pond storage does not preclude dry underground storage in the future.



Our employees are some of the most experienced and highly regarded nuclear workers in the world

The safe management of used fuel at Sellafield underpins new nuclear build in the UK.

Sellafield's Reprocessing Activities

Sellafield has a purpose-built suite of facilities in which to expertly manage customers' used fuel. A range of UK and overseas fuels can be accepted including Magnox, AGR, PWR, BWR and several novel fuel types.

Firstly the fuel is unloaded from its transport containers then it is placed in underwater storage in ponds, before it is chemically separated in one of the two reprocessing plants. Finally the separated uranium and plutonium powders are then placed in stores in advance of either being manufactured into new fuel at Sellafield or being shipped out to other fuel manufacturing facilities.



"At Thorp we are totally focused on safely completing customer contracts and the plant has many years of operating life available in order to fulfil current commitments and any new missions."

Steve Cockayne, Head of Thorp

Fuel Preparations

Used nuclear fuel is transported from customers' reactors to Sellafield by road, rail and sea in specially designed shielded transport containers weighing up to 110 tonnes. The fuel is removed from the transport containers into one of our underwater fuel storage ponds.



Planning permission for Thorp was sought in the mid 1970s and final consent to operate was granted in 1997



Thorp Receipt and Storage ponds have a capacity for 3,300t of used AGR and LWR fuels



The Sellafield site railway system moves the used fuel between the different process and storage plants

Fuel Storage

The used fuel is stored in large storage ponds which are generally 8 metres deep in order to keep the fuel cool. At all times there is some 2.5 metres of water above the fuel to protect the workforce from the radiation which is shielded by the water. The fuel remains in the storage ponds for a minimum of 3 to 5 years depending upon the fuel type to allow the short-lived radioactivity to decay.

In the storage ponds PWR and BWR fuels are contained in long steel containers known as multi-element bottles (MEBs) whilst AGR and Magnox fuels are stored in steel boxes.

Thorp Reprocessing

Thorp combines all of the facilities necessary for reprocessing uranium oxide fuels in one plant, enabling the fuel to be received at one end and the uranium and plutonium to be supplied at the other.

Thorp is capable of reprocessing a full range of fuel sizes. The fuel is sheared into short pieces and dissolved in nitric acid. The uranium and plutonium are then chemically separated from the waste materials and converted into powders and placed in cans and drums for safe storage.



UK AGR fuel arrives at Sellafield by rail for storage and reprocessing

Magnox Reprocessing

Magnox reprocessing comprises a number of plants that together perform a similar operation as Thorp for uranium metal fuels.

The fuel rods have had their outer casings removed or decanned in the preparation stage, so there is no need to shear this fuel. The whole fuel rods are dissolved in nitric acid then a series of processes chemically separate the uranium, plutonium and waste streams. The uranium and plutonium powders are dried and placed in cans and drums for safe storage.

Product Storage

The uranium and plutonium separated from used fuel during reprocessing are securely stored at Sellafield on behalf of customers. The uranium powder is stored in 200-250kg drums and placed in specially designed stores. The plutonium is held in 7-8kg triple stainless steel cans within secure vaults. The plutonium powder can be manufactured into new MOX fuel at Sellafield and the uranium powder can be exported for recycle into new fuels.

One gramme of plutonium contains as much energy as two tonnes of coal or one tonne of crude oil.



Construction of the new state-of-the-art store for customers' plutonium

Achievements

In order to improve our flexibility, a new store and export facility has been built to remove redundant fuel containers from the ponds. This work should release space for an additional 1,000 tonne of used fuel.



Medium Active Salt Free Evaporator (MASFE)

A key £20m project to install a new Medium Active Salt Free Evaporator (MASFE) required part of the Thorp roof to be removed and four massive vessels craned in, the largest of which was the size of a bus!

£20m

Thorp has recently reprocessed its 6,000th tonne of fuel including fuel from both the UK and overseas.

A total of 950 tonnes of Thorp uranium has been exported abroad to be recycled into LWR fuel and more than 15,000 tonnes of Magnox uranium have been recycled into AGR fuel, which would power over 100 million homes for 1 year.

950 tonnes



Swedish research reactor fuel

Almost 5te of Swedish research reactor fuel has successfully been processed through Fuel Handling Plant (FHP) and the Magnox reprocessing plant.

Almost one fifth of the UK's electricity is generated by nuclear stations and without reprocessing they couldn't keep operating as their pond storage would soon fill to capacity leading to the shutdown of stations.

Continual Delivery

At Sellafield we are experts in the management of nuclear waste. We have a whole suite of plants which process the various streams of nuclear waste to convert them into stable solid formats suitable for long term storage and eventual disposal should an underground deep repository become available.

High level waste

One of the key waste streams from reprocessing is the liquid high level waste. This waste is separated out from the reusable uranium and plutonium during reprocessing. The high level waste comprises fission products which are produced within the reactor and it is these materials which reduce the efficiency of the fuel. This used fuel therefore has to be discharged from the reactor and fresh fuel loaded in its place.

The high level waste is very radioactive containing 99% of the radioactivity in all waste arising from reprocessing used fuel, however the physical volume of this waste is small. The first part of treating this waste is to concentrate the waste down in evaporators to further reduce its volume in preparation for its incorporation into glass – a process known as vitrification.

Return of waste

All new overseas reprocessing contracts signed since 1976 contain a return of waste clause. This means that the waste associated with reprocessing overseas customers' used fuel belongs to the customers and will be returned to them. In 2010 we started returning vitrified high level waste to customers in both Japan and Europe.

"41,000 tonnes of Magnox fuel has been reprocessed since the 1960s. Magnox Reprocessing is focused on delivering the Magnox Operating Plan in partnership with the Magnox Reactor fleet, our customers, regulators and stakeholders."

Paul Brennan, Head of Magnox



In line with the terms of a waste substitution agreement, this waste will all be returned in the form of vitrified high level waste. Any other waste streams will not be sent to customers, however an additional quantity of the vitrified waste will be returned to ensure that customers receive the equivalent quantity of radioactive materials.

New evaporator

One of the major new projects at Sellafield is the construction of a new evaporator to support continued reprocessing operations. This £400m project is vital to support reprocessing operations and is due to start operating by 2015. Until this project is completed, reprocessing throughput will be limited by the capacity of the existing evaporators.

In the meantime every effort is being made to protect and extend the life expectancies of the existing three evaporators in order to accept the high level waste streams from our reprocessing plants and keep them operating.



1,850 vitrified waste containers will be shipped to overseas customers which will take 10 years to complete

Service

We provide a comprehensive waste management service to deal with all the wastes arising from reprocessing.





Planning future facilities to support spent fuel management

Any programme of new reactor build in the UK will require used fuel management and Sellafield is ideally situated to provide such a service.

The future

Commercial reprocessing at Sellafield provides a vital source of funding in order to enable high hazard decommissioning and waste treatment work to be carried out. There remains hundreds of tonnes of UK and overseas reprocessing business to complete and the income from this business will fund the clean-up work which will save the UK taxpayer billions of pounds.

Both Thorp and Magnox reprocessing plants are anticipated to operate for many years to come. The availability of the supporting evaporators to process high level waste will impact on how long the plants will operate. Also the expectations of UK customers and their used fuel requirements will determine the operational lifetime of the plants.

The Government has stated that any new reprocessing contracts would be subject to consultation and no new reprocessing contracts are actively being sought for the two reprocessing plants.

As yet no decision has been taken on the management of used nuclear fuel from any new build reactors. There are a number of options available to the reactor operators. Here at Sellafield we will continue to offer spent fuel management services in support of reactor operators.



Nuclear materials are stored safely in purpose designed, high security stores

As things currently stand, the two existing reprocessing plants at Sellafield will have fulfilled their order books and will have shutdown before any new reactors could be built in the UK.

If the decision was taken to reprocess future spent fuel, then Thorp would require to be refurbished or a new reprocessing plant would have to be built. Thorp is a well proven, flexible reprocessing plant and has been designed so that the minimum operational life expectancy of 25 years could be extended.

The existing reprocessing facilities at Sellafield are both major technical and commercial achievements of which the UK can be justifiably proud.



Customers can have their plutonium recycled and manufactured into MOX fuel



Sellafield Ltd prepares and packages customers' uranium to be exported and recycled into new fuel.

Recycling



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Sellafield Ltd is owned by Nuclear Management Partners and operates on behalf of the Nuclear Decommissioning Authority

