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Shipment of research reactor spent fuel from Australia to France

COGEMA

Executive summary

The first maritime shipment of research reactor spent fuel from Australia to France initiates a new partnership between the Australian Nuclear Science and Technology Organisation, ANSTO, and the French Compagnie Générale des Matières Nucléaires,COGEMA.

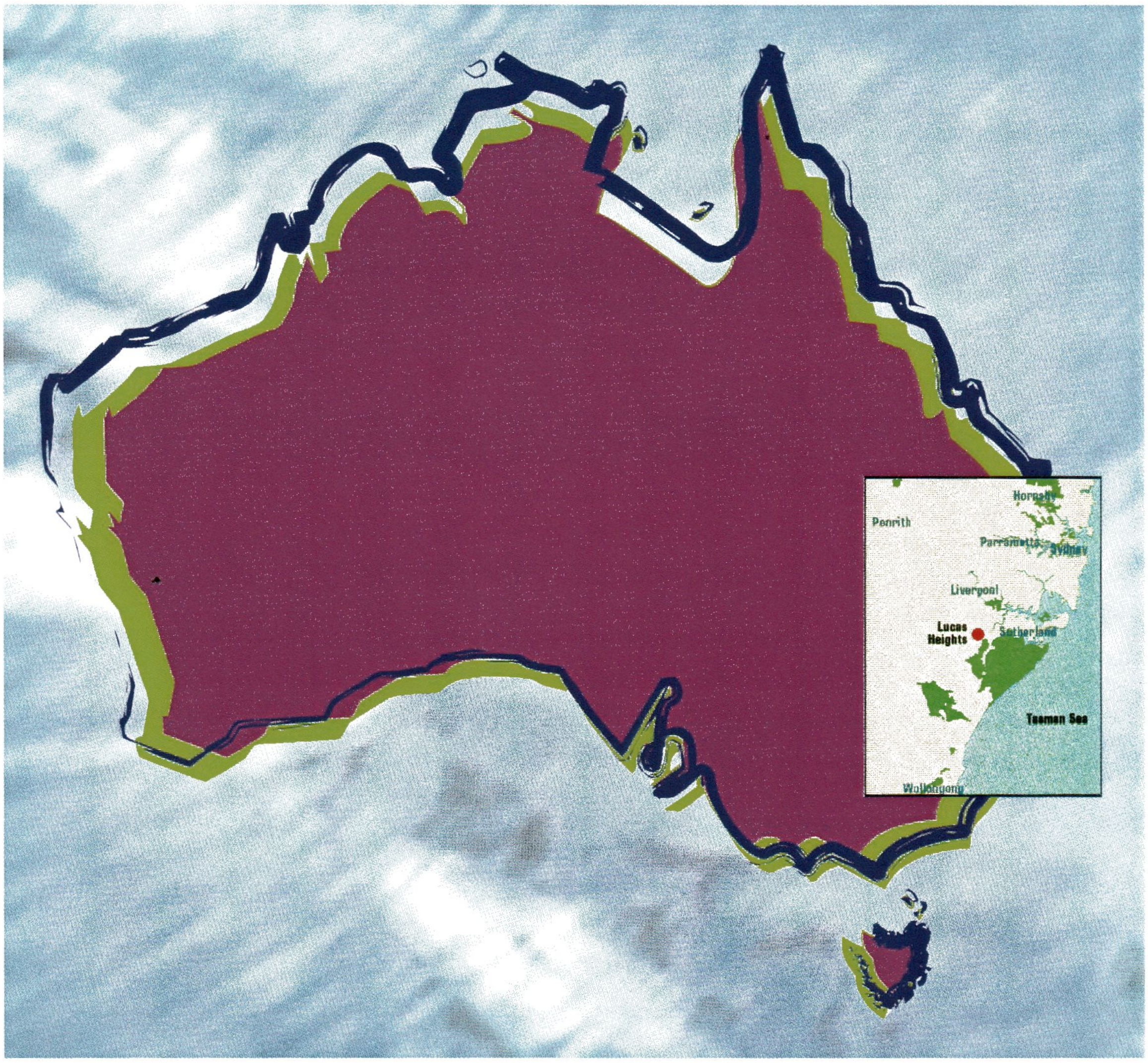
The spent fuel elements that will be transferred to France arise from the HIFAR research reactor, operated by ANSTO. HIFAR is at the heart of Australia's nuclear science and technology program, which encompasses the fields of nuclear medicine, serving domestic and foreign markets, materials and environmental research.

Spent fuel from nuclear research reactors may be managed under three main strategies: long-term storage, direct disposal or overseas reprocessing. Given the particular nature of ANSTO's fuel, Australia has chosen the overseas reprocessing path due to the widely recognised advantages of this proven industrial solution.

To implement this strategy, ANSTO has contracted with COGEMA, the world leader in nuclear fuel reprocessing, with more than three decades of successful and safe industrial operation.

The reprocessing operations as well as the associated transports will be carried out under very stringent Quality Assurance / Quality Control policies and will be in full compliance with all relevant international and national regulations, particularly those related to safety.

Content



The Lucas Heights Science and Technology Centre, site of Australia's nuclear research activities

Australia was one of the first countries to build a nuclear research reactor. The High Flux Austalian Reactor (HIFAR), the only functioning nuclear reactor in the country, is operated by ANSTO at the Lucas Heights Science and Technology Centre site, some forty kilometers south of Sydney.
It is at the heart of almost all ANSTO's research activities and supports those of several other organisations on the Lucas Heights site.

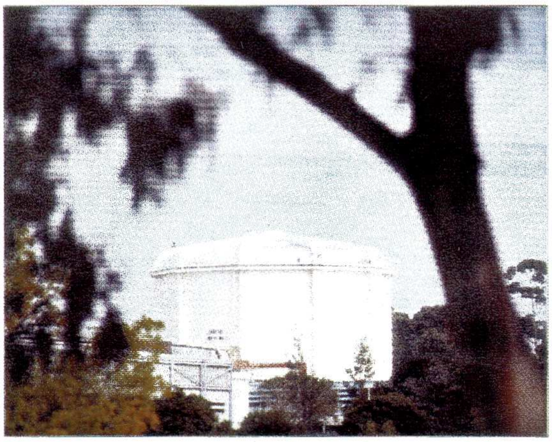
Nuclear activities in Australia

HIFAR

The Australian research reactor

What is a nuclear research reactor?

Research reactors are smaller than nuclear power reactors used to generate electricity, in terms of size and power output. For instance, commercial power reactors often exceed 3,000 megawatts and may hold 150 tonnes of fuel, whereas HIFAR nominal maximum power output is 10 megawatts, with a total fuel load of only 7 kilograms.
Research reactors play a vital role in important medical, environmental, agricultural, scientific and industrial applications.

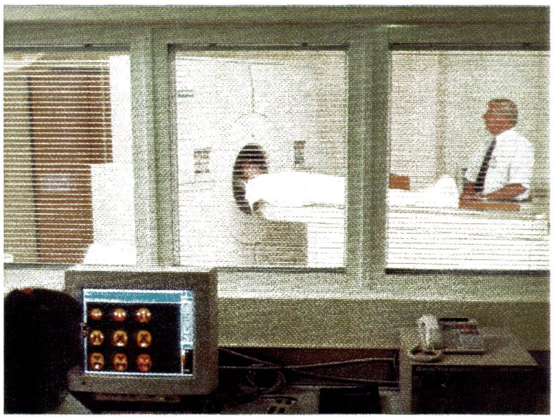

HIFAR research reactor steel containment building

HIFAR, a key tool in Australian nuclear expertise

HIFAR has operated at Lucas Heights since 1958.
Today, HIFAR irradiates materials and generates neutron beams for various purposes in the fields of medicine and health, scientific research, the environment and industry.
By the end of 2005, after more than 47 years of operation, HIFAR will be shut down and replaced by a new research reactor that will be constructed at Lucas Heights.

Medical applications:

HIFAR generates a range of radioactive elements called radioisotopes. They are selected for their specific characteristics appropriate for diagnostic or therapeutic applications such as muscular skeletal injuries, pain palliation, heart disease, and the detection and treatment of cancer.



ANSTO produces almost 90% of Australia's nuclear medicine requirements

Its biggest customers are the nuclear medicine departments of hospitals and clinics in Australia and the Asian region.

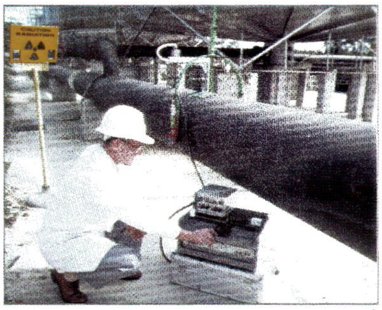
Nuclear medicine is one of the fastest growing fields in modern medicine.

On current projections, nearly every Australian can expect to have a nuclear medicine procedure in their lifetime.

Scientific applications:

With more than 7,000 hours in neutron beam time provided each year, HIFAR is a major research tool for scientists and students from Australia and overseas.

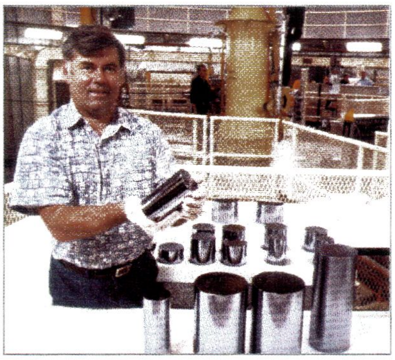
Studies of the chemical structures and magnetic properties of materials are made using neutron diffraction or scattering techniques. These studies permit the development of stronger, lighter, more heat resistant materials for industry, more useful chemicals and advanced pharmaceuticals.



An expert using a radioisotope and detecting equipment to check the integrity of a pipeline

Industrial applications:

HIFAR irradiates silicon crystals, transmuting silicon atoms into phosphorus to suit the needs of electronic components manufacturers from Japan and other countries. The silicon irradiated in HIFAR is returned to silicon suppliers where it is sliced into wafers and supplied to electronics companies.



Irradiated silicon produced in HIFAR is used extensively in the electronics industry

It is subsequently used in Charge Coupled Devices (CCDs) in video cameras and fax machines, in high power transistors, diodes, thyristors and Silicon Controlled Rectifiers (SCRs) for power transmission and air conditioning control units, and in computer DRAM (Dynamic Random Access Memory).

Research reactors worldwide

Research Reactors are often called RTRs (Research and Test Reactors).

There are currently more than 250 research reactors operating worldwide.

About 50 have a similar capacity to HIFAR.

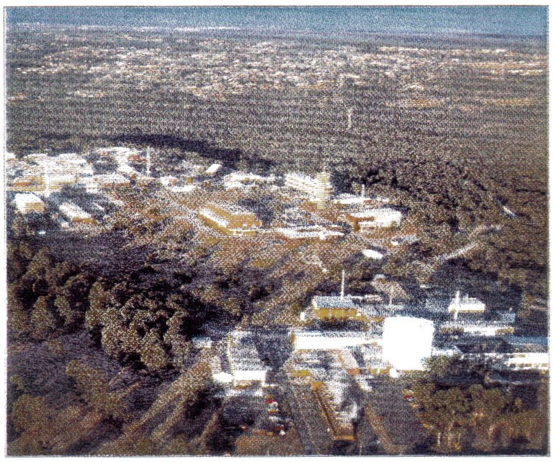
Research reactors are commonly located within urban populations and on university campuses.

60 countries across every continent operate RTRs.

Source: IAEA Research Reactor DataBase (RRDB)

ANSTO

Operator of HIFAR



The Lucas Heights Science and Technology Centre site

Established in April 1987 to replace the Australian Atomic Energy Commission, the Australian Nuclear Science and Technology Organisation, ANSTO, is at the centre of Australian nuclear expertise.
This Australian Government agency occupies a 70-hectare site separated from residences by a 1.6 km buffer zone of predominantly virgin bushland.

With a staff of more than 800, ANSTO is one of the largest employers in the Sutherland Shire local government area and makes a significant economic contibution to the Shire and nearby areas.

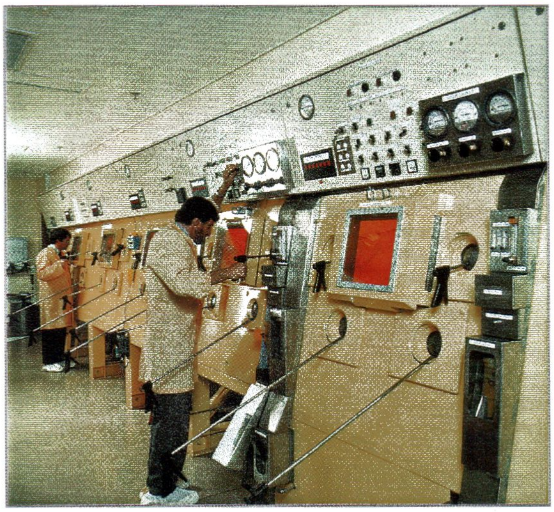
The Lucas Heights Science and Technology Centre is also home to part of the Commonwealth Scientific and Industrial Research Organisation and other businesses involved in science and technology. Together with the use of contractors and service providers from the local area, some 1,100 people are employed at the site.

ANSTO pursues several objectives:

• to provide expert scientific and technical advice across the nuclear fuel cycle to government in support of nuclear policy issues of strategic national interest and Australia's international obligations in this area.
ANSTO provides notably the technical basis for Australia's participation in:
– the United Nations' International Atomic Energy Agency (UN-IAEA) and,
– the Organisation for Economic Cooperation and Development's Nuclear Energy Agency (OECD-NEA).

• to operate large nuclear science and technology based facilities in Australia and overseas for the benefit of industry and the Australian research and development community.
The facilities operated by ANSTO include particularly the research reactor HIFAR, the National Medical Cyclotron (NMC) and the Australian National Tandem Accelerator for Applied Research (ANTARES).

• to undertake research on specific topics to advance the understanding of nuclear science and the nuclear fuel cycle.
ANSTO operates in a number of research areas. Among them are the application of nuclear physics, advanced ceramics, the processing and utilisation of radioactive materials, radioactive waste management, bio-medicine and health, environmental sciences, research in crystal and molecular structures, and radiopharmaceutical sciences.



ANSTO's staff at work

• to apply resulting technologies and other relevant, unique capabilities to focussed research and development and other scientific activities to increase the competitiveness of Australian industry and improve the quality of life for all Australians.

The HIFAR research reactor.
The top has been removed for routine maintenance

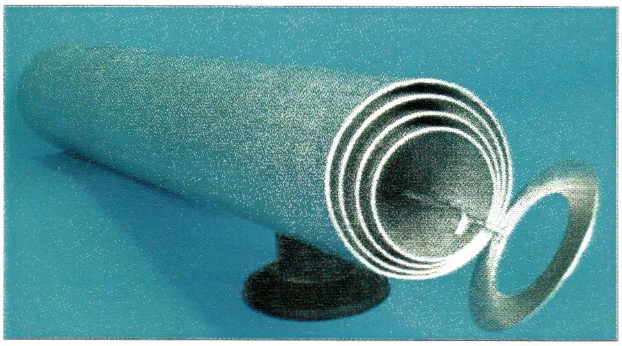
Since the beginning of its operations some forty years ago, HIFAR has accumulated an inventory of more than 1,400 spent fuel elements. ANSTO, with the approval of the Australian Government, has selected the overseas reprocessing path. To implement this strategy, ANSTO has contracted with COGEMA.

ANSTO's spent fuel management

HIFAR

How does the reactor operate?

The HIFAR core contains 25 fuel elements, containing enriched uranium, which is alloyed with aluminum. All HIFAR elements were manufactured in the UK, while the enriched uranium was supplied by both the UK and the USA. After the fuel is placed inside the reactor core, fission - the splitting of uranium atoms - occurs.
After some time, the nuclear fuel is no longer able to operate efficiently. Therefore every four weeks, three or four used or spent fuel elements are removed from the reactor and replaced by new fuel elements.
Annually, HIFAR uses around 37 fuel elements.
Once discharged from the reactor core, the spent fuel elements are stored in pools for cooling.
Storing spent nuclear fuel elements for several years under water allows them to lose much of their activity.
When the heat has decreased sufficiently, interim dry storage is made possible.



HIFAR fuel element as prepared for shipment

OPTIONS

available for spent fuel management?

Depending on the nature of the fuel, the long-term options for research reactor spent fuel management may include extended interim storage, direct disposal and overseas reprocessing.

Long-term interim storage

The long-term interim storage of spent fuel does not constitute a reliable solution. Indeed, some research reactors operators have encountered corrosion and material degradation problems in existing facilities. This option therefore cannot be considered as an acceptable solution.

Direct disposal

The direct disposal of research reactor spent fuel elements option faces several unsolved difficulties. Given the nature of aluminium clad fuel, one has to ensure that the fuel and its enriched uranium content will remain safe and stable over a long period of time.
Technical and economical risks and uncertainties may therefore impair the development of the direct disposal option for research reactor spent fuel for many years.

Reprocessing

The overseas reprocessing option is a reality, as demonstrated by decades of experience in several countries around the world. In France, COGEMA's track record in reprocessing encompasses more than 30 years, mainly in the large scale La Hague plant.

Separating the remaining enriched uranium still contained in the spent fuel from the waste, makes the uranium available for further use. The isolation and conditioning of the ultimate waste into a highly stable form provides a safe and sound solution for transport, long-term storage and final disposal. Moreover, it significantly minimises the ultimate volume of the waste disposed of when compared to the other options generally available for RTR spent fuel management.

RTR spent fuel reprocessing, main advantages:

- ***Recovery of valuable and reusable material***
- ***Reduction of volume of ultimate waste***
- ***High stability of the ultimate residues***
- ***Safe conditioning for transport, long-term storage and final disposal***

ANSTO's strategy

ANSTO's spent fuel management

Dry underground storage facility *at ANSTO used to hold the spent fuel element inventory*

The strategy put in place by ANSTO and approved by the Australian Government involves the following successive steps:

- Reprocessing of spent fuel overseas, as no reprocessing facility has been established nor will be established in Australia

- Conditioning of the waste into a dedicated form (known as long-lived intermediate waste form), suitable for final storage.

- Return of the waste to Australia.
- Long-term storage of the conditioned waste in a national intermediate level radioactive waste storage facility.

Three shipments of spent fuel had already been sent overseas prior to the ANSTO-COGEMA agreement, two to the United Kingdom and one to the United States.

Previous shipments to the United Kingdom and the United States

The first shipment to the UK, in 1963, was of 150 elements, while the second, in 1996, was of 114 elements. The two shipments were sent to the United Kingdom Atomic Energy Authority's Dounreay plant in Scotland.

HIFAR has also used US-origin fuel elements. The United States has launched a program to repatriate the spent fuel of US-origin, and 240 spent fuel elements were shipped to the US Department of Energy's Savannah River site, in 1998. No wastes will be returned to Australia from these US-origin fuel elements.

Soon after this last shipment, the United Kingdom Government decided Dounreay would not enter into new fuel reprocessing contracts. This meant that ANSTO had to look to other commercial reprocessors to handle its non-US origin spent fuel.

***ANSTO's staff** completing preparations for a previous shipment of spent fuel*

A new PARTNERSHIP

ANSTO / COGEMA

ANSTO and COGEMA completed negotiations and a contract was signed in January, 1999. Under the terms of this contract, COGEMA will assist ANSTO in the implementation of its strategy of durable and reliable back-end management for the research reactor spent fuel.

The services that COGEMA shall perform are, briefly:

- Transport of the spent fuel elements in dedicated casks on specially equipped ships from Australia to France.
- Reprocessing of the spent fuel elements at the COGEMA-La Hague plant.
- Conditioning of the ultimate waste into a stable form.
- Return of ultimate residues for storage and final disposal in Australia.

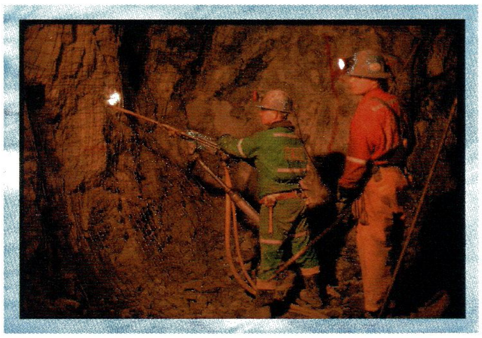
The contract covers all non-US HIFAR spent fuel (about 1,300 fuel elements) and has provisions for the reprocessing of the spent fuel from the replacement reactor.

The 1,300 HIFAR spent fuel elements will be transported in four shipments from the end of 1999 to 2004.

The ultimate residues shall be returned to Australia, as provided for by the French law, and by the terms of the commercial agreement. Both the French and Australian Governments support the principle of the return.

The return shipments of residues, which will be encased in special canisters contained in dual-purpose casks (for transport and storage), shall take place by 2015. The quantity of residues to be returned is estimated to be 36 canisters having a total volume of around 6 cubic meters.

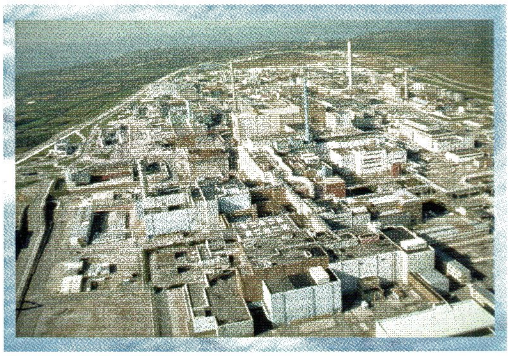
The COGEMA Group is active throughout the world in the nuclear fuel cycle



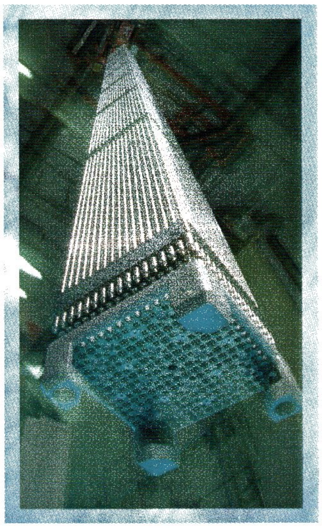
Uranium mining

Uranium enrichment

Uranium conversion



La Hague reprocessing plant



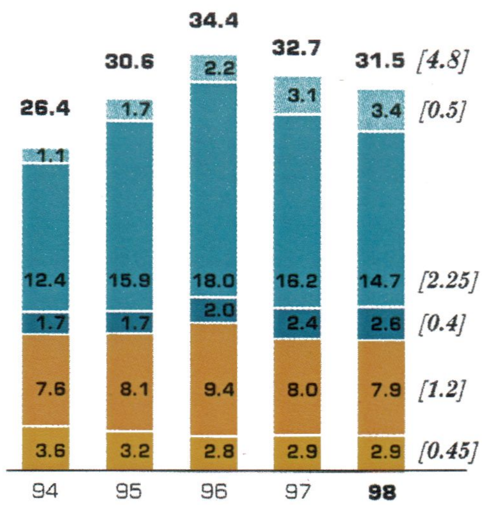
Fuel assembly manufacturing

Nuclear transport

COGEMA, a sound and reliable partner

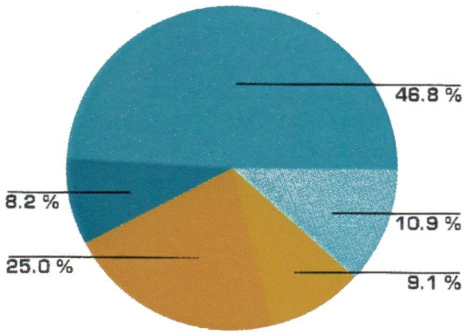
France is one of the leading nuclear technology countries in the world with 58 nuclear power plants in operation. Nuclear provides 76% of French electricity output. Several companies and research institutes are in charge of running the French nuclear technology program. Among them, COGEMA Group, established in 1976 specialises in the nuclear fuel cycle.
Its main share holders are the French State (81.5%), the Total Fina-Elf Group (15%) and an engineering group, Technip (3.5%).
The COGEMA Group is active throughout the world in various fields from uranium mining and enrichment to spent fuel reprocessing and recycling as well as transport. Outside the nuclear field, the COGEMA Group also provides engineering and services to several industries.
With a workforce of 18,700 highly skilled and well-trained persons and a consolidated sales revenue of more than 31 billion French Francs for fiscal year 1998, COGEMA ranks among the foremost French industrial groups.
COGEMA provides services to French and foreign customers: 40.5 % of the above cited figure was achieved abroad.
COGEMA has subsidiaries and affiliates mainly in the USA, Germany, Belgium, Spain, Ukraine, Japan, Republic of Korea, China, Taiwan and Australia.
COGEMA's activities contribute to the optimisation of the use of energy resources and the minimisation of ultimate waste volume and toxicity in line with the objectives defined at the 1992 Earth Summit regarding sustainable development.

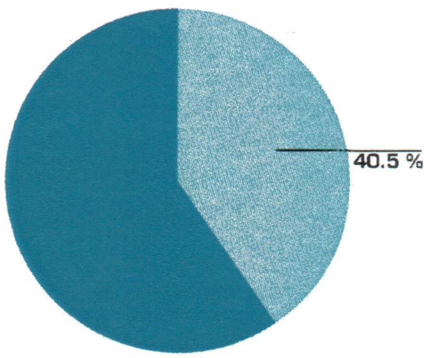
COGEMA 1998 KEY FIGURES



Consolidated sales revenue

Contributions of each activity to consolidated sales revenue of the COGEMA Group in 1998



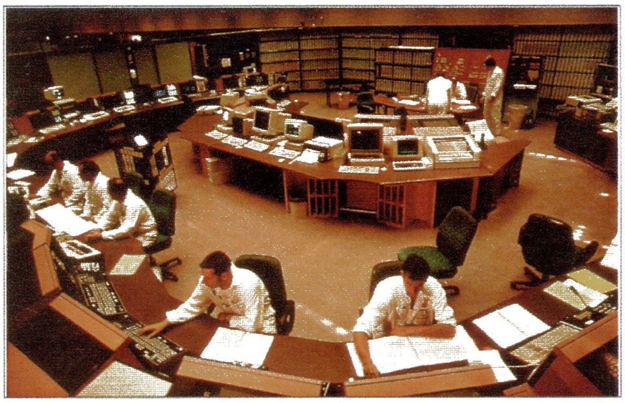


Share of sales abroad in consolidated sales revenue

COGEMA

and the management of RTR (Research and Test Reactor) spent fuel

COGEMA is the world's largest provider of spent fuel reprocessing services, with over 14,500 tonnes of Light Water Reactor (Power Reactor) spent fuel reprocessed by mid-1999. COGEMA has many years of experience reprocessing RTR spent fuel from French research reactors. The first reprocessing plant in operation in France was Marcoule, which operated from the mid-1950's to September 1997.



Control room at COGEMA-La Hague

The La Hague industrial complex, located in Normandy, started up in 1966 and has been reprocessing nuclear spent fuel from French and foreign utility customers since then.

COGEMA-La Hague has a nominal capacity of 1,700 tonnes per year and has contracts to reprocess nuclear spent fuel with about 29 utilities from 6 countries (France, Japan, Germany, Switzerland, Belgium and the Netherlands).

The whole plant has reached a high degree of industrial performance together with outstanding quality, safety, flexibility and environmental protection results.

La Hague plant evolution has always been characterised by the implementation of state-of-the-art equipment. New units are less than 10 years old and will be operational for several decades into the next century.

COGEMA has set up a unique gathering of the most advanced technologies to minimise and manage waste arising from nuclear spent fuel processing.

More specifically, the COGEMA Group has gained sound experience in RTR spent fuel management, including transportation, reprocessing, conditioning and shipment of the related ultimate waste.

In addition to the contract with ANSTO, COGEMA has spent fuel management contracts with the Belgian BR2 research reactor and the international ILL research reactor in France.

Transportation of RTR spent fuel

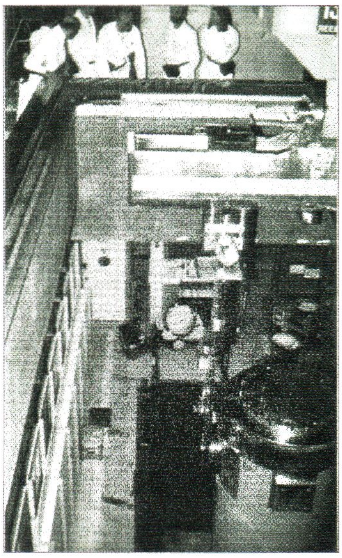
Shipment of RTR spent fuel from the Belgian BR2 research reactor

COGEMA through its subsidiary TRANSNUCLEAIRE offers optimised services covering the complete transport chain (cask design and manufacture, transport preparation and follow-through, maintenance).

TRANSNUCLEAIRE uses several types of casks for the transport of RTR spent fuel.
In 1999, TRANSNUCLEAIRE has introduced a new generation transport cask, called the TN-MTR. This cask has been specially designed for easy handling, without sophisticated equipment. It will be used for the transport of ANSTO's spent fuel elements. RTR spent fuel transportation is routinely made around the world.

In 1998, 16 shipments were performed by TRANSNUCLEAIRE, two of which were from the Belgian BR2 research reactor.

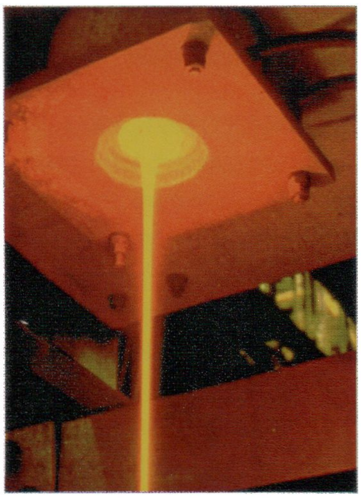
Reprocessing of spent fuel



Unloading RTR spent fuel at La Hague

About 13,000 kg of aluminide spent fuel arising from 21 research reactors and 5,900 kg of heavy metal of other types of RTR fuels were successfully reprocessed at the COGEMA-UP1 plant located at Marcoule. UP1 was shut down for commercial reasons in 1997 after forty years of satisfactory operation. The know-how gained through this experience has been transferred to the framework of La Hague plant activities.

Conditioning of the waste

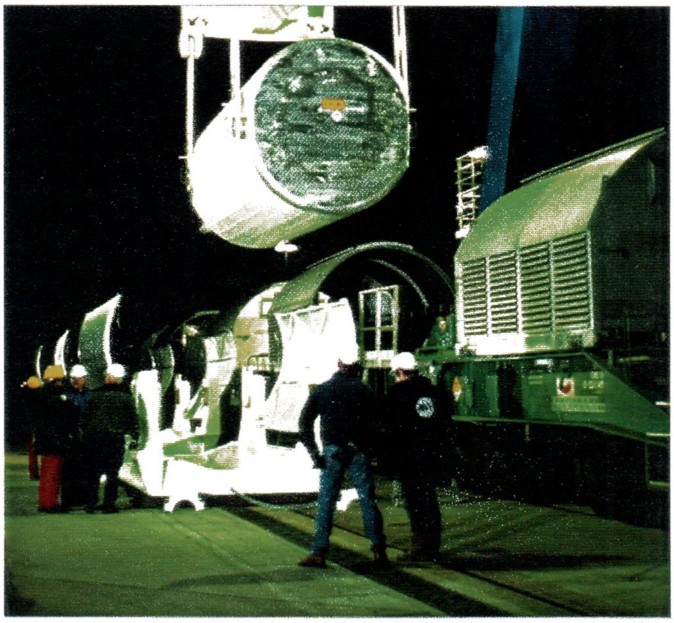


Glass pouring at the vitrification facility at COGEMA-La Hague

For the ultimate residues to be disposed of in Australia, COGEMA will use the Universal Canister. The Universal Canister can accommodate every type of waste for storage and final disposal including vitrified fission products and compacted structural pieces that arise from reprocessing operations.

As of mid-1999, 6,600 vitrifed residues canisters have been safely produced at COGEMA-La Hague in full compliance with customer requirements and the relevant national regulations.

Transportation of ultimate residues



Previous return shipment of vitrified residues from COGEMA-La Hague to Japan

The return of residues is a well-established procedure as 6 overseas transports of vitrified residues have already been safely conducted by sea, road and rail (4 to Japan and 2 to Germany).

The transport of the conditioned ultimate residues as well as the reprocessing and conditioning steps abide by the most stringent international and national regulations and standards.

The COGEMA-La Hague plant

The reprocessing of HIFAR spent fuel elements will be performed under the routine, well-established industrial process in use at COGEMA-La Hague. Reprocessing is a series of mechanical and chemical operations which separate the valuable and reusable material still contained in nuclear spent fuel (such as enriched uranium) from final wastes that have no further use and cannot be recycled. After having been separated, the wastes are conditioned into a very stable and compact form suitable for transport, storage and final disposal.

Reprocessing, a durable and dependable solution

The PROCESS

The different steps

Reprocessing involves several successive steps. In addition, preliminary operations are carried out before actual reprocessing begins.

Reception and storage in spent fuel storage pool

On arrival at the COGEMA-La Hague reprocessing plant, after checking the transport casks and their contents, the fuel elements will be removed from the transport casks, placed in baskets and stored underwater in a deactivation pool, enabling cooling, as necessary, before the commencement of reprocessing.

Spent fuel reprocessing

Reprocessing will begin with the dissolution operation. Once out of the pool, the spent fuel will be cut into pieces as necessary and dissolved into a nitric acid liquor. The liquor arising from HIFAR spent fuel dissolution will be blended down with liquors from dissolution of commercial power reactor spent fuel.

In the further process steps, uranium will be separated for storage and subsequent recycling. Fission products, the very low quantity of plutonium, and structural pieces will then be conditioned into a very stable form suitable for transport, storage and final disposal.

Waste conditioning

The industrial process applied to the conditioning of these various categories of wastes will vary according to their nature.

Fission products and plutonium will be vitrified, that is, incorporated into a stable glass matrix, while structural pieces will be compacted in discs.

Almost all the radioactivity will be encased in the glass matrix.
Both the glass matrix and compacted discs will then be encased in a standard stainless steel package referred to as the Universal Canister.

After being filled, the canisters will be hermetically sealed and will undergo a series of thorough checks.

ENCAPSULATION

The Universal Canister

The conditioned ultimate residues that will be returned to Australia are industrially proven high technology products, manufactured under strict Quality Assurance and Quality Control systems.

The main characteristics of the Universal Canister are as follows:
Height: 1.34 m
Outside diameter: 43 cm

The Universal Canister

An industrially proven high technology product...

The industrial processes (vitrification, compaction and conditioning in standard packaging) that will be used to safely immobilise the various categories of residues removed from HIFAR spent fuel through reprocessing at La Hague result from thirty years of extensive research carried out in France. These R & D activities were aimed at identifying the most stable solid form to immobilise the resulting long-lived intermediate level wastes.

All the industrial processes, whose efficiency has been internationally recognised, are already or will be shortly implemented on a commercial scale at the COGEMA-La Hague reprocessing plant. More than 6,600 canisters of vitrified residues have been safely produced as of September 1999.

...manufactured under very stringent Quality Assurance and Control systems (QA/QC)...

All the conditioned ultimate residues to be returned to Australia will be manufactured in compliance with specifications meeting the IAEA criteria for long-lived intermediate level wastes and approved by the relevant competent authorities in Australia and France. COGEMA will implement very stringent Quality Assurance systems and Quality Control program (QA/QC) to guarantee that the conditioned ultimate residues comply with the above mentioned specifications.

More specifically, a dedicated QA Department has been set up at La Hague. It guarantees the whole plant Quality System while monitoring the quality of products delivered by nearly 200 suppliers. Each year, 100,000 conditioned products are checked according to this framework.
In addition, on November 26, 1997, the La Hague plant was granted the ISO 9002 certification, following a thorough audit of the site. This proves the consistency and efficiency of the QA system in place at La Hague.

On top of that, foreign COGEMA customers have contracted the internationally known Bureau Veritas with the responsibility of controlling the operations, the independent checking of the QA programs and the ability to certify compliance of each vitrified residues canister with agreed specifications.

...offering numerous advantages

The vitrification and compaction of final wastes as well as the use of a standard packaging to condition these ultimate residues provide several advantages.

- **High stability and safety of the ultimate residues**

The industrial technologies developed and implemented at COGEMA-La Hague provide for a stable

and long-term immobilisation of the various wastes sorted out through reprocessing. As for the vitrified residues, the high stability of such a glass matrix is illustrated by analogy with the glass obsidian, a natural mineral that remains for thousands of years without alteration.
The ultimate residues are therefore stable for transport, long-term storage and final disposal.

• Volume reduction of ultimate residues for disposal

The RTR spent fuel management policy as implemented at La Hague offers an important volume reduction factor as compared to the other options generally available for RTR spent fuel management. In addition, the improvement over the years of the techniques used at La Hague allows an optimisation of the waste conditioning. For instance, thanks to the compaction technique, the volume of the final residues has been divided by 4 compared to the previous conditioning process (cementation) used to immobilise structural pieces that are now compacted.

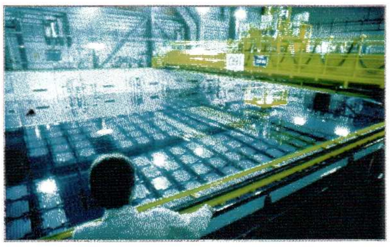
• Easy handling and management of the ultimate residues for disposal

This advantage results from the use of a standard package, the Universal Canister, to accommodate all types of long-lived and intermediate level wastes, regardless of their form, activity and final destination.

The final residues that will be manufactured at COGEMA-La Hague will be directly suitable for final disposal without any further conditioning. The conditioning of waste into universal canisters gives the ability to rationalise waste management for on site handling, for transport operations, and for interim storage and ultimate geological disposal. For the return shipment, the Universal Canisters will be loaded into dual-purpose storage and transport casks.

Main steps of reprocessing

Spent fuel deactivation in storage pool



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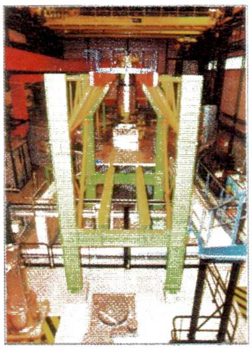
Dilution of the HIFAR fuel dissolution liquor in the main flux resulting from commercial power reactors spent fuel dissolution



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Chemical separation →

Uranium

Plutonium

Fission products

Structural pieces

→

Vitrification

Compaction

→

Universal Canisters of vitrified and compacted residues

Interim storage

COGEMA &

RADIATION

In perspective

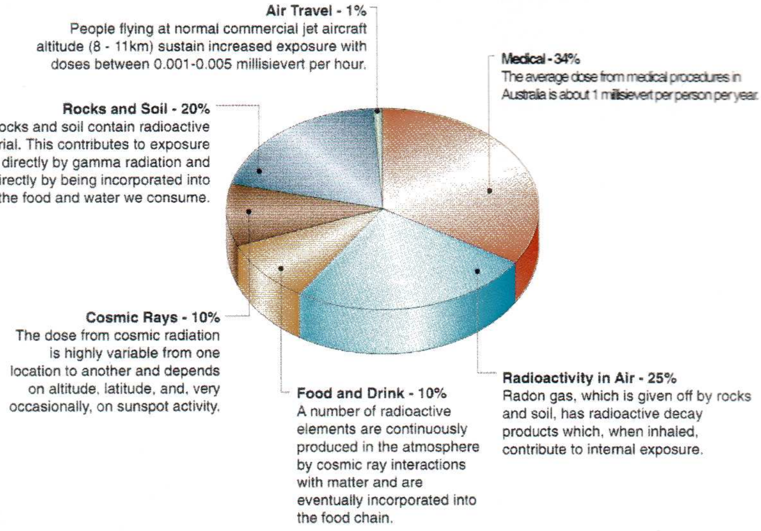
Q What is radioactivitiy?

Radioactivity is the property of certain atoms to emit radiation. The atoms constituting all matter are made up of a nucleus around which electrons gravitate. The nuclei are themselves made up of two kinds of particles : protons and neutrons. The nuclei may be stable or unstable, the latter change spontaneously and turn into new atoms of different chemical elements, while emitting one or more radiation. They are said to be radioactive. The radiation consists of the emission of different kinds of particles carrying more or less energy.

Q Where does radioactivity come from?

Radioactivity is an integral part of the life of the universe. It is present everywhere, even without any human contribution.

• 65 % of the radiation dose received by man is natural.



Distribution of average annual radiation dose

Natural radioactivity nowadays originates mainly from four sources :

- cosmic rays from the sun and the outer space,
- radiation emitted by numerous radioactive elements such as uranium and thorium naturally present in the Earth's crust,
- air, containing emanations of radon, a radioactive gas produced by the decay of uranium and thorium contained in the Earth's crust,
- natural radioactivity contained in food and drinks.

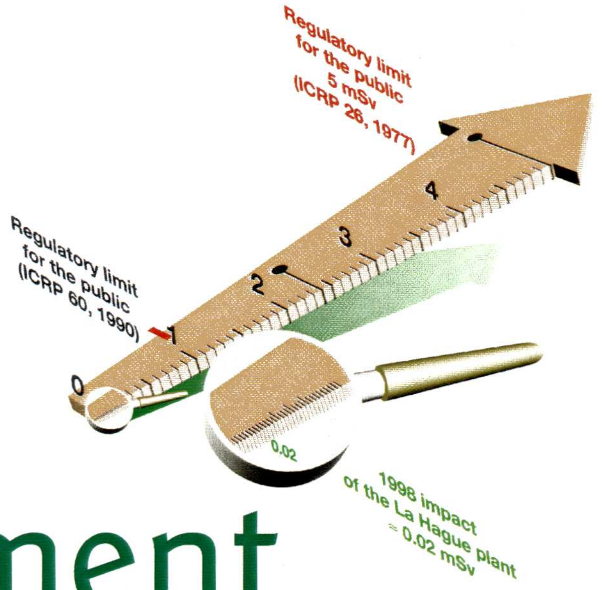
• 35 % of the radiation dose received is man-made. This radioactivity comes from:

- medical irradiation which is the greatest source of exposure owing to the development of radiotherapy, nuclear medicine and thermal cures (some mineral waters are rich in radium and thorium),
- technical and industrial activities such as air travel, TV sets or computer screens also bring their contribution on a more daily basis.

Q How is radioactivity measured?

Radioactive activity is measured in becquerels (Bq), the number of disintegrations of nuclei occurring each second in a sample. The amount of energy imparted to tissues from exposure to radiation is referred to as absorbed dose, the unit used is the gray (Gy).

The biological effects of radiation on an exposed organism, referred to as effective dose equivalent, is measured in sieverts (Sv), but the thousandth of a Sievert, the millisievert (mSv) is currently used. A modern chest X-ray results in an approximate dose of 0.03 mSv. Throughout the world, the annual average equivalent dose due to natural exposure is around 2.4 mSv.



the environment

COGEMA

Caring for the environment

The general environment policy of COGEMA

From the very beginning the nuclear industry has been particularly careful to minimise harm to the environment. COGEMA's care for the environment is one of the most important components of its general policy. COGEMA has for a long time been a signatory of the "Companies charter for a sustainable development" and has made every effort to integrate the spirit of this Charter into its own structure and into its daily management methods. This has been done by controlling the undesirable effects of radiation and of by-products as well as to make the best possible use of raw materials and rehabilitation of sites.

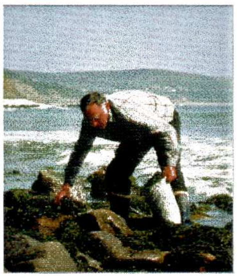
In the implementation of this policy, COGEMA owes a great deal to the total commitment of its employees. The care of environment is placed under the responsibility of the Direction of Quality-Safety-Environment at headquarters, with a team of environmental advisers at each site.

This commitment to environment protection has led to setting up an environmental management system based on the ISO 14000 standard on each of COGEMA's sites. This initiative is part of a much wider Quality management process that has been set up in the majority of COGEMA plants and sites. About thirty of these are certified as conforming with the ISO 9000 standard.
The Quality Assurance and Quality Control programs are audited by an independent third party, the internationally known Bureau Veritas, making sure that these programs set-up by COGEMA are appropriate and consistently applied.

The environment and health impact of the COGEMA-La Hague reprocessing plant

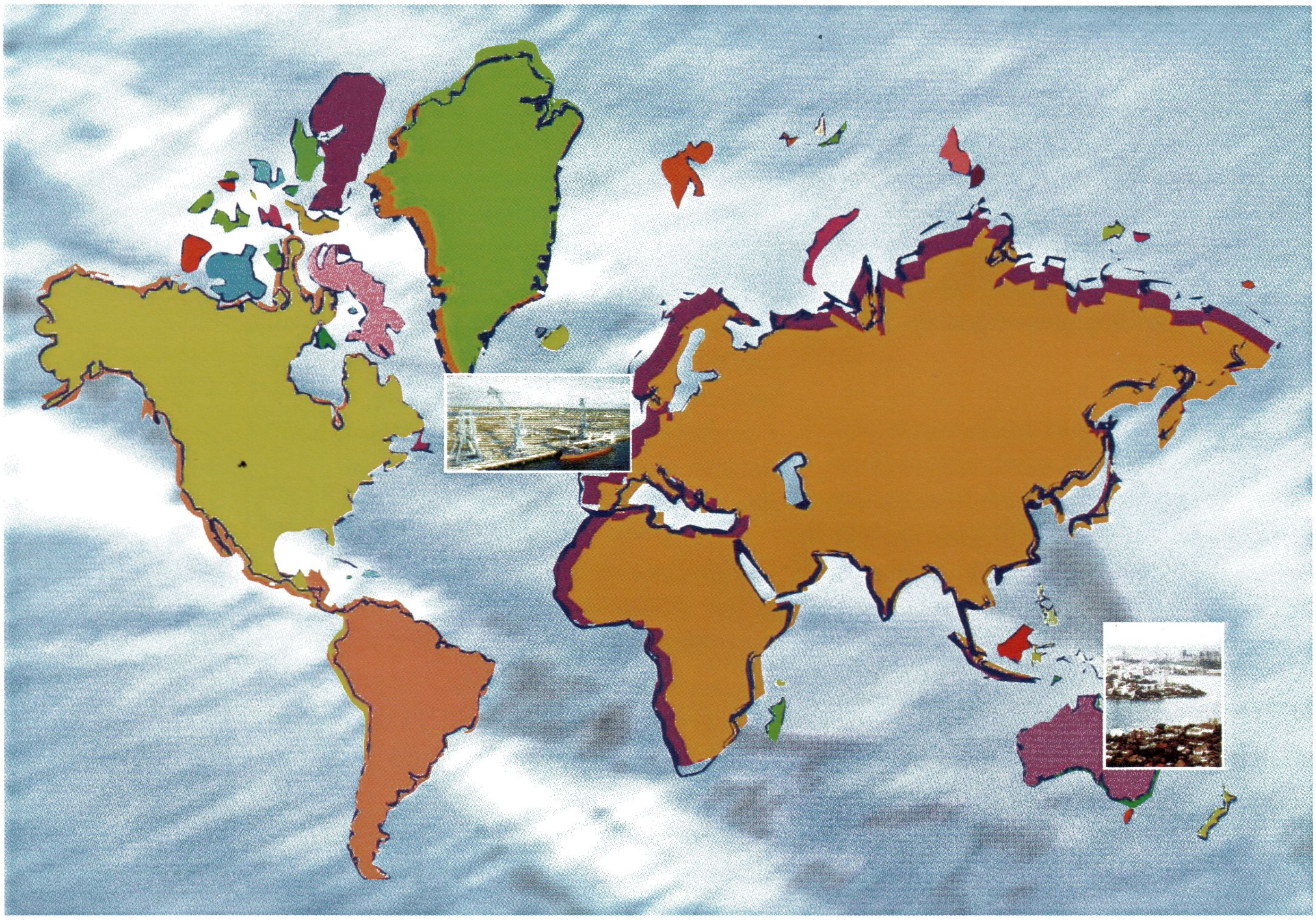
To assess the environmental impact of the activities performed at La Hague, COGEMA employs permanently 24 people and 5 specialized vehicles.
Sampling is done on the atmosphere, rainwater, water tables, water used in homes or in agriculture, sea water, streams, plants, meat and milk from cattle raised in the surroundings, fish, molluscs, crustaceans and algae.
Each year, 25,000 samples are taken, on which more than 80,000 analyses are carried out.

In 1997 the impact of COGEMA-La Hague releases for the "critical group" (i.e. the more theoretically exposed people) was 0.017 mSv per year, i.e. eight times lower than the impact from the maximum authorized releases set by decrees of three Ministries (0.15 mSv), and one hundred times lower than the impact of natural radioactivity in the region, which is 2.6 mSv per person per year.



Monitoring the environment

Monitoring the environment



HIFAR spent fuel elements will be transported by sea from Australia to France in specially designed transport containers, or casks, on board a dedicated vessel.
The casks and ship used, as well as the organisation of the transport meet the latest requirements of the enforceable international and national regulations.

Transport of spent fuel *from* Australia *to* France

TRANSPORTATION

The logistical framework

The different steps

The shipment of HIFAR spent fuel elements will involve several successive steps.

- Loading fuel elements at the reactor site into the dedicated casks.

The spent fuel elements will be loaded under water into the transport casks at ANSTO's site, following established and practised procedures.The casks will then be drained, vacuum dried and hermetically sealed.

- Transfer of the transport casks by road from the Lucas Heights site to a port in New South Wales.

The loaded casks will be tied down in specially strengthened steel shipping ISO containers and transported by road to the port.

- Loading of the casks onto a dedicated ship.

ANSTO has contracted an experienced transport agent to be responsible for all transport preparation and implementation between the reactor and the ship, including loading of casks onto the vessel.

- Sea transportation from the Australian port to the French port of Cherbourg (Manche).

This sea transportation will be carried out on a dedicated ship meeting the requirements of the INF-2 classification set down by the International Maritime Organisation (IMO). The INF code applies to the ships carrying Irradiated Nuclear Fuel. Such ships have been operated by TRANSNUCLEAIRE since 1995.
COGEMA is responsible for all transport preparation and implementation from the time

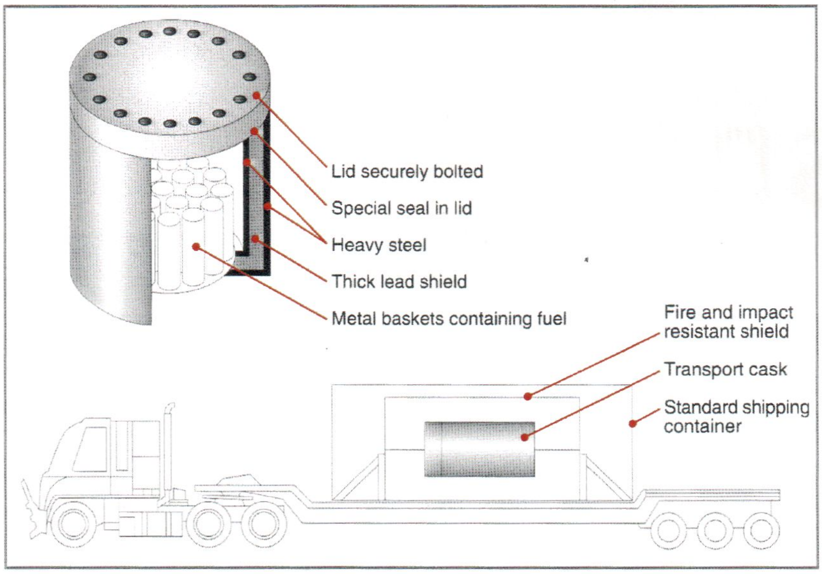
the casks are loaded onto the ship until their arrival at the reprocessing site, and has subcontracted all the related transport services to TRANSNUCLEAIRE.

• At Cherbourg transfer of the transport casks from the vessel to the COGEMA-La Hague reprocessing plant by road transport.

Once arrived at the Cherbourg port, the shipping containers will be transferred, by using a harbour crane, from the vessel to a trailer with a maximum gross weight of 40 metric tonnes, meeting all domestic regulations regarding hazardous material transportation.

They will then be transported by road to the La Hague reprocessing plant where the shipping containers will be unloaded from the trailer.

Later, the spent fuel elements will be unloaded underwater from the transport casks, placed in baskets and stored underwater in a deactivation pool.



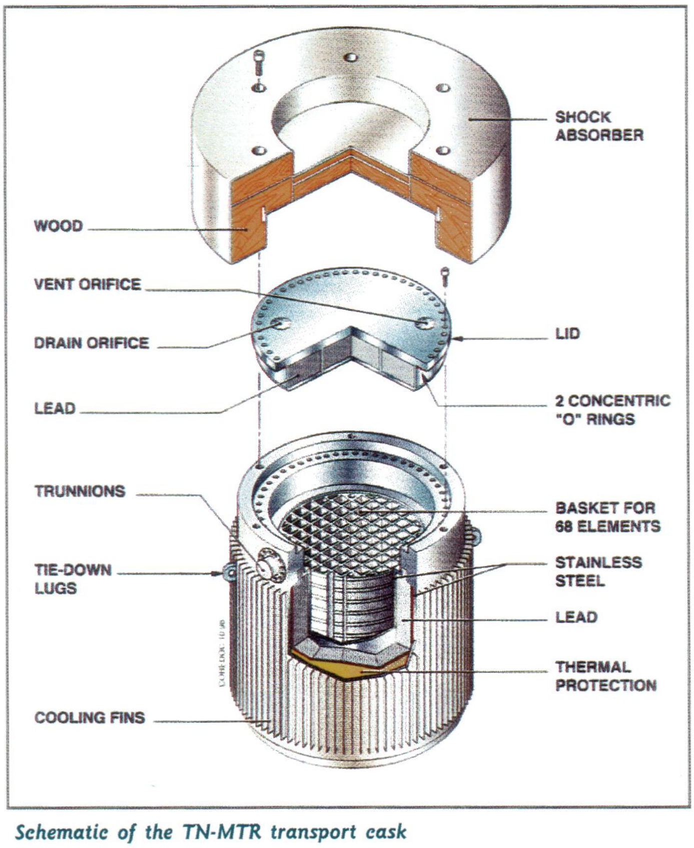
Schematic of the LHRL - 120 transport cask

Specially designed transport casks

ANSTO's spent fuel elements will be transported in specially designed casks.

Three types of casks with similar safety characteristics will be used. These casks, named LHRL 120, TN 7-2 and TN-MTR, are cylindrica structures and weigh around 20 tonnes each. Th LHRL-120 was designed and built purposely for the carriage of HIFAR spent fuel and has performed previous shipments with an exemplary safety record.

The TN 7-2 and TN-MTR casks have been designed by TRANSNUCLEAIRE for accommodating different types of RTR spent fuel, including the HIFAR fuel elements. TRANSNUCLEAIRE has designed more than one hundred shipping casks and containers meeting all regulatory requirements.



Schematic of the TN-MTR transport cask

The TN-MTR cask, the latest designed o TRANSNUCLEAIRE, incorporates state o the art features, high capacity and easy handling.

All casks were designed and built to standards for Type B(U)F packaging set by international experts representing the 127 member countries of the Internatio nal Atomic Energy Agency (IAEA) and their security and reliability have been carefully tested. They have been fully licensed for the transport of RTR spent fuel by the relevant competent authorities in Australia and France.

Dedicated vessel

A specific purpose vessel will be used to transport ANSTO's spent fuel elements from Australia to France.
This European registered ship is 90 meters long and 16 meters wide and carries sufficient fuel to complete a journey without any port-call.
It has regularly been used to transport radioactive materials between Europe, United States and Asia.

It meets the international standards and requirements of the INF-2 classification set down by the International Maritime Organisation (IMO).

According to the INF-2 classification, the ship is equipped with:

- Lateral reinforcement tanks for minimising damage and for safety in case of accident
- Additional fire detection and fire fighting systems. The ship is covered by a fire detection system and has sophisticated fire extinguishing equipment on board, including the ability to protect the casks by spraying water
- Duplicated electrical systems
- Radiological monitoring equipment
- Modern communication and tracking system.

A TRANSNUCLEAIRE specific purpose nuclear materials transport vessel

The INF-2 classification requirements also include a radiation protection training program for the crew and a specific shipboard emergency plan.

TRANSPORTATION

The regulatory framework

The casks and ship used, as well as the organisation of the transport meet the latest requirements of the enforceable international and national regulations.

The objective of the regulations is to protect the public, transport workers and property from both the direct and indirect effects of radiation during the transport of radioactive material.

In particular, the transportation of research reactor spent fuel complies with two types of stringent and well-established regulations: dangerous goods and radioactive materials.

- Dangerous goods transportation is regulated by various rules depending on the mode of transport (road, rail and sea) and the countries involved. In Australia, these rules include the Australian Dangerous Goods code. In France, the current regulation for road transport is based on the following European Union Directive:
  - the order relative to the carriage of dangerous goods by road based on the European Agreement concerning the international carriage of Dangerous goods by Road (or ADR).

  Sea transportation complies with the rule of the International Maritime Dangerous Goods (IMDG) code, adopted by the International Maritime Organization (IMO). This code offers guidance to persons involved in handling and transport of all hazardous material in ports and on board ships.

- In the case of radioactive material transportation, the International Atomic Energy Agency, a

United Nations' body based in Vienna, Austria, establishes standards. These standards are enforced by each country's Authority and apply in Australia and in France.
The philosophy of these regulations is that safety is ensured by the special packages whatever the mode of transport used. For this reason, the regulations define three packaging categories and design criteria, taking into account the radioactivity as well as the form of the material transported.

In order to transport research reactor spent fuel, the transport casks must comply with the highly stringent IAEA Type B(U)F specifications. A list of very stringent tests must be performed to check the resistance and safety of the package.

These tests include notably:

- Two punishing drop tests.

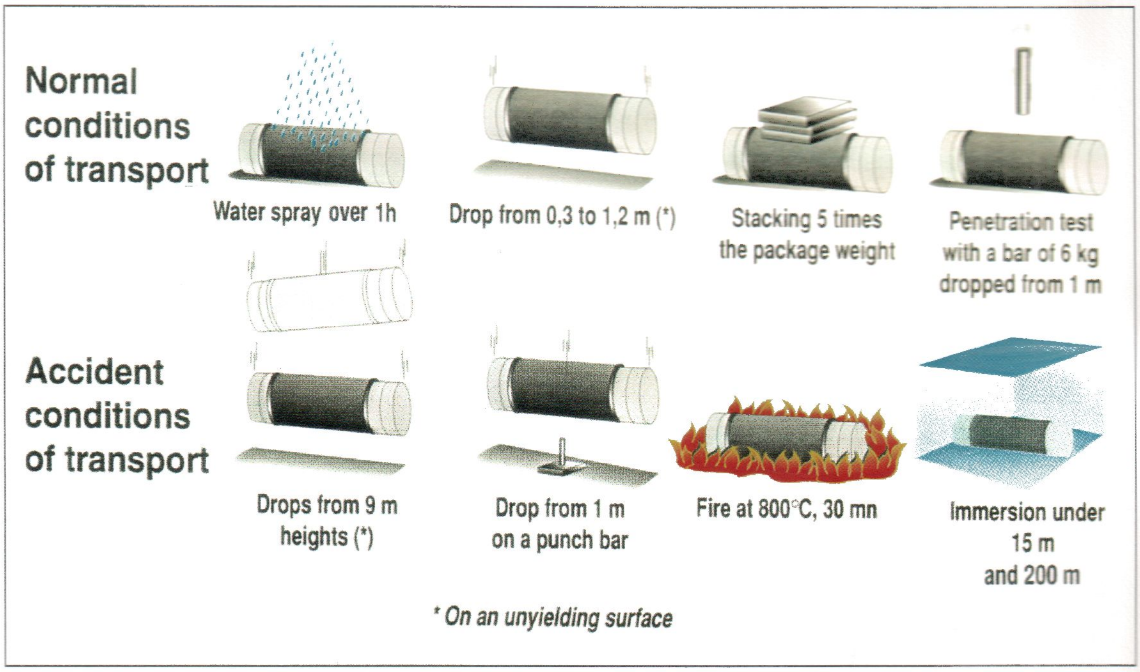
In one, the cask is dropped from a height of one meter onto a steel punch bar.
In another test, the cask is dropped nine meters onto an unyielding surface - a surface more inflexible than any found in nature - to stimulate real impacts from far greater heights.

- Fire test

The cask is subjected to fire testing, requiring it to withstand an all-engulfing fire - far more destructive than real fires - of 800 degrees Celsius for 30 minutes.

- Pressure tests

The cask is also given immersion tests where it must withstand the pressure of at least 15 meters of water for a period of not less than 8 hours, and at 200 meters for at least one hour.
After these tests the cask must remain leaktight and retain enough of its shielding to ensure that any radiation dose is within internationally agreed limits.
Compliance with regulations results in certification by the relevant nuclear safety authority. The casks that are used for the shipment have been licensed by the relevant Australian and French authorities.
Moreover, in 1993, the IMO established the INF code, which recommends measures ensuring the safety of the vessels carrying radioactive material, covering the design specifications of the vessel concerned.
The vessel to be used complies with INF-2 classification.



Main tests for Type B packages

LIABILITY
and Insurance

The safety arrangements – the specially designed casks and the dedicated vessel – provide substantial protection against risk of accidents.

In the highly unlikely event of an accident with consequences arising from the radioactive nature of the transported materials, the Paris Convention and, if applicable, the Brussels Convention would enable a person who suffered injury or damage from the radioactive characteristics of the cargo to recover compensation.
The conventions cover damage suffered on the high seas and liability is backed up by insurance.

For countries that are not covered by these conventions, such an accident affecting their territory or territorial waters would be dealt with under the relevant applicable law.

In the case of an accident not having any radiation consequences, the relevant civil law would apply.

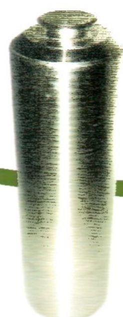
Insurance provisions are contained in French domestic regulations to cover valid compensation claims in the event of an accident occuring during radioactive materials transportation. COGEMA fully complies with these regulations.
Insurance for the transportation between the ANSTO site and the port is provided by a Deed of Indemnity signed between the Commonwealth and ANSTO.
In some 40-years experience of transporting thousands of such shipments of radioactive material around the world in accordance with the IAEA Transport Regulations, there have been no personal injuries incurred as a result of the radioactive nature of the material.

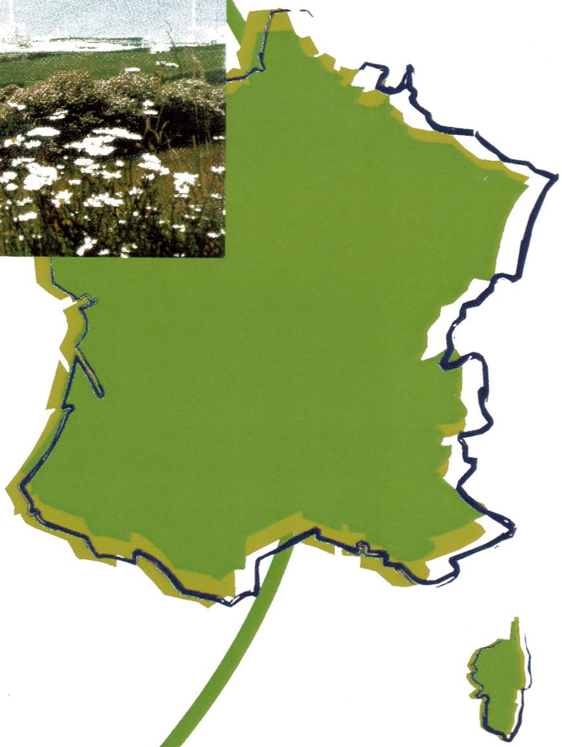
SAFEGUARDS
arrangements

The shipment of spent fuel from Australia to France will be conducted in accordance with all international safeguards and security requirements. These include International Atomic Energy Agency (IAEA) safeguards under the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and the Convention on the Physical Protection of Nuclear Material and will be undertaken pursuant to the Agreement between the Government of Australia and the Government of the French Republic concerning Nuclear Transfers between Australia and France dated January 7, 1981.

At La Hague, spent fuel and all nuclear materials are submitted to EURATOM and IAEA safeguards.

At *a*





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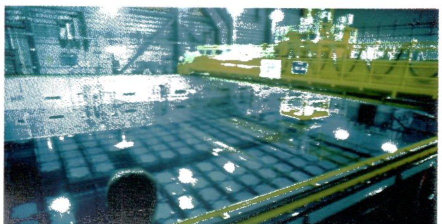

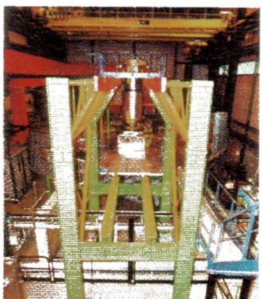

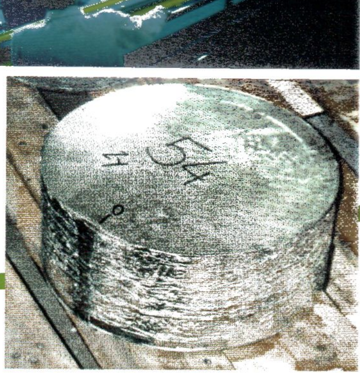

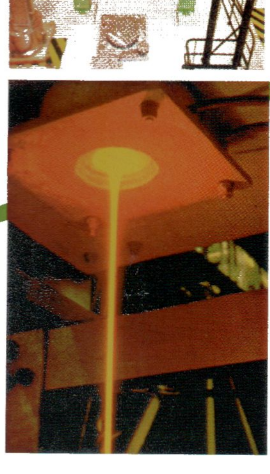

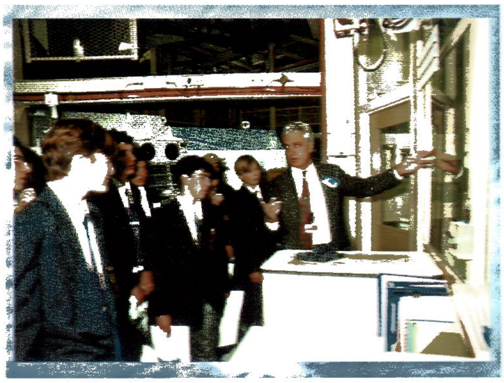


ansto

Want to
contact us?

Do you wish to know more? Do you have a question about reprocessing? Interested in transport issues? Would you like to look at our reports and brochures?
Please do not hesitate to contact us!
ANSTO and COGEMA operate dedicated websites where you can find lots of information and news, download brochures and annual reports, find other links...
Plus, if you phone, fax or write to us, we will be delighted to send you informational documents, such as annual reports or activity surveys.

Where to
find us?

ANSTO

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Fax: 61-2-9543-5097
www.ansto.gov.au

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78141 Vélizy cedex
France
Tel.: 33-1-39-26-30-00
Fax: 33-1-39-26-27-00
www.cogema.fr

Other
useful links

Shipment of nuclear material between Australia and France follows international regulations and rules issued mainly by the International Atomic Energy Agency (IAEA) and the International Maritime Organisation (IMO).
These two UN-affiliated bodies have their own websites. There you will find useful information on nuclear energy as a whole (www.iaea.or.at) and nuclear transport and regulations issues (www.imo.org).

IAEA

P.O Box 100 Wagramerstrasse 5
A-1400 Vienna
Austria
Tel.: 43-1-26000
Fax: 43-1-26007
www.iaea.or.at

IMO

4 Albert Embankment
London SE 1 7SR
Tel.: 44-171-735-7611
Fax: 44-1-171-587-3210
www.imo.org

Australian Nuclear Science and Technology Organisation
www.ansto.gov.au

Compagnie Générale des Matières Nucléaires
www.cogema.fr

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