Australian Government

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Nuclear-based science benefiting all Australians

Managing radioactive waste and used reactor fuel

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The Australian Nuclear Science and Technology Organisation (ANSTO) is the home of Australia's nuclear science expertise. This unique expertise is applied to health, climate change, water resource management, the environment and a range of scientific research disciplines.

ANSTO is a Federal Government agency and operates Australia's only nuclear reactor - used for research and isotope production, not nuclear power generation. ANSTO applies nuclear science in a wide range of areas for the benefit of all Australians.

ANSTO staff have extensive skills and expertise in nuclear technology and its applications, and in particular, the handling of radioactive materials.

The OPAL research reactor is a state-of-the-art multi-purpose open-pool reactor which uses low enriched uranium fuel. OPAL provides life-saving nuclear medicines, neutrons for scientific research and irradiation services.

There is about a one in two chance of an Australian needing a nuclear medicine scan during his or her lifetime.

ANSTO's nuclear infrastructure includes the OPAL research reactor, particle accelerators, radiopharmaceutical production facilities, and a range of other unique research facilities. ANSTO previously operated two other research reactors which were permanently shut down in 1995 and 2006 respectively and will be decommissioned.

OPAL is used to produce radioactive products, particularly those used in nuclear medicine. Each year, ANSTO provides over 500,000 patient doses of life-saving nuclear medicine to help in the diagnosis and treatment of a range of serious diseases.

ANSTO provides around 80 per cent of nuclear medicines supplied to Australian hospitals. Nuclear medicine is used to diagnose and treat serious diseases such as cancer.

OPAL is also a source of neutron beams for scientific research, and is used to irradiate various substances, including silicon for semiconductor applications.

In addition, ANSTO has an international reputation for undertaking environmental work in climate change, air pollution and the sustainability of groundwater use.

These activities have delivered considerable benefits to all Australians for over half a century.

The operation of ANSTO's facilities produces small amounts of radioactive waste and used fuel resulting from the OPAL reactor. This is managed in accordance with national and international standards.

ANSTO has safely managed radioactive waste for over 50 years and places the highest priority on the safe management of its waste and used fuel.

ANSTO is regulated by an independent safety regulator, the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). ARPANSA is charged with the responsibility to protect the health and safety of people, and to protect the environment, from the harmful effects of radiation.

ANSTO undertakes research in a number of areas including water resources. ANSTO aims is to improve water balance and sustainability for key water storages and resources across Australia.

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Radiation

Radiation is emitted by both natural and man-made sources. It is around us all day, every day and sustains our lives. We could not live without it.

We can see because our eyes detect and analyse the radiation in light. Infra-red radiation, whether from the sun or from a glowing fire, keeps us warm. Radio waves allow us to communicate sound and pictures over huge distances. All living things rely on some form of radiation for their existence.

Natural background radiation occurs naturally in the earth, and surrounds us all the time.

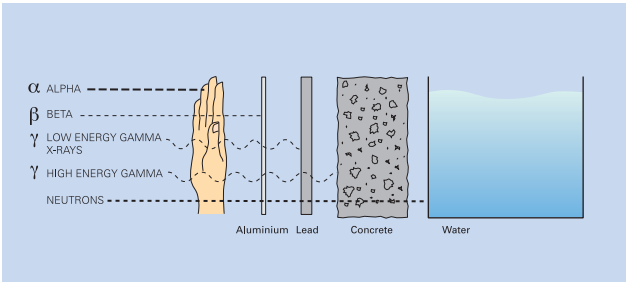
Radiation can be classified into two main groups ionising and non-ionising

- **Ionising radiation** - interacts with an atom causing it to lose one or more electrons. Some examples include alpha, beta and gamma radiation, X-rays and neutrons.
- **Non-ionising radiation** - is any type of electromagnetic radiation that does not have the ability to ionise atoms. Some examples include radio waves and microwaves.

We receive small amounts of ionising radiation from X-rays, air travel, smoke detectors, and the use of radioactive materials in medicine, industry and agriculture.

Even the very air we breathe and our own bodies contain naturally occurring radioactivity.

The average Australian receives about 1.5 millisieverts (1.5 mSv) per year of natural or background radiation. In many areas of the world, natural radiation levels are significantly higher.



Different forms of ionising radiation have different penetration levels:

- **Alpha radiation** - can be stopped by your hand or a piece of paper
- **Beta radiation** - can be stopped by a piece of aluminium foil
- **Gamma radiation or X-rays** - can only be stopped by a dense material such as lead, steel, concrete or several metres of water
- **Neutrons** - can be stopped by hydrogen rich material such as water or plastic.

Radioactivity refers to particles or energy emitted from the nucleus of radioactive atoms.

Radioactive decay rates are normally stated in terms of half-lives. This is the rate of decay or the time required for the radioactivity to be reduced by half. Half-lives can vary from fractions of seconds to billions of years.

Radioactivity gradually diminishes as radioactive elements decay into more stable elements, so waste gradually becomes less radioactive and safer to handle. The time which this takes depends on the half-life of the radioactive substance involved. This decay can also release heat.

All radioactive waste can eventually be handled in the same manner as normal waste. The shorter the half-life, the sooner this is. It may be in 20 years for some material, hundreds of years for other material, or many thousands of years.

Waste gradually becomes less radioactive and safer to handle

Types of radioactive waste

Low-level waste contains very small amounts of radioactivity and does not require shielding to protect workers during normal handling or transportation.

Ninety-two per cent of the radioactive waste produced by ANSTO is low-level waste, comprising paper, plastic, gloves, cloths and filters which contain small amounts of short-lived radioactivity.

Intermediate-level waste requires shielding during handling, processing and storage, but does not generate significant heat. Shielding can be barriers of lead, steel or concrete.

Intermediate-level waste at ANSTO is generated chiefly from radiopharmaceutical production and reactor operations. Only 2.5 cubic metres of intermediate-level waste is generated each year by ANSTO.

High-level waste is not produced by ANSTO. High-level waste comes from the reprocessing of used nuclear fuel from nuclear power reactors which do not exist in Australia.

Ninety-two per cent of waste produced by ANSTO is low-level waste

Low-level waste mainly comprises paper, plastic, gloves, cloths and filters used in nuclear medicine production.

Both low and intermediate-level waste will result from the decommissioning of the shut down reactors over the next decade.

Some of the used fuel from the former research reactors was transported overseas to the United Kingdom and France for storage and reprocessing. This will eventually return to Australia as intermediate-level waste after reprocessing to extract recyclable material.

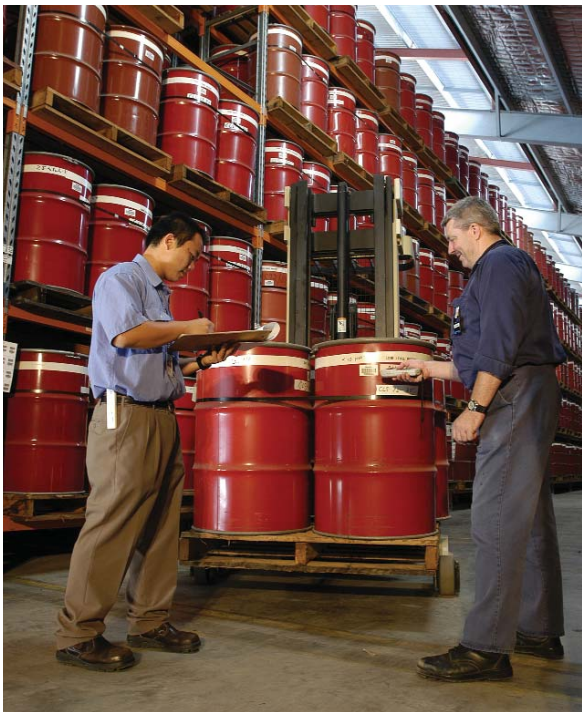
Hot cell operators are shielded from radiation by thick glass and use robotic arms to manoeuvre radioisotopes and equipment within the cell.

Radiation can be detected and monitored using special equipment such as Geiger counters, contamination monitors and electronic personal dosimeters.

Waste storage and disposal

Low-level waste – ANSTO shreds and compresses its low-level radioactive solid waste and places it into 200 litre steel drums, which are stored on site in dedicated buildings on racks.

The radioactivity in the drums is measured using a scanning system. The drums are bar-coded and the radionuclide content of each drum is entered into a database to enable a complete record of ANSTO's radioactive wastes to be compiled and tracked at all times.



Low-level waste contains very small amounts of radioactivity and does not require shielding to protect workers during normal handling or transportation.

The Centre de l'Aube radioactive waste repository in the Champagne district in France is typical of a modern approach to placing all radioactive waste in a single location where it can decay. In this case after 200-300 years the waste can be treated as general industrial waste.

Once a permanent central radioactive waste facility is established in Australia, these waste drums will be placed in that facility and allowed to decay to natural background radiation levels. At that stage – after about 300 years – the low-level waste is equivalent to domestic or industrial rubbish and poses no risk.

Outside of ANSTO, Commonwealth radioactive waste exists in approximately 30 locations around Australia. Waste from medical and industrial applications is held at over 100 other locations under the jurisdiction of the states and territories.

It is considered international good practice to locate these wastes in one central location, as has been done in the Champagne district of France and elsewhere.

Liquid waste is treated in ANSTO's on-site treatment plant.

Intermediate-level waste – Intermediate-level solid waste can be shielded by barriers of lead or concrete, or stored in deep pools of purified water. ANSTO's intermediate-level solid waste is loaded into special bins and safely stored in underground shielded concrete pits located on ANSTO's site.

Once a central waste facility is built in Australia, ANSTO's inventory of intermediate-level solid waste would be further packaged and relocated to an intermediate-level waste store.

High-level waste – ANSTO does not produce any high-level waste but does market 'Synroc' technology that can 'lock up' high-level radioactive waste safely for many hundreds of thousands of years.

Liquid waste – Liquid waste is treated in ANSTO's on-site treatment plant where radioactive material is precipitated out of the liquid and then managed as solid waste. All liquids discharged to the sewer meet radioactivity limits based on the World Health Organisation drinking water standards.

Once a central waste facility is built in Australia, ANSTO's inventory of solid waste will be relocated to that facility.

Used reactor fuel management and transportation

Used reactor fuel from ANSTO's former reactors has been safely shipped overseas for reprocessing or storage since 1963. Since then, including the 2009 shipment to the United States, ANSTO has planned and managed nine shipments, two of them to the United Kingdom, four to France and the other shipments to the United States.

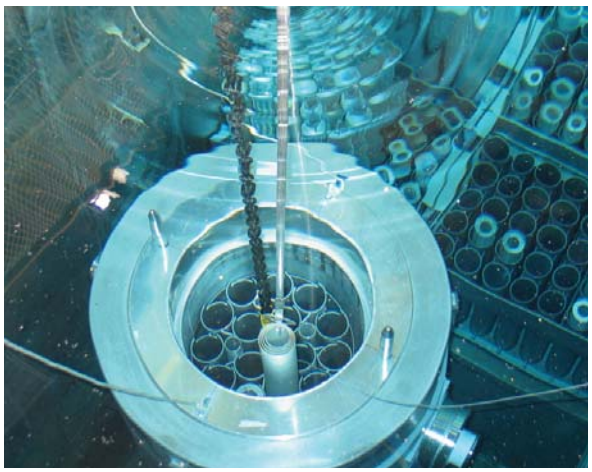
The strategy for management of used fuel depends on the uranium's country of origin. Under international agreements, used fuel made from uranium originally enriched in the United States will be returned to the United States and permanently stored there.

Used fuel made from uranium originally enriched in the United Kingdom was sent to Scotland and France for reprocessing. During this process, the remaining enriched uranium in the fuel is extracted and recycled. What remains is intermediate-level waste which, under international agreements, will return to Australia.

Used fuel from the new OPAL research reactor will be securely stored at ANSTO in the reactor storage pool which has a capacity of 10 years. The first shipment of this fuel, which would be sent to the United States for permanent storage would be in around 2014.

All shipments of radioactive material to and from Australia are conducted in accordance with international safety, safeguards and security requirements.

Metal baskets hold the used fuel.



The used fuel is loaded into metal baskets under water which acts as a radiation barrier. The baskets are subsequently drained, vacuum dried and hermetically sealed.

The metal baskets containing the fuel are loaded into transport casks.

Transport casks are then loaded into standard shipping containers and secured in place.

The transportation of radioactive materials has a remarkable safety record. Internationally, there have been over 7,000 shipments of used fuel. There has never been an incident that resulted in the release of radioactivity.

ANSTO's used fuel is safely and securely packed in transportation casks that have undergone rigorous testing to ensure they cannot be ruptured, even in the most severe accident. Transport by sea uses special purpose-built cargo ships designed to carry radioactive material.

The transportation of radioactive materials has a remarkable safety record.

Used fuel is transported by truck in fuel baskets inside specially designed transport casks which are placed in standard shipping containers.

Used fuel shipment process:

- **Specially designed transport casks** - In order to transport research reactor used fuel, the transport casks must comply with very stringent standards for high impact, high temperatures (in excess of 800 degrees Celsius) and withstand extreme high pressures whilst ensuring any radiation levels are within international limits.
- **Loading used fuel into the dedicated casks** - Used fuel elements are loaded into the transport casks on ANSTO's secure site following established and practised procedures. The casks are then vacuum sealed.
- **Transfer of the transport casks by road from Lucas Heights to port** - The loaded casks are secured in steel shipping containers and transported by road to port.
- **Sea transportation from Australian ports to the overseas destination** - Sea transportation is carried out on a dedicated ship meeting International Maritime Organisation requirements for ships carrying irradiated nuclear fuel.

In order to transport research reactor used fuel, the transport casks must comply with very stringent standards

The shipping containers containing the spent fuel are loaded onto trucks for transport from ANSTO's Lucas Height site to the sea port.

The level of radioactivity detectable outside the heavily shielded casks is very low. If a person were to stand next to a cask the radioactivity level would be slightly above natural background levels and similar to airline flight.

Sea transportation is carried out by a dedicated ship that meets International Maritime Organisation requirements for carrying nuclear fuel.

Centralised radioactive waste management facility

Consistent with international best practice, Australia is progressing towards a centralised radioactive waste management facility to ensure that radioactive waste is safely, securely and efficiently managed.

ANSTO is not Australia's only producer of radioactive waste material. Generation by other research organisations, nuclear medicine clinics and hospitals mean that such waste is held at over 100 locations around Australia.

The Australian Government has for some time proposed a centralised radioactive waste management facility be built in Australia. Criteria developed for similar facilities overseas would be applied in the design and construction of that facility. After the initial transportation of existing waste to the facility, subsequent shipments would be relatively infrequent.

Many centralised radioactive waste facilities exist overseas, and their operation – and the transport of waste to them – has an exemplary safety record.

Low-level waste is typically placed in a concrete lined and sealed trench. After a period of up to 300 years its radioactivity levels will have reduced to background levels, making it safe and equivalent to domestic rubbish.

Intermediate-level waste will be placed and monitored regularly in a storage building. At some point in the future it could then be permanently placed in a deep geological disposal facility.

Australia is progressing towards a centralised radioactive waste management facility to ensure that radioactive waste is safely, securely and efficiently managed.

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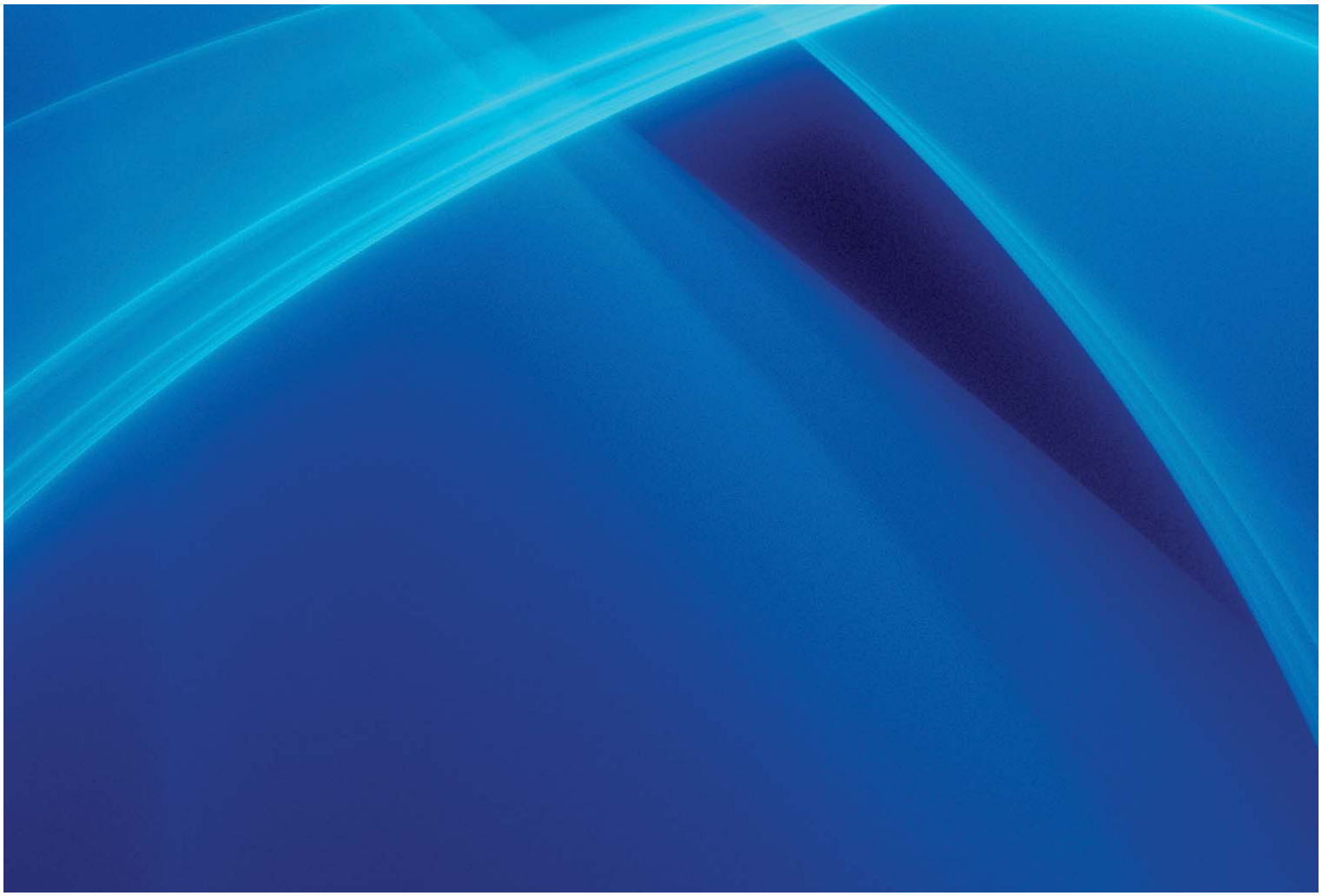

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