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EXPLAINER

Radioactive Waste

ANSTO and its predecessor, the Australian Atomic Energy Commission, have safely and responsibly managed radioactive waste at Lucas Heights over the past 70+ years.

For decades, nuclear medicines produced by ANSTO's multi-purpose research reactors HIFAR and OPAL, have benefited generations of Australians and people overseas.

With these benefits, comes a responsibility for Australia to safely deal with the by-products, including radioactive waste. ANSTO has comprehensive plans to safely manage its radioactive waste at Lucas Heights in both the short and long term.

What is radioactive waste?

ANSTO's radioactive waste is a by-product from the production of lifesaving nuclear medicines, other beneficial industrial and research activities, and the operation of nuclear research reactors.

It can also be generated from the dismantling or decommissioning of nuclear facilities or instruments, such as concrete, soils and building materials.

This type of waste contains radioactive materials that are no longer useful and send out higher levels of radiation than the background radiation in nature.

Radioactivity gradually and naturally diminishes as the radioactive elements decay into more stable elements. The period of time required for radioactive elements to decay is dependent on the half-life of the radioactive element – also known as the nuclide or isotope.

Over time, radioactive waste becomes less radioactive, making it safer to handle and manage. Radioactive waste can come in many different shapes, types, and sizes, including liquid, solid, and soft matter waste.

In Australia, radioactive waste is classified into three main categories – **low-level**, **intermediate-level** and **high-level** waste. ANSTO does not produce high-level radioactive waste.

Just like car batteries, mobile phones and some household chemicals, this material requires particular procedures and methods for its management, storage and disposal.

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EXPLAINER

How ANSTO generates its radioactive waste

ANSTO is one of Australia's largest public research organisations and custodian of much of our country's landmark and national research infrastructure, including the OPAL multi-purpose research reactor, the Australian Synchrotron, the Centre for Accelerator Science, and neutron beam instruments at the Australian Centre for Neutron Scattering.

Since the 1950s, ANSTO has operated Australia's only three nuclear research reactors, and now manages the large majority of the low-level and intermediate-level radioactive waste in Australia.

ANSTO's radioactive waste management facilities deal with a diverse range of wastes generated from:

- operation of the OPAL reactor and prior research reactors,
- nuclear medicine production,
- research programs on nuclear fuels,
- waste-forms for complex nuclear wastes, and
- new radionuclide and radiopharmaceutical syntheses for clinical trials.

ANSTO also manages liquid, solid, and gas waste streams, with low and intermediate-levels of radioactivity.

Most of ANSTO's radioactive waste comes from the production of nuclear medicines.

Nuclear medicine production

ANSTO is central to Australia's nuclear medicine manufacturing capabilities, and produces around 75 - 80 per cent of the nuclear medicines used in Australia. On average, every Australian is likely to benefit from nuclear medicine at least twice in their lifetime.

Through the work of ANSTO, Australia is a world leader in the advanced manufacturing and distribution of diagnostic and therapeutic nuclear medicines. These medicines are used for the diagnosis, staging, and treatment of diseases like cancer; heart disease; and lung, liver, and muscular-skeletal conditions.

Around 700,000 nuclear medicine procedures are carried out each year in Australia. These include diagnostic imaging scans such as PET and SPECT to aid in patient management, and a growing range of therapies.

Anyone who has received a CT SPECT scan in Australia is likely to have been administered with nuclear medicine produced by ANSTO at Lucas Heights.

Each week, the radioisotopes produced at ANSTO enables between 10,000 to 12,000* nuclear medicine procedures in more than 250 hospitals and nuclear medicine clinics around Australia. Read more in our Nuclear Medicines backgrounder [link].

[*] based on published Medicare statistics combined with non-MBS data sourced from the nuclear medicine community: http://medicarestatistics.humanservices.gov.au/statistics/mbs_group.jsp

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EXPLAINER

Types of radioactive waste

Low level waste

Around 86 per cent of the radioactive waste produced by ANSTO is low-level waste.

Low-level waste emits radiation at levels which generally require minimal shielding and can be safely handled with standard personal protection equipment (PPE) during handling, transport and storage. It is characterised by a contact dose rate of less than 2 millisieverts per hour.

Low-level waste can be made up of:

- laboratory waste - paper, plastic, gloves, cloths and filters,
- equipment - metals and plastic, and
- bulk materials - concrete or soil from building waste.
- This waste is sorted and placed into 200 litre drums, which are safely stored on-site in dedicated buildings on an interim basis.

(Above) Left and Right: Sorting and recording low level waste

(Above) Left: Low level waste barrels in ANSTO's waste stores, and Right: Examples of low level waste

Intermediate level waste

Intermediate-level waste emits higher levels of radiation and requires additional shielding to protect workers and the environment during handling, transport and storage.

It is characterised by a contact dose rate of 2 millisieverts per hour and above.

ANSTO's intermediate-level waste is typically generated from radiopharmaceutical production and nuclear research reactor operations, such as the liquid waste generated from the production of nuclear medicine, Molybdenum-99, in Australia.

Spent fuel from ANSTO's nuclear research reactors which is sent overseas for reprocessing, is later returned to Australia as vitrified waste. This vitrified waste is immobilised in steel canisters and transported in large containers, where is it safely and securely stored on an interim basis at ANSTO.

The return of ANSTO's radioactive waste from France in 2015 and the UK in 2022 is categorised as intermediate-level waste.

High level waste

High-level waste has higher levels of radiation that require increased shielding and isolation from human contact and cooling due to its heat-generating capacity. No high-level waste is produced at ANSTO.

Treating and managing radioactive waste

All low-level radioactive waste generated at ANSTO undergoes an initial waste characterisation process, whereby it is placed in containers, drums or bags and tested to determine its level of radioactivity, chemistry make-up, and physical and biological properties.

This allows ANSTO's Waste Management Services Team to determine the applicable regulatory classification and inform the best way to store and manage the waste.

Drums containing low-level waste are routinely measured using a barcoded scanning system and logged to help ANSTO understand the progress of radioactive decay over time.

The drums are barcoded and the radioactive content of each drum is entered into a database to ensure the waste is safely, securely and efficiently managed in compliance with the standards set by the IAEA and the Australian regulator ARPANSA.

ANSTO uses an automated and sophisticated storage and retrieval system to move the 200-litre drums of low-level waste, transporting these drums through a combination of conveyors, pallets, racking, and a pallet stacker crane. The drums are housed in the automated system and then processed through a super-compactor to further reduce their shape and size for eventual disposal.

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EXPLAINER

The future of Australia's radioactive waste

The Australian Radioactive Waste Agency is leading the safe and secure, long-term management and disposal of Australia's waste.

Radioactive waste is managed at over 100 locations around Australia, including ANSTO, hospitals, universities, and national science and defence facilities.

All radioactive waste in Australia is managed in accordance with national and international standards. The management of waste generated by Commonwealth bodies, including ANSTO, is regulated by the independent safety regulator, the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA).

ANSTO is a responsible waste holder and has the extensive expertise to safely and securely store its own radioactive waste until a national disposal pathway becomes available. However, ANSTO is not legally mandated to dispose of its wastes permanently at Lucas Heights.

ANSTO will continue to safely hold its radioactive waste at Lucas Heights until a future disposal pathway is available. This may require construction of additional interim waste management facilities at Lucas Heights in the future.

More information about the management of radioactive waste in Australia can be found at the Australian Radioactive Waste Agency website.

Right: Sorting low level waste into containers

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EXPLAINER

Innovative waste solutions – ANSTO Synroc® waste treatment facility

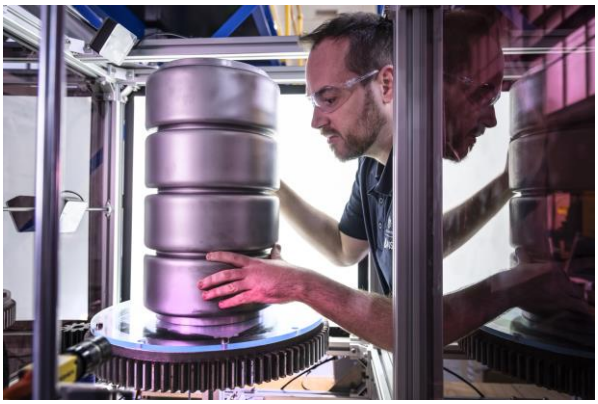
A safe, secure and innovative waste treatment technology, ANSTO Synroc®, is the first new waste treatment technology to be implemented globally in the last 20 years.

This patented technology is the central feature of a new, first-of-a-kind, fully engineered, waste treatment facility located in Lucas Heights. Once operational, the facility will treat intermediate-level liquid waste generated from the production of the nuclear medicine radioisotope, Molybdenum-99, and immobilise this into a highly-durable, solid waste form ready for final disposal.

The facility will be fully automated and will deliver an end-to-end lifecycle on radioactive waste for ANSTO's nuclear medicine precinct.

A unique and crucial component of the ANSTO Synroc® process is its hot isostatic press , which applies pressure and heat to specifically-designed canisters of waste, to consolidate and reduce the waste volume.

Learn more about ANSTO Synroc® at the ANSTO website.



Left: ANSTO Synroc® canisters pre and post the hot isotopic pressing process, and Right: ANSTO Synroc® canister ready for hot isotopic pressing

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EXPLAINER

Managing spent reactor fuel and repatriation of waste

In accordance with international agreements, ANSTO's spent fuel is securely and routinely sent overseas for reprocessing with its global partners.

ANSTO has undertaken 10 international shipments of spent fuel from the HIFAR and OPAL research reactors. The last export of spent fuel was carried out in 2018.

Spent fuel from the OPAL research reactor is not categorised as waste in Australia. It is only characterised as waste (intermediate-level) once it has been re-processed overseas, and the vitrified material is returned to Australia.

Spent fuel management

To prepare for a spent fuel shipment, all spent fuel rods are placed together in secure storage pool areas to dissipate the heat generated from fission reactors in the reactor core.

From here, the spent fuel rods are carefully loaded into specially designed, purpose-built casks that provide heavy shielding during transportation by road and sea. These casks meet the most stringent standards set by the IAEA.

The spent fuel is then shipped overseas to partners in the UK, France, or the US where they undergo reprocessing. During this process, any residual materials such as uranium are extracted and recycled for use in other countries' nuclear power programs and for other peaceful purposes.

The remaining material is broken up and mixed in with molten glass through a process called vitrification. This process safely immobilises the resulting waste into sealed, stainless-steel canisters for long-term storage until they can be returned to Australia. Each stainless-steel canister weights around 500 kilograms when full.

Repatriation of waste to Australia

ANSTO has facilitated two repatriation projects for the return of re-processed waste to Australia. The first shipment to Australia from France occurred in 2015, which saw the return of the resulting radioactive waste from ANSTO's four spent fuel shipments sent to France between 1999 and 2004.

The most recent repatriation of waste was sent from the UK in 2022 and is the resulting waste of a spent fuel shipment sent to the UK in 1996.

In both repatriations, the waste returned to Australia was transported in forged steel transport and storage casks called a TN-81.

These 100 tonne casks house the stainless-steel canisters of vitrified waste, and measure 6.5 metres long and 3 metres wide. They are heavily shielded for safety and protection during transportation and long-term storage, and are widely used in Europe for transport and storage of radioactive waste.

In total, ANSTO has two TN-81 casks in interim storage at its intermediate-level waste facility in Lucas Heights.

Above: A TN-81 cannister of intermediate level waste being loaded onto a truck for return to ANSTO's Lucas Heights for interim storage.

Left: A TN-81 cannister of intermediate level waste being offloaded from the ship, ready for loading onto the truck.

Right: The TN-81 cannister being transported through ANSTO's Lucas Heights campus, in front of the OPAL reactor.