Idaho Department of Environmental Quality

The INL Oversight Program

Protecting the Snake River Plain Aquifer through continued cleanup of radioactive waste at the Idaho National Laboratory (INL) Site

Under the 1995 Settlement Agreement, the Department of Energy (DOE) is responsible for meeting a number of requirements to clean up and remove radioactive waste at the INL Site.

Certain requirements of the 1995 Settlement Agreement are in place to reduce the risk to the ***Snake River Plain Aquifer***, a vital water supply for drinking and agriculture, from becoming contaminated. This publication focuses on DOE's efforts toward meeting those requirements for the removal of radioactive waste from Idaho.

Three major types of radioactive waste covered in the 1995 Settlement Agreement

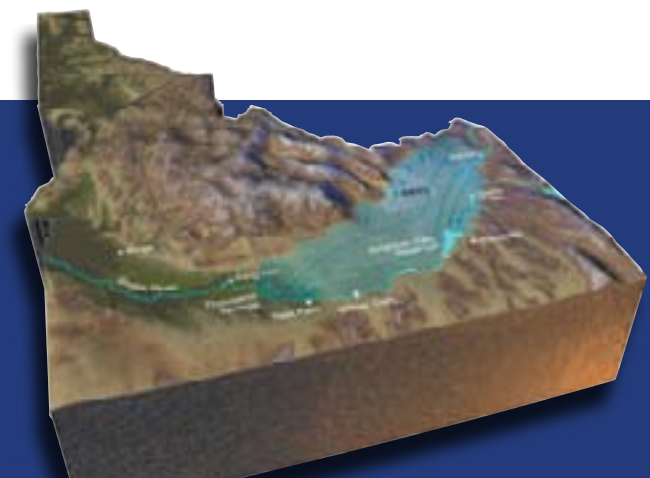
- **Spent Nuclear Fuel**
- **Transuranic**
  - *contact-handled*
  - *remote-handled*
- **High-Level**
  - *sodium-bearing*
  - *calcine*

1995 Settlement Agreement

In 1995, the DOE and the U.S. Navy made a historic agreement with the State of Idaho that set out requirements for removing radioactive waste from Idaho. Known as the 1995 Settlement Agreement, it can be found on the DEQ website at: www.deq.idaho.gov/inl-oversight. Idaho remains the only State with a court order requiring that radioactive waste be removed by specified dates.

Key requirements for the cleanup of radioactive waste are:

- **Convert all liquid high-level waste into solids by the end of 2012**
- **Remove transuranic waste from Idaho by 2018**
- **Remove spent nuclear fuel from wet storage and relocate into dry storage by the end of 2023**
- **Remove all spent nuclear fuel from Idaho by the beginning of 2035**
- **Treat high-level waste so that it is ready to be disposed of outside of Idaho by 2035**



All spent nuclear fuel must be removed from Idaho by 2035 and until recently the expectation was that it would be sent to a geological repository planned at Yucca Mountain in southern Nevada. The location is embroiled in much controversy, however, leaving uncertainty as to where the fuel will go when it leaves Idaho. Meanwhile, the Blue Ribbon Commission on America's Nuclear Future (the Commission) was established in January 2010 by the Secretary of Energy, under the direction of President Obama, to assess alternatives for storage and disposal of spent nuclear fuel and high-level waste. A draft report from the Commission is expected by July 2011. More information on the Commission's activities can be found at the website (www.brc.gov).

Summer 2011

Spent Nuclear Fuel

Ninety percent of spent nuclear fuel at the INL has already been moved from wet storage into safer dry storage facilities — *ahead of schedule.*

In 1995, the DOE began emptying canals and pools at the INL Site that once held spent nuclear fuel. Spent nuclear fuel is removed from a reactor and initially put into a concrete basin filled with water that cools the fuel and provides shielding from radiation. After several years, it is safe to move the fuel into dry storage. Dry storage of spent nuclear fuel at the INL Site provides a barrier between its radioactivity and the Snake River Plain Aquifer. This barrier provides a safer, long-term storage option without water.

Spent nuclear fuel in wet storage

Spent nuclear fuel in dry storage

The DOE began moving spent nuclear fuel stored at the INL Site in 2003, starting with the 30-year old underwater storage canal at the Power Burst Facility, to a dry storage facility at the Idaho Nuclear Technology and Engineering Center. Now only some Navy spent nuclear fuel and fuel from two test reactors (EBR II and ATR) remain to be secured in dry storage by 2023.

EBR II reactor

Shipment preparation of spent nuclear fuel that will be placed in an underground storage vault

Excluding Navy spent nuclear fuel, the DOE has approximately 271 metric tons of spent nuclear fuel stored at the INL Site. The inventory of spent nuclear fuel continues to increase as new shipments are received. A maximum amount of 55 metric tons for the DOE and 575 shipments for the Navy, are allowed under the 1995 Settlement Agreement.

The spent nuclear fuel at the INL comes from several sources including:

- **Some 50 reactors that have operated at the INL Site**
- **Reactors operated at other DOE sites**
- **Foreign and domestic research reactors (these are small reactors used at universities throughout the world for teaching, testing, and research)**
- **U.S. Navy reactors on submarines and aircraft carriers**
- **A few commercial power reactors for which the DOE has responsibility to manage the fuel**

Spent nuclear fuel consists of enriched uranium (uranium-235) usually contained in fuel rods that are placed in a nuclear reactor to generate heat, which can then be transformed into energy such as electrical power. Spent nuclear fuel is highly radioactive and will remain so for thousands of years, so it must always be properly shielded and safely stored and disposed of.

Contact-Handled Transuranic Waste

Over 43,000 cubic meters of contact-handled transuranic waste have been safely shipped from INL to the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico*, nearly the same amount as from all other DOE sites combined.

Weekly, 12 to 14 shipments of contact-handled transuranic waste leave the Advanced Mixed Waste Treatment Project (AMWTP) at the INL Site for permanent disposal at WIPP. Of the original 65,000 cubic meters of contact-handled transuranic waste stored in INL's above-ground Transuranic Storage Area:

- More than 43,000 cubic meters have already been shipped out of Idaho,
- Another 315 cubic meters have been packaged and are ready for shipment
- About 22,000 cubic meters remain at the Transuranic Storage Area

The AMWTP is so versatile and successful that contact-handled transuranic waste from Nevada was treated at the INL and shipped directly to WIPP in 2009. The DOE plans to send additional contact-handled transuranic waste to the AMWTP over the next several years for similar treatment. Under the 1995 Settlement Agreement, this waste must be treated and shipped out of Idaho within one year of its arrival. Using the AMWTP in this manner allows the DOE to more efficiently and economically dispose of the nation's transuranic waste.

***Transuranic waste* is any waste that contains more than a specified amount of radionuclides that emit alpha particles (a certain type of radioactivity) and are heavier than uranium—thus, *beyond uranium or transuranic.* Transuranic waste commonly consists of used protective clothing, tools, glassware, equipment, soils, and sludges—byproducts of nuclear weapons research, development, and production.**

Waste shipments

The DOE expects to remove contact-handled transuranic waste from Idaho by 2015, three years ahead of the deadline set in the 1995 Settlement Agreement.

The AMWTP, which began operation in 2003, is the only DOE facility of its kind that has the ability to reduce the size of transuranic waste packages using a 62-ton device called a supercompactor. With a force at 2,000 tons, this device can crush 55-gallon drums filled with waste into "pucks" one-fifth their original size. Usually five of these pucks are repacked into a 110-gallon drum, greatly reducing the volume and number of shipments that must be disposed of at WIPP.

The interior of the AMWTP supercompactor

Drums showing waste before compacting

Transuranic waste is classified as either contact-handled or remote-handled based on the amount of radiation emitted from the exterior surface of the package surface. Contact-handled transuranic waste can safely be handled directly. Remote-handled transuranic waste must be handled from a safe distance using equipment such as mechanical arms to protect workers from radiation.

compacted "puck"

*for further information on WIPP, see wipp.energy.gov

Remote-Handled Transuranic Waste

INL, the first DOE facility to send remote-handled transuranic waste to WIPP, remains on course to meet the 1995 Settlement Agreement deadlines for removal from Idaho.

DOE completed its first campaign to send remote-handled transuranic waste to the Waste Isolation Pilot Plant on March 10, 2011. This campaign which began in 2007 to remove approximately 640 drums of Remote-handled transuranic waste from vaults at the Radioactive Waste Management Complex.

In 2009, the INL Site was able to begin a second remote-handled transuranic waste disposal campaign, due to funding provided by the American Recovery and Reinvestment Act. This project involves 160 canisters and large liners (roughly 26 cubic meters) containing remote-handled transuranic waste stored in vaults below ground north of the Materials and Fuels Complex (MFC). For this waste to be processed at INTEC, an additional hot cell was renovated, including the design and installation of additional container cutting equipment to accommodate the larger size of the canisters and large liners. The first shipment of this waste to WIPP was completed in March 2010. The DOE expects that all the canisters and large liners will be processed by June 2012.

There are 18 containers of waste at INTEC that are currently being managed as suspect, remote-handled transuranic waste and are being managed that way. The DOE expects to ship these 18 containers out of Idaho before September 30, 2012. There are approximately 120 additional containers of waste being stored at the MFC that will require treatment to eliminate sodium contamination. Those containers probably will not be treated and shipped out of Idaho until after December 30, 2012, depending on installation of sodium treatment capabilities. The remainder of the remote-handled transuranic waste on the INL Site will be processed and sent to WIPP by the end of 2018.

Operator looking through an oil-filled leaded glass window into a hot cell used for remote-handled transuranic work

Interior of hot cell used for remote-handled transuranic waste work

Remote-handled transuranic waste must be characterized and, in some cases, treated before it can be shipped out of Idaho. Treatment could include sorting, size reduction, sampling (if necessary), and physical and radiochemical characterization of the waste to ensure it meets the stringent requirements for disposal at WIPP. Remote-handled transuranic processing activities are performed in heavily shielded enclosures referred to as hot cells, to ensure the waste is contained and workers are protected from intense radiation fields.

The information on this page does not apply to any transuranic waste managed by the Naval Nuclear Propulsion Program who is a co-signatory on the 1995 Settlement Agreement.

Idaho and DOE resolve the meaning of *"all"* transuranic waste

For many years, Idaho and the DOE disagreed over how much transuranic waste must be removed from the INL Site. The Settlement Agreement requires all transuranic waste located at the INL Site be shipped out of Idaho. The DOE claimed that "all" meant only the above-ground transuranic waste located in the Transuranic Storage Area at the INL. Idaho contended that all transuranic waste meant just that—all—including the waste buried in the subsurface disposal area (buried waste).

After several court hearings, Idaho prevailed-and an agreement* was reached in July 2008 setting out detailed performance obligations for the removal of buried transuranic waste.

Requirements of the agreement include:

- **Removal of waste from at least 5.69 acres at the Subsurface Disposal Area**
- **A minimum of 7,485 cubic meters of waste will be shipped out of Idaho**
- **Oversight and review of buried waste operations by DEQ**
- **Continuing jurisdiction of the Settlement Agreement by the federal courts**

Removal of buried waste

The DOE has removed buried waste from over two acres and has packaged almost 4,700 cubic meters. More than 50% of the buried waste has already left the state. The DOE plans to have this buried waste removed from Idaho by 2022.

After the buried waste has been removed from the Subsurface Disposal Area, a surface barrier will be put over the entire area, significantly decreasing the risk of contamination reaching the Snake River Plain Aquifer. The DOE, with oversight by the DEQ, will monitor the area for decades to ensure continued protection of the aquifer.

SUBSURFACE DISPOSAL AREA

* The agreement can be found on the DEQ website at deq.idaho.gov/inl-oversight

DOE to use *innovative technologies* to treat high-level waste at the INL Site

Sodium-bearing

The DOE's unique Integrated Waste Treatment Unit (IWTU) is nearly complete. The IWTU will be used to convert the remaining 900,000 gallons of sodium-bearing liquid high-level waste at the INL Tank Farm into a safer solid granular form through a process called steam reforming. This process must be completed by December 2012.

Integrated Waste Treatment Unit at completion as planned

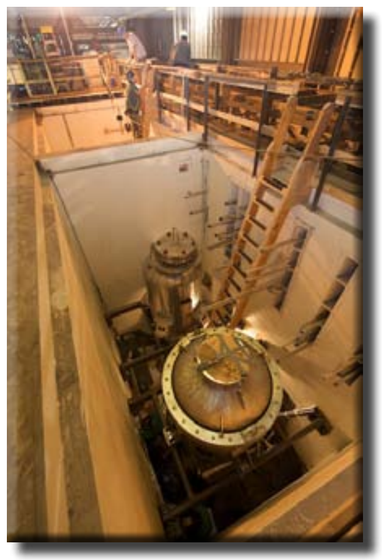
Lifting treatment vessel into the Integrated Waste Treatment Unit

All the sodium-bearing waste must be in a form that is ready for shipment out of Idaho by 2035. This may entail further treatment of the waste in a manner similar to the treatment of calcined high-level waste. When treatment of the sodium-bearing waste is complete, all tanks formerly containing liquid high-level waste at the INL Site will be filled with grout, providing greater protection of the Snake River Plain Aquifer.

In INL's history of spent nuclear fuel reprocessing, chemical cleaners were used during the second and third extraction cycles to flush piping. The cleaners contained concentrated levels of sodium, resulting in a waste mixture high in sodium.

Integrated Waste Treatment Unit under construction

Steam reforming uses steam as the heat source to vaporize the acidic radioactive liquid sodium-bearing waste. The off-gasses are treated, leaving waste in a solid granular form that consists primarily of inorganic salts and resembles coarse sand. The DOE expects to generate about 650 canisters of the solid sodium-bearing waste, which will be stored adjacent to the IWTU in the Product Storage Building. Although steam reforming has not been used on this particular type of liquid radioactive waste before, the technology has been used successfully to convert radioactive waste from a commercial reactor from a liquid into a solid form.



Treatment vessel in place in Integrated Waste Treatment Unit

Calcine

Hot isostatic pressing (HIP) is the technology recently selected by the DOE to treat calcine. At the end of 2009, DOE chose to use HIP to convert 5,750 cubic yards of calcine, a high-level waste, into a durable, more secure form. Processing is expected to start in 2021 and use much of the IWTU facility after treatment of sodium-bearing waste is complete (see left).

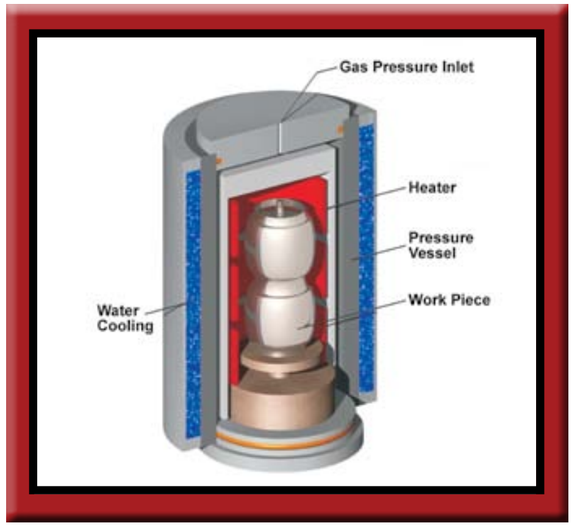


Diagram of the Hot Isostatic Pressing process

Canister before and after the Hot Isostatic Pressing Process

In the planned HIP process, calcine is mixed with treatment additives and loaded into thin-wall canisters that are welded shut. These canisters are then heated while intense pressure is applied from all directions (isostatic) using argon gas. This process changes the calcine into a glass-like form with no voids in the material. The overall volume of the calcine is reduced, minimizing the space needed for storage and final disposal. The HIP process has not been used before on radioactive waste, but tests show this process has great potential to treat the dry high-level waste at the INL.

Calcine stored at the INL Site resulted from reprocessing spent nuclear fuel. Rather than simply storing the liquid high-level waste in underground tanks as was done at the Hanford and Savannah River sites, DOE treated the waste to convert it into calcine, a dry granular substance resembling laundry detergent. Calcine is stored in stainless steel bin sets inside concrete vaults under a permit issued by DEQ. The last of the non-sodium liquid high-level waste was calcined in 1998 in compliance with the 1995 Settlement Agreement.

High-level waste is highly radioactive material resulting from the reprocessing of spent nuclear fuel. Reprocessing at the INL involved dissolving spent fuel in acid and then chemically extracting uranium. The liquid that remained after this operation is very acidic and highly radioactive. It also contains chemicals that make it a hazardous waste.

Calcine Storage Vaults

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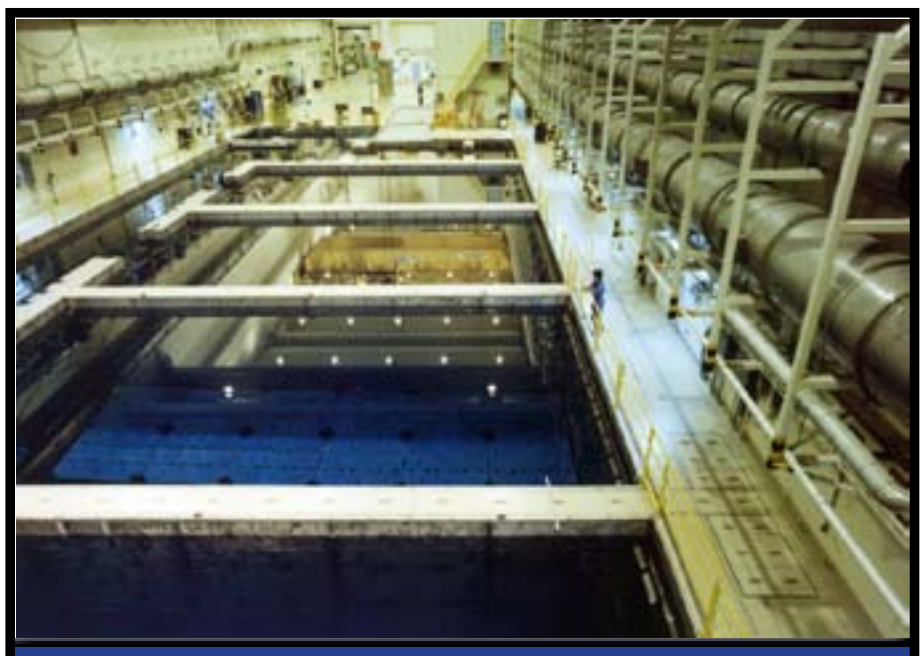
Significant progress in cleaning up the Idaho National Laboratory Site



Spent Nuclear Fuel in Wet Storage

Integrated Waste Treatment Unit under construction

Removal of Buried Waste

Additional information about the DEQ-INL Oversight Program can be obtained at www.deq.idaho.gov/inl-oversight or by calling 1-800-232-4635. This publication and previous DEQ-INL Oversight Program publications are also available at the same website.

If you would like to be on the mailing list for future issues of the DEQ-INL Oversight Program publications, please email us at **INLoversight@deq.idaho.gov**

All photos courtesy of Department of Energy