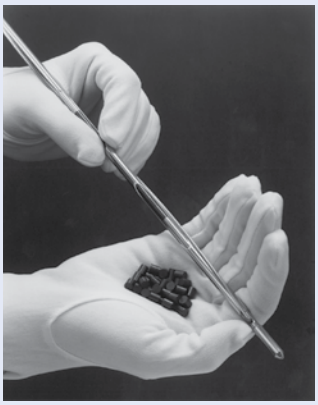
UniStar NUCLEAR ENERGY

USED NUCLEAR FUEL— A NATIONAL ENERGY RESERVE

A UniStar Issue Brief



Fuel pellets and cutaway of a fuel rod.

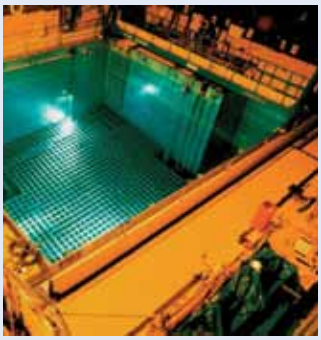
A nuclear fuel pellet is a wonder of modern science packed into the tiniest of packages. After spending about five years in a reactor and producing about 3,600 kWh of electricity with no harm to the environment, it emerges physically hot and radioactive, but still containing over 95 percent of its original uranium. Such used nuclear fuel can and is being safely stored at commercial reactors around the country, either in fuel pools like the one shown at the bottom right or in dry storage containers. Used nuclear fuel's remaining energy value makes it, in effect, a recoverable, strategic energy reserve for future generations. Present day arguments against reprocessing only reflect current economics and technologies. But we can safely stockpile used fuel for over a hundred years and literally have generations to implement a final disposition. Suggestions that we should forego safe, clean, reliable nuclear energy due to unjustified concerns with the used fuel only serve to encourage electrical generation through means that are less safe, less clean, and less reliable.

WHAT IS USED FUEL?

The nuclear fuel cycle begins with uranium ore, which is mined and purified to obtain natural uranium. The purified natural uranium initially contains only about 0.7 percent of the fissionable isotope U-235, which is increased to about 4 percent through a process called enrichment.[1] The enriched uranium is then prepared as small ceramic cylinders called fuel pellets. These pellets are inserted into fuel rods, then grouped into fuel assemblies for loading into the reactor core.

In the reactor, individual U-235 atoms absorb neutrons causing them to split, or fission, into two smaller atoms. Each fission reaction releases energy that is converted to heat and then steam to generate electricity. The fission reactions also produce additional neutrons that continue the fission chain reaction with other U-235 atoms. The two smaller atoms produced when the U-235 atom splits are called fission products. Some of these fission products very quickly decay into stable atoms but some, cesium-137 and strontium-90 for example, will remain radioactive for an extended period of time.

Fuel assembly.



Fuel pool to store nuclear fuel.

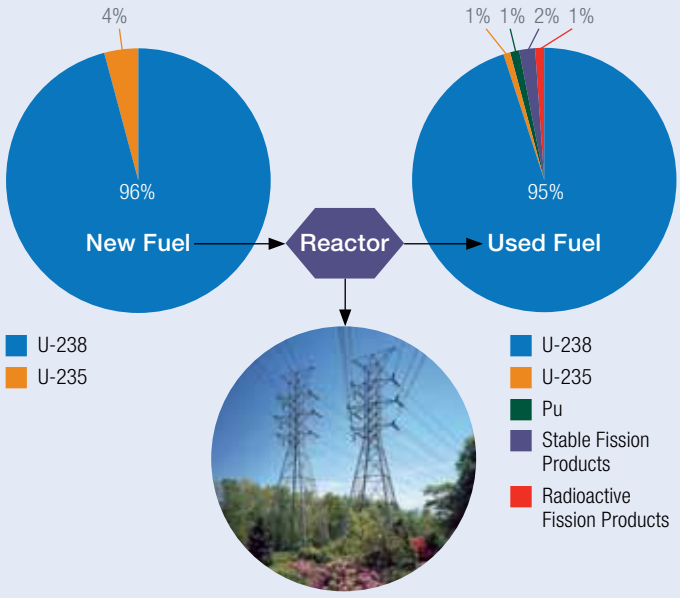
USED FUEL IS NOT WASTE

Nuclear fuel is not like coal. Only a small portion is consumed as it is used and it is not converted to an ash or bulk waste. Instead, the fission products that are trapped within the ceramic fuel pellet build up, and begin to absorb some of the neutrons needed to sustain the chain reaction. Nuclear fuel is "used" not when it has been entirely consumed by fission, but when the fission product buildup makes the chain reaction too difficult to sustain.

Motor oil makes a more useful comparison to the uranium cycle than coal combustion. Used motor oil can be re-refined into new oil and reused. Similar to nuclear fuel, only the contaminants have to be removed. Most of the original oil is still there.

After reprocessing, one gallon of used motor oil provides the same 2.5 quarts of lubricating oil as you would get from 42 gallons of crude oil.[2] Similarly, one ton of used nuclear fuel has all of the original uranium obtained from 320 tons of uranium ore.

Due to the fission products that are present, used fuel is highly radioactive. It requires special skills and technologies for safe handling. Although these contaminants are present, the fuel itself is not waste and shouldn't be thought of that way. It's more of a reserve inventory that requires rework.



HISTORY OF USED FUEL IN THE U.S.

Development of commercial power reactors dates back to 1955 when the Atomic Energy commission (AEC) first announced a joint government–commercial program. However, private ownership of special nuclear material, including the fuel for nuclear reactors, was not permitted until 1964. In the early days of commercial nuclear development, reprocessing of used fuel was thought to be essential to extending the supply of uranium for fuel. By 1956, private firms were being encouraged to provide these services on a commercial basis. Over the next twenty years attempts were made to license and operate commercial reprocessing facilities in New York, Illinois, and South Carolina, only one of which (West Valley, NY) actually reprocessed any fuel.

A facility near West Valley, New York successfully reprocessed nuclear fuel from 1966 through 1972. However, it was unable to economically comply with increasingly stringent, retroactive changes to regulatory requirements, and the West Valley facility closed in 1976. A second facility in Morris, Illinois, was completed in 1971 and underwent several years of testing. In 1974, the project was terminated without ever reprocessing any used fuel. The Morris facility is now an off-site, wet pool, storage facility. A third facility in Barnwell, South Carolina was completed and undergoing preoperational testing in 1977 when the Carter Administration announced its decision to indefinitely defer any commercial (i.e., civilian) reprocessing of used fuel in the United States. The United States Nuclear Regulatory Commission (NRC) then terminated licensing activities for nuclear fuel reprocessing.

By the time President Ronald Reagan had lifted the reprocessing ban in 1981, the discouraging history of these private ventures, the low price of uranium, and plentiful availability of uranium fuel had combined to eliminate any market interest for commercial reprocessing. Nuclear energy in the United States was effectively committed to the once-through fuel cycle, that is, use fuel once in a reactor and then dispose of it in a deep geologic repository.

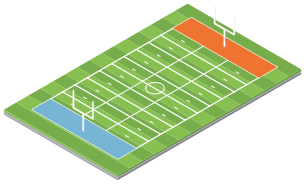
THE NEW PLAN

In 1982, Congress passed the Nuclear Waste Policy Act (NWPA), which required the Department of Energy to identify and characterize potential sites for two deep geologic repositories for used fuel and related high-level waste (HLW). Development and operation of the repository would be financed by the Nuclear Waste Fund (NWF) generated from a fee on the nuclear electricity industry. In1987, the NWPA Amendments designated Yucca Mountain in Nevada as the nation's first permanent waste repository for used nuclear fuel.

Today after consuming 23 years of work and $8 billion of the NWF,[3] the Yucca mountain project is best described as dead but waiting for the medical examiner to finish the paperwork. The Obama administration has zeroed out the budget for the project and appointed a Blue Ribbon Commission to develop a new strategy. However, the NWPA still exists as federal law and the administration's actions are the subject of multiple federal lawsuits.

More than 50 years since the National Academy of Sciences first recommended a deep geological repository for spent fuel and HLW and more than 60 years since the United States first developed and used reprocessing technologies, the U.S. still has no permanent repository and no plans, policies, or programs that will permit reprocessing of its used nuclear fuel.

Soda Cans and Football Fields



All the used nuclear fuel produced by the U.S. in 40 years of operation would, if stacked end to end, cover an area the size of a football field to a depth of less than 10 yards.

If your lifetime energy needs came from nuclear, your portion of the waste fits in a soda can.

GAINING PERSPECTIVE

The political polarization of the nuclear waste issue makes the prospects of either a permanent repository or fuel reprocessing program seem very dim for the next few decades. So how seriously does this hurt the development of new nuclear energy facilities in the U.S.? Well as it turns out, not very much, for two reasons. First, the amount of used fuel in question is comparatively small. The used fuel in storage at licensees' sites today, from the entire 40 years of commercial nuclear electrical generation is only about 63,000 metric tons.[4] If it were all brought to a single location, this waste would barely cover a single football field, 10 yards deep. In comparison, regulated hazardous wastes in the U.S. would fill the New Orleans Superdome, 15 times over, every year.

Amount of Waste Generated in Million Tons/Year

254	Municipal Solid Waste
136	Coal Ash
47	EPA Hazardous Waste
0.2	Used Nuclear Fuel

Second, dry storage of used fuel at individual nuclear generating sites has eliminated concerns that expensive, complicated fuel pools would have to be continuously enlarged to accommodate the accumulated used fuel. Instead, dry storage on a small area within the existing security envelope, has been amply demonstrated to be safe and economical.

Likewise, transportation of used fuel has the same level of preparation, testing, certification, and real world demonstrations of safety as every other activity related to commercial nuclear energy. The NRC has an extremely rigorous program for certifying shipping casks for transporting used nuclear fuel. This has been augmented by dramatic testing under extreme conditions by national laboratories.

Sandia National Laboratories Crash Test

A flatbed semi-trailer carrying a 22-ton Type B Package on it, after being crashed into a 690-ton concrete block at 60 mph.

There have been more than 3,000 shipments of used nuclear fuel and HLW, representing more than 1.7 million miles of transport on U.S. highways and railroads. There have been only nine accidents, none of which resulted in leaks of radioactivity, radiation exposure, injuries, or harm to the environment.[5]

TODAY'S CHOICES

In the absence of an assured path forward for disposition of used fuel, commercial nuclear facilities have constructed and licensed their own Independent Spent Fuel Storage Installations (ISFSI) to safeguard and store their fuel. There are now ISFSIs licensed at 49 of the 63 U.S. reactor sites. In 2010, the NRC updated its Waste Confidence findings to state that used fuel can be "…stored safely and securely without significant environmental impacts for at least 60 years after operation at any nuclear power plant."[6]

In summary today, certain facts are self-evident:

- There will be no permanent repository and no commercial reprocessing in the United States for at least several decades.
- A nuclear facility built today can safely store its used nuclear fuel for at least 120 years.
- Used fuel consists of large quantities of recoverable fuel materials mixed with a small amount of removable contamination.

PRESERVING OPTIONS FOR FUTURE GENERATIONS

It's time for a new plan. We need to get beyond the concept that used fuel is a waste that requires immediate, permanent disposal. The energy reserves contained in used fuel are too valuable to simply discard. Future generations will be able to apply superior technologies for reprocessing and nuclear energy. We already have the technology to safely store and stockpile the fuel for future use. We should consolidate that storage as required and advantageous.

Our Nation's nuclear energy policy needs commitment, not chaos. One principle within that policy should be to store and protect used nuclear fuel, for as long as necessary, consistent with its value as a strategic national energy reserve. In the meantime, new nuclear energy development should proceed without being held hostage to exaggerated perceptions of problems with used fuel. Used nuclear fuel is not waste but a strategic material of great potential value. It must be preserved and protected for the use of future generations as a source of clean, safe, carbon-free energy.

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If you want to look closer at the research behind the information in this publication, please visit our web site at www.unistarnuclear.com. There you will find an annotated version of this Issue Brief with links to the original research and other data behind this publication as well as all of the other publications in the Issue Briefs series.

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