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The Front End of Nuclear Power - How Nuclear Power Gets Its Fuel

Uranium: Enrichment, Nuclear Fuel Fabrication, and More

The nuclear industry claims it emits no carbon and unbelievably, also claims zero emissions. Repeated continuously by the media and politicians, the public has taken this patently false information for granted.

Industries in this paper are part of the ***"Front End"*** *of nuclear power, which gobbles up huge amounts of energy. ONFN has a second flier on the Front End industries of* ***Uranium: Mining and Milling****, which have left a* ***legacy of abandoned mines*** *as well as tailings ponds and piles – many on the lands of Indigenous peoples.*

The real product of nuclear power is not electricity; it is forever-deadly radioactive waste, the ***"Back End"*** *of nuclear power. How much energy will it take to attempt to isolate this waste from the environment for hundreds of thousands of years? And nuclear reactors cannot run without outside electricity to keep them cool!*

☢ ***Radioactivity is emitted throughout the industries listed in this paper as well as in transportation.***

CONVERSION: After uranium has been mined and milled, the "yellowcake" – a mixture of uranium oxides – went to the Honeywell Metropolis Works facility in Metropolis, IL. This facility added fluorine to the uranium, creating uranium hexafluoride (UF6) which can be heated to a gas for enrichment. The process of creating UF6 is known as "conversion." The 1958 facility exposed the community to continuous and increasing UF6 emissions through two ownerships until it was idled in 2018 due to slack demand for UF6. It is expected to reopen in 2023. As the nation's only converter, the crossover between nuclear weapons and power is unmistakable here. A good deal of UF6 is exported.



The aging Honeywell facility

ENRICHMENT: Uranium (hexafluoride) is then "enriched" to increase the percentage of fissionable Uranium-235 from less than 1% to between 3-5% for nuclear power and to over 90% for nuclear weapons and submarines. Taxpayers heavily subsidize enrichment for nuclear power, and totally subsidize enrichment for nuclear weapons.

Gaseous Diffusion Enrichment: The K-25 enrichment plant in **Oak Ridge, TN** operated from 1945 to 1987. The 2-million-square-foot building has been demolished. Starting in the 1950s, high-enriched uranium was made for nuclear weapons at the **Portsmouth (OH) and Paducah (KY)** Nuclear Sites. The enormous (100 acres under roof) Portsmouth facility ***used as much electricity as New York City*** according to the former Atomic Energy Commission. Both facilities later also made low-enriched uranium for reactors. Now closed, tens of billions of public dollars are being spent for cleanup. Cleanup is a misnomer because high-level nuclear waste was brought into both facilities and run through the process buildings, contaminating the entirety of both sites with plutonium and other transuranics.

Centrifuge Enrichment: The only currently operating uranium enrichment facility in the U.S. is **Urenco** near Eunice, NM, which produces low-enriched uranium for reactors using centrifuge technology. Centrifuge facilities can easily convert to making high-enriched uranium for weapons. Centrifuge technology was stolen and has spread around the world. The U.S. government is currently promoting and subsidizing the startup of a new High Assay Low Enriched Uranium (HALEU) facility at the Portsmouth Nuclear Site, which can enrich to 25%. The Dept. of Energy (DOE) defines 20% as High Enriched – it is weapons usable. HALEU would fuel yet unbuilt reactors which the government is also almost completely subsidizing. The overlap between civilian and military is conspicuous here.

Stop Laser Enrichment! The Dept. of Energy (DOE) is negotiating with Global Laser Enrichment to build a laser enrichment facility at the Paducah (KY) Nuclear Site. In 2014 the Kentucky Fish and Wildlife Commission voted to **turn over 665 acres of a wildlife management area** for this private enterprise. Laser enrichment poses a serious nuclear weapons proliferation risk through its small size and lack of heat signature. Undetectable by satellite, the world would not know what nations have nuclear weapons capability, a serious threat to global stability.

DOWNBLENDING: **Downblending** consists of mixing high-enriched uranium from weapons with natural or depleted uranium to make low-enriched fuel for power. Nuclear Fuel Services (NFS) in Erwin, Tennessee has been fined for violations and accidents at its Blended Low-Enriched Uranium project. NFS is the only nuclear facility to be the subject of congressional hearings and to be **declared a public health hazard** by the Agency for Toxic Substances and Disease Registry. BWXT in Lynchburg, VA, also downblends. Historically, downblending has occurred at Department of Energy (DOE) sites in Oak Ridge, Tennessee and Savannah River, South Carolina.

FUEL FABRICATION: Major nuclear fuel fabrication facilities are in Erwin, Tenn.; Columbia, S. Carolina; Wilmington, N. Carolina; Richland, Washington; and Lynchburg, Virginia. Uranium oxide is pressed and sintered (baked) at over 3000°F into ceramic pellets. There is a danger of criticality in this process. Columns of pellets are encased (clad) in zirconium alloy metal tubes, creating fuel rods. Multiple rods are put together into fuel assemblies. There is considerable variation among fuel assembly designs for different types of reactors. About 27 tons of enriched uranium is used yearly by a 1,000 MWe nuclear reactor.

In air, zirconium alloys are flammable at high temperatures. Their reactivity in water at high temperatures leads to the formation of hydrogen gas. This reaction was responsible for hydrogen explosions at Three Mile Island and in 3 reactors at Fukushima, Japan. The peak fuel cladding temperature set by the NRC, 2,200°F, is too high to ensure public safety, according to citizen arguments before the NRC.

Nuclear Fuel Services (noted on page 1) in Erwin, Tennessee, fabricates high-enriched fuel for nuclear submarines which deploy nuclear warheads – highlighting the connection between nuclear power and nuclear weapons.

DECONVERSION: The waste product of uranium enrichment is "depleted" uranium hexafluoride (DUF6), which comprises over 99% of the original uranium. DUF6 is not only radioactive, but also highly chemically reactive. Deconversion removes fluorine from DUF6, reducing it to depleted uranium (DU). Mid America Conversion Services is operating DUF6 deconversion plants at the Portsmouth (OH) and Paducah (KY) Nuclear Sites. The deconversion process is often referred to as conversion, creating confusion between the two. There were 700,000 metric tons of highly reactive DUF6 stored in about 63,000 steel cylinders on the 2 sites. Many are over 60 years old and rusting. Progress on deconversion has been slow. This may be because DOE has a "use" for the DUF6 waste.



Assessing Depleted Uranium in Iraq
Photo: U.N. Environment Programme

The Dept. of Energy, without doing the required Environmental Impact Statement, gave Mid-America Conversion a license for a new process that would use the radioactive DUF6 waste to make depleted uranium for military use - yet another link between civilian and military nuclear technology. See our flier ***Portsmouth Conversion Facility to Make Depleted Uranium for Warfare***.

There is little civilian use for depleted uranium (DU), **which contains all the radioactivity of the DUF6**. DU is used as armor in tanks and military vehicles and in armor-piercing shells and bunker buster bombs. Hundreds of tons of DU munitions have been detonated in Iraq and Afghanistan. **Serious health risks** occur when this material is ingested or inhaled by people in war zones or test areas. Cleanup of contaminated areas **remains to be accomplished**.

An International Isotopes (INIS) deconversion plant in Idaho has been used to produce DU for the military. Aerojet Ordnance in Jonesborough, TN, deconverts DUF6 and fabricates depleted uranium metal for antitank rounds.

Hydrogen is needed for deconversion. ONFN's flier ***Hydrogen at Davis-Besse, Portsmouth and Beyond*** exposes most new hydrogen proposals as dirty, not green as advertised.

REPROCESSING AND MOX FUEL: Reprocessing of irradiated (used) nuclear fuel – classified as high-level nuclear waste – was initially performed to extract plutonium for nuclear weapons. Later this waste was termed a "peaceful resource" and attempts were made to use the plutonium in commercial nuclear fuel. Mixed oxides of plutonium and uranium (MOX) can be fuel in some types of nuclear reactors. Nuclear Fuel Services (NFS) **reprocessed irradiated fuel from both military and commercial reactors at West Valley**, N.Y. from 1966 to 1972. Serious contamination and inability of NFS to meet standards led to closure. Responsibility for cleanup – estimated by the Government Accountability Office at **up to $10 billion** – is now resting with the state of New York and federal taxpayers. The **Shaw Areva MOX Facility** at Savannah River, S. Carolina - 60% complete - was granted 10 extra years for completion until 2025. Cost estimates have zoomed from $4.9 billion to $30 billion.

SHIPPING: Throughout the "Front End", transportation of radioactive materials occurs by road, rail, and barge. Scores of accidents involving radioactive materials have been reported. Cities, towns, and rural areas have been contaminated. Safety planning is critical, but costs local and federal taxpayers millions of dollars.

CLEANUP OF FRONT-END FACILITIES: All the aforementioned activities and industries contaminate air, land, and water with radioactivity and chemical toxins. The U.S. has spent billions but has scarcely begun to deal with "cleanup" – as if that were possible – of nuclear power's front-end facilities. In addition, cleanup of nuclear weapons facilities and isolating high-level radioactive waste must be accomplished. Future generations will be saddled with these tasks, costs, and immense energy (hopefully from other than carbon) requirements far into the future.

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This sheet is by no means an inclusive list of U.S. front end facilities, active, closed, or proposed.
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