ACCELERATOR TRANSMUTATION OF WASTE

Science for the 21st Century

will include advances in the accelerator transmutation of nuclear waste

In medieval times, alchemists dreamed of "transmuting" lead into gold. They never achieved that dream, but it may someday be possible to change the high-level nuclear waste produced by nuclear power plants into much more manageable wastes. Under the U.S. Accelerator Transmutation of Waste Program, Los Alamos and other Department of Energy laboratories are studying and developing accelerator-driven technologies that can transmute such waste into more benign, stable waste forms.

About 95 percent of reactor waste is uranium that by itself does not require long-term, permanent storage. The rest is plutonium and other transuranics (minor actinides) and highly radioactive fission products. The transuranics and fission products are far more hazardous than uranium.

Los Alamos has been studying ATW technology options for a decade. While many potential designs for an ATW system have been examined, the main technical components remain the same: a high-power proton linear accelerator, pyrochemical spent fuel treatment/waste cleanup system and subcritical waste burner that's based largely on existing nuclear technology.

The U.S. nuclear power industry will generate approximately 70,000 tons of high-level nuclear waste by 2015, including about 550 tons of plutonium. ATW potentially can reduce the amount of waste requiring permanent storage to less than 3,000 tons, including less than 1 ton of plutonium. In addition, these wastes would require a few centuries of isolation instead of 10,000 years.

ATW begins with a spent fuel treatment center, where the uranium and short-lived fission products that do not need to be transmuted are separated from the rest of the waste. These short-lived fission products are prepared for disposal, while the uranium can be recycled for reuse or prepared for disposal. The remaining transuranics (plutonium, neptunium, americium and curium) are transferred to the waste burner, where they are fissioned into materials that pose mostly short-lived hazards. Because these transuranics have some undesirable fuel characteristics, the fission process is controlled using neutrons produced by the accelerator's proton beam as it strikes a spallation target. The long-lived fission products capture neutrons and are converted into stable, nonhazardous materials. A linear accelerator based upon the one at Los Alamos — the most powerful of its kind in the world — conceivably could drive several subcritical burners at once.

Because plutonium releases energy as it is destroyed by fission in the waste burner, the process can power itself. Only a fraction of the energy is needed to supply the ATW system; the rest can be sold to power companies, offsetting ATW development and construction costs. Perhaps most important, destroying the weapons-grade plutonium enhances nonproliferation efforts.

Los Alamos, in collaboration with eight other DOE laboratories, recently developed a five-year "road map" (reference number DOE/RW-0519) for ATW research and development, which includes examining all available technology development options; developing a prototype test facility; and demonstrating key aspects of the technologies. Los Alamos plans to conduct some of those demonstrations. Researchers are working on designs that would lower the cost of such a system, which is one of the major hurdles that must be overcome. While an ATW facility may be years away, its potential for solving a worldwide environmental dilemma is undeniable.

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