

Controversy continues to swirl around uranium enrichment contract

A little-used nuclear fuel may be the foot in the door for a US company hoping to snag a far bigger prize.

The chairs and ranking members of two House Science, Space, and Technology subcommittees have asked the Department of Energy to justify the October award of a \$115 million contract to Centrus Energy to demonstrate technology for producing a specialized nuclear fuel for advanced reactors. The bipartisan quartet questioned DOE's decision to bypass competitive bids for the work; expressed skepticism over the need for the fuel, known as high-assay low-enriched uranium (HALEU); and asked why DOE's civilian nuclear program was tapped to pay for a program that ultimately will be of far greater benefit to defense applications.

HALEU is enriched in isotope uranium-235 up to 19.75%—just below the 20% threshold that defines highly enriched uranium (HEU). Some designs for advanced reactors would require enrichment levels above the 4–5% that fuels the existing fleet of US commercial reactors.

DOE insists that Centrus is the only company qualified to produce the HALEU because it is owned and operated by a US entity and will use a domestically developed enrichment technology. Under existing US regulations, that qualifies Centrus HALEU to be used in advanced reactors that may be acquired by the military, the agency's notice of award said. No domestic-origin requirements are necessary for uranium that is used for civilian purposes.

"We note that the entire decision to issue the award to Centrus on a sole-source basis seems organized around outcomes that would advantage the Department of Defense exclusively, which has neither contributed financially to the demonstration nor articulated a formal requirement or needs assessment concerning HALEU," the lawmakers said in

their 13 November letter to then Energy secretary Rick Perry and his successor Dan Brouillette. The letter was signed by Representatives Mikie Sherrill (D-NJ) and Ralph Norman (R-SC) of the subcommittee on oversight and investigations and Conor Lamb (D-PA) and Randy Weber (R-TX) of the subcommittee on energy.

A DOE spokesperson said the department will respond to the lawmakers' questions. The spokesperson did not reply to PHYSICS TODAY's questions about the contract award, and Daniel Poneman, Centrus president and CEO, declined to be interviewed. Poneman, who was deputy energy secretary from 2009 to 2014, has argued previously that the US should not become dependent on foreign sources of uranium for its defense needs. Further, he has said nonproliferation policy requires a strict divide between civilian and military programs and materials.

In a response to emailed questions from PHYSICS TODAY, a Centrus spokesperson said that the company has invested \$3 billion in shareholder funds to develop the centrifuge technology and will incur a loss in performing the new contract. DOE's support for the company's technology "reflects its unique importance to meeting US national security and nonproliferation requirements as well as advancing American nuclear leadership," she wrote.

The Centrus contract calls for construction of a small demonstration plant with 16 of its AC100M centrifuges by October 2020 and production of a "small quantity" of HALEU by September 2021. In budget documents for fiscal year 2020, DOE says it will not pay for any subsequent expansion of the plant's capacity.

In parallel, however, DOE's National Nuclear Security Administration (NNSA) formalized plans last year to acquire a far



larger uranium enrichment plant to produce both LEU for tritium production and eventually HEU for naval propulsion reactors. Although the NNSA hasn't formally requested proposals from industry, Centrus is considered the leading contender for that plant because of domestic-origin requirements. The agency said it would decide by the end of 2019 whether to use the AC100M or a smaller centrifuge in development at Oak Ridge National Laboratory. No announcement had been made at press time.

In a 2015 report to Congress, the NNSA said a plant meeting defense enrichment needs would require 1660 centrifuges and cost anywhere from \$3.1 billion to \$11.3 billion. The 2015 report found there was sufficient LEU on hand to meet NNSA tritium requirements until at least 2038 and enough HEU to meet naval reactor needs until 2064 (see PHYSICS TODAY, March 2019, page 28). The Government Accountability Office has said the NNSA cost estimates don't meet GAO reliability standards.

Conflicting interpretations

The Defense Department is expected early this year to solicit industry proposals to



CENTRUS ENERGY'S 120-centrifuge uranium enrichment demonstration plant was in operation from 2013 to 2016 in Piketon, Ohio. The 12-meter-tall AC100M centrifuges have been decommissioned, but Centrus has continued developing the technology under contract with the Department of Energy.

build a prototype of a portable advanced reactor for powering remote military bases that now require periodic fuel deliveries. Such compact reactors are expected to require HALEU fuel. But the fact that DOD has dedicated no funding to microreactors to date “is a strong indication that [DOD] does not have a near-term need for HALEU to support any defense applications,” the four lawmakers wrote.

US policy stipulates that uranium used for any military purpose, including nuclear fuel, must be enriched using US-origin technology. A corollary would seem to require that all US commercial reactor fuel be enriched using US technology, since US military bases draw power from a commercial grid that gets nearly 20% of its power from nuclear plants. But in fact, two-thirds of the uranium supplying US commercial reactors in 2018 was enriched abroad, much of it in Russia.

The Nuclear Energy Institute, an industry trade group in the US, estimated in 2018 that industry would require 53

tons of HALEU by 2025 and 590 tons by 2030. But the lawmakers noted that the only advanced reactor design presently undergoing US licensing approval—that of NuScale Power—doesn’t need HALEU, and it isn’t even expected to achieve commercial operation until 2026. Advanced reactor designs requiring HALEU are “extremely unlikely” to need a supply of HALEU in the time frame spelled out in the Centrus award, they said.

The last Cold War-era enrichment plant was permanently closed by Centrus’s bankrupt predecessor in 2013. Since then, no domestic enrichment plants have employed US-developed technology. Centrus now is a uranium broker to nuclear utilities. Its main source of enriched uranium is the Russian state-owned TENEX.

The sole enrichment plant in the US today is operated by Urenco, which is owned by a Dutch-German-UK consortium that developed its centrifuge technology abroad. No one currently enriches

HALEU commercially, but Urenco announced plans last year to add HALEU capability to its New Mexico plant. The Urenco partner governments have said their 1995 agreement with the US does not prohibit the company from providing HALEU for military reactors or LEU for tritium production. The agreement does limit Urenco’s uranium product to “peaceful non-explosive purposes,” but it doesn’t cover tritium. It’s worth noting that tritium, a vital component of all US nuclear weapons, is produced in a civilian reactor as a by-product of electricity generation. That arrangement crosses the purportedly red line between weapons and civilian nuclear facilities.

Unlike DOE, the Pentagon apparently hasn’t dismissed the possibility of using Urenco HALEU. A 2018 report commissioned for the US Army noted that for a “modest- to large-scale deployment” of portable reactors, Urenco is the lowest-cost HALEU source. Urenco has estimated the up-front cost to meet HALEU demand at \$300 million to \$500 million, and company officials told the army that production could begin in five to seven years. DOE’s timeline for a new enrichment plant with sufficient capacity to meet anticipated demand for those reactors is in the late 2030s or later, the army report stated.

Although adjustments to the agreement between the US and Urenco governments would be required, “it is possible however, that the [Urenco] owners could approve fuel enrichment to support military electrical power production,” the report said.

In the July–August 2019 issue of *Arms Control Today*, Frank von Hippel and Sharon Weiner noted that the strict US interpretation of the peaceful-use restriction was established in 1998, when the US still operated enrichment plants employing domestic technology. The authors said that the production cost of LEU for the proposed NNSA plant would be up to 40 times as much as the current market price. The authors also noted that the Dutch and UK governments and the two German utilities that own Urenco have expressed interest in selling the company, which had an estimated market value of \$10 billion in 2013. That’s within the upper bound of the NNSA’s cost estimate for a new plant that would have only 1/50 of Urenco’s enrichment capacity. And those estimates

don't allow for the large cost overruns that typically occur on DOE nuclear facility construction.

Other supply options

In a report last year, DOE's Nuclear Energy Advisory Committee (NEAC) was sharply critical of the agency for reallocating \$23 million in FY 2019 funding from the nuclear energy research program to pay for the Centrus plant. That decision left only \$10.6 million for academic research on the nuclear fuel cycle last year. The funding cut occurred just prior to the due date for academic research proposals, after "massive efforts" had been expended on proposal preparation, the committee said.

The report said other "very promising routes" could provide HALEU. DOE has set aside a portion of its surplus of HEU to be diluted to HALEU. By 2023 the agency plans to recover another 5 tons of HALEU in spent fuel from a decom-



A PORTABLE REACTOR DESIGN BY HOLOSGEN can fit inside a standard shipping container and generates 13 MW of power for 12–20 years. The reactor would use high-assay, low-enriched uranium containing up to 15% ^{235}U .

missioned experimental breeder reactor in Idaho. And Congress appropriated \$20 million in FY 2019 to recover HEU from spent naval reactor fuel stored in Idaho for potential conversion to HALEU. The NEAC report also suggested that 34 tons of surplus weapons-grade plutonium slated for disposal under a bilateral agreement with Russia could be diluted to provide the equivalent of 170 tons or

more of US-origin HALEU. DOE plans instead to render the plutonium unusable and store it permanently at its Waste Isolation Pilot Plant in New Mexico.

Terms of the award call for Centrus to match 20% of the federal funding, the lawmakers' letter stated, in apparent contravention of 2005 legislation that requires no less than a 50–50 share.

David Kramer

Reevaluating teacher evaluations in higher education

Relying on students to rate professors is convenient, cheap, and problematic.

For decades student evaluations have been the mainstay of attempts to measure the quality of teaching at colleges and universities across the US and beyond. Now, as part of a growing focus on teaching in higher education, and because of mounting evidence of student biases, those evaluations are increasingly in the crosshairs. A smattering of institutions have begun revamping their approaches to student evaluations of teaching (SETs), and those independent efforts are fueling momentum on a national scale.

SETs have become the norm in higher education because they are convenient and cheap. The questions and scoring vary by discipline and institution, but typically before they see their final grade, students are asked to fill out a survey about the course and the instructor. Department heads or other campus officials calculate averages and often compare a given teacher's ratings to others' in the department and across the institution. The ratings inform promotion and tenure



FACULTY MEMBERS BRAINSTORMED how to improve teaching and teaching evaluations last April in Boulder. Gabriela Weaver (in turquoise), Ann Austin (in purple), and Noah Finkelstein (with fingers at the board) are principal investigators on a multi-institutional, cross-disciplinary project that looks at teaching effectiveness.