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Phasing Out Highly Enriched Uranium Fuel in Naval Propulsion: Why It's Necessary, and How to Achieve It

Executive Summary
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- Longstanding and bipartisan U.S. nonproliferation policy, initiated by the administration of President Gerald R. Ford in the mid-1970s, aims to reduce global commerce in highly enriched uranium (HEU) – a nuclear weapons-usable material – to prevent nuclear proliferation and nuclear terrorism.

- If foreign countries are permitted to develop nuclear navies fueled by HEU, they could divert some of it to make nuclear weapons. Criminals or terrorists also might steal HEU from a naval fuel cycle – during fabrication, transport, or storage – to make Hiroshima-type nuclear weapons (not merely dirty bombs).

- Iranian officials have claimed repeatedly that they need to produce HEU for a future nuclear navy.

- Global use of naval nuclear fuel, now mainly by the United States and Russia, entails up to three tons of HEU annually – sufficient for over a hundred nuclear weapons per year – dwarfing all other worldwide non-nuclear-weapons uses of HEU combined.

- Two of the six countries with nuclear navies, France and China, already fuel their vessels exclusively with low-enriched uranium (LEU), which is not suitable for nuclear weapons.

- In January 2014, the U.S. Department of Energy's Office of Naval Reactors reported to Congress that an "advanced fuel system," if successfully developed for the U.S. Navy, could "allow using LEU fuel with less impact on reactor lifetime, size, and ship costs."

- The DOE report also stated that –

> "Advanced fuel system development would be a long-term effort that must start well in advance of a ship application. The investment to develop a fuel technology and determine its viability is estimated to be up to $2 billion over at least 10 to 15 years."

(continued on reverse)

- Conversion of anticipated next-generation U.S. nuclear naval vessels to LEU fuel could incur marginal costs or savings, but would not require increasing the size of the force, and so would not significantly impact the overall cost of the naval nuclear enterprise.

- The current U.S. stockpile of HEU designated for naval fuel is sufficient until 2064, according to DOE. If next-generation U.S. naval vessels are not converted to LEU fuel, the United States would have to resume production of HEU, potentially undermining longstanding U.S. efforts to halt worldwide production and use of this nuclear-weapons material.

- To reduce worldwide use of HEU naval fuel, and associated risks of nuclear proliferation and nuclear terrorism, the United States could pursue expeditious conversion to LEU fuel of its next generation of nuclear naval vessels – starting with the attack submarines (SSNs) scheduled to replace the current Virginia-class in about 20 years – and challenge other countries to reciprocate, a diplomatic approach that has worked in the past.

- This would require the U.S. government to initiate R&D of an LEU advanced fuel system as soon as possible, to maximize the prospects of it being available for the next generation of SSNs in the 2030s.

- The initial R&D budget would be relatively small, but the program would need to start soon and be restricted to development of an LEU advanced fuel system, in order to contain costs and help persuade other countries to join a global phase-out of naval HEU fuel.

Conversion Timelines for U.S. and Russian Nuclear Navies

Country	Vessel Type	Latest HEU-fueled class built or under design	First commissioned	Service life (years)	Years from construction start to commissioning	Deadline to start construction of LEU-fueled replacement‡	Deadline to start 10 - 15 year design of LEU fuel/reactor
USA							
	SSN	Virginia	2004	33	5	2032	2017
	SSBN	Ohio-replacement	2031	40	10	2061	2046
	CVN	Ford	2016	50	11	2055	2040
Russia							
	SSN	Yasen	2014	25 - 30	21[ɣ]	2029[†]	Soon
	SSBN	Borei	2013	25 - 35	17[*]	2028[†]	Soon
	SSGN	Antey	1986	25	4	No known plans to replace this class	
	CGN	Kirov	1980	20-25	7	No known plans to replace this class	

‡Assumes that each replacement class requires the same time to construct as its predecessor class, except as noted.

ɣConstruction of the first Yasen SSBN was delayed by funding problems.

*Construction of the first Borei SSBN was delayed by missile problems.

†Based on estimates of the shortest service life of the current class, and 10 years from construction start to commissioning.