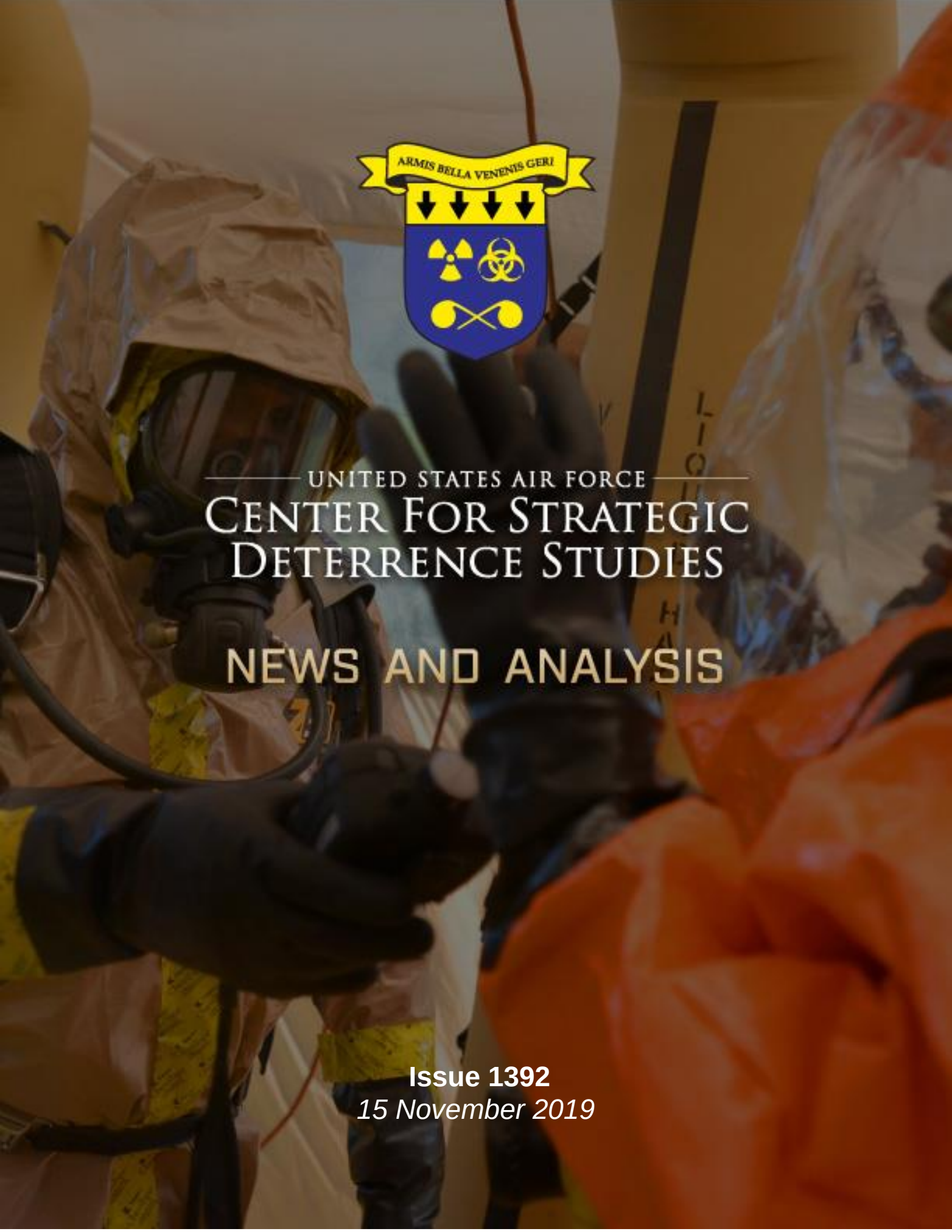

UNITED STATES AIR FORCE

CENTER FOR STRATEGIC DETERRENCE STUDIES

NEWS AND ANALYSIS

Issue 1392
15 November 2019

Feature Report

"*NUCLEAR WEAPONS SUSTAINMENT: Improvements Made to Budget Estimates in Fiscal Year 2019 Joint Report, but Opportunities Remain to Enhance Completeness*". Published by U.S. Government Accountability Office; Nov. 7, 2019

https://www.gao.gov/products/GAO-20-37R

GAO: The Departments of Energy and Defense expect to spend hundreds of billions of dollars over the next decade to sustain and modernize the U.S. nuclear arsenal. The agencies are required to estimate the cost of this work over the next 10 years and provide annual updates in a joint report.

We found the departments' estimates were generally consistent with their internal funding and modernization plans. However, Energy did not include a full 10 years of budget data in the joint report—information that could help Congress understand long-term investment needs.

We recommended that Energy include this information in the future.

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NUCLEAR WEAPONS

USNI News (Annapolis, Maryland)

Navy Undersea Warfare Priorities: Strategic Deterrence, Lethality and Networked Systems

By Megan Eckstein

Nov. 8, 2019

ARLINGTON, Va. – With the Columbia ballistic missile submarine program set to take up a large portion of Navy shipbuilding funds in the next two decades and flat budgets expected in the near-term, the Navy's undersea warfare community has clearly prioritized where any available funds should go to support the National Defense Strategy.

With the Columbia SSBN program and the strategic deterrence it provides being a clear top priority, the Navy's undersea warfare director said, the submarine community views increasing lethality as a second priority and then creating a networked undersea domain as a third priority.

Rear Adm. Thomas Ishee said during this week's Naval Submarine League's annual symposium that flat budgets in the future would equate to diminished buying power due to inflation and rising costs, "so it's going to be very important for us to really solidify and stick to our priorities, which are, in the strategy for resourcing: strategic deterrence is number one, there's no doubt that we are going to fund that. We need to fund that in a responsible way that does not adversely affect the other programs that we have. Increasing lethality; again, to me that means the Virginia Payload Module, the advanced payloads and integration of those. And then to move farther into this domain-centric warfare in the undersea domain. Take the capabilities that we have; add to them; [add] command, control and communication to them; be able to display and use that in a common operating picture."

On the lethality piece, Ishee said the Virginia Payload Module added to the Block V Virginia-class attack submarine design would be a good near-term step to increase the lethality of the force. VPM brings the subs from 12 missile tubes to 40, helping to make up for the loss of four Ohio-class guided-missile submarines (SSGNs) strike missile platforms as they retire from service. He said the VPM would also be ready to carry future advanced payloads as they come into the fleet.

In the mid-term, Ishee said lethality would be boosted by investments in new sensors and payloads and increased range of weapons, to give the Navy more options to use submarines to go after undersea, surface and land targets.

"We're working to develop advanced missiles and undersea payloads to expand the competitive space while growing longer arms," he said.

As examples, Ishee said the first refurbished Harpoon anti-ship missile would be delivered to the submarine fleet in Fiscal Year 2021. The Tomahawk land-attack missile, which the submarine community has used for decades, would be supplemented with a maritime strike variant for surface engagements at longer ranges "and a joint multiple-effects warhead system to expand the Tomahawk target sets." Investments in hypersonics and supersonics would benefit the submarines' weapons inventory as well, and a spiral development approach on the Navy's heavyweight torpedo program would yield longer ranges and "versatile payloads" for various effects.

Asked afterwards what kinds of additional "advanced payloads" the Navy was seeking, Ishee told USNI News that "right now the priorities in the short term are mostly about enabling kinetic payloads with longer range. As I look to the future, I think more about electromagnetic warfare kind

of payloads, about all I can say about that. But lot of the effects that we are having success with in other domains, we need to be able to generate those effects from the undersea."

He said those capabilities are being laid into the Tactical Submarine Evolution Plan (TSEP) that outlines capabilities to be introduced to the force, but he added they were not yet being added into funding plans.

In the long term, Ishee said, lethality would be boosted by the SSN(X) program. As the Virginia class bumps up against its power and space margins for new capabilities, SSN(X) will be designed to have improved mobility, speed and stealth; greater magazine size and payload integration capability; artificial intelligence to increase warfighter decision space; and improved survivability, so the hull could take a hit and keep on fighting in a high-end battle.

Ishee said top-level requirements have been discussed for this next-generation boat but that the requirements would be finessed over the next year. He said he expected SSN(X) to be a revolutionary change in submarine capabilities, instead of the evolutionary change the Virginia class has brought since its design began after the Cold War. The timing of the start of the SSN(X) program remains unclear, he said.

The third priority for Navy undersea warfare funding is to move from a platform-centric approach to a domain-centric approach. Investments in the last decade in the P-8A Poseidon maritime surveillance airplane, helicopter-based and destroyer-based sensors, undersea surveillance systems and unmanned underwater vehicles have completely changed the ability to understand what's happening under the water, and the service needs to connect the information to create a larger common operating picture (COP), as well as view financial investments in a holistic way, Ishee said.

As a mid-term effort, Ishee said he hoped to see the creation of an undersea test bed, a government-furnished test range where companies or government labs could bring sensors, communications suites, weapons, unmanned vehicles and more "to test and compete different technologies in a competitive environment – so run these through battle scenarios to see how well new ideas and technologies are able to adapt and be used."

Asked by USNI News during a question-and-answer session what investments he most wanted to see from industry, Ishee said, "to me, the biggest piece is that communication and command and control piece, and the ability to see in the underwater domain so we can have a COP in the underwater domain. We're doing pretty well in individual technologies and capabilities as we bring those forward; now we need to be able to link those together so we can use them as one big system.

"So getting to a standard communication package, getting to a standard protocol so that you can take – I'd love to be able to, in my test bed, be able to provide a large diameter UUV that industry could come in and plug in a sonar sensor to a standard interface, plug in a weapon or put a weapon into a payload bay in a standard way, be able to communicate with that UUV and plan it and execute a mission through a standard set of protocols," he continued.

"So to me it's all about the command and control and communication, link these things together to be able to get them in the water and see what works in a larger scale, a real-life scale, and then spiral development."

To aid this effort, Ishee said in response to another question that the TSEP, which outlines desired investments in the submarines themselves, may be supplemented or replaced by an undersea domain evolution plan that looks at the entire domain and ways to grow capability overall in undersea warfare. Funding today is stovepiped by program, he said, which makes it harder to standardize communication links or interfaces, and makes it hard to align funding. A system-of-systems portfolio, and a capability evolution plan to guide it, would help in that effort, he said.

In the long term, Ishee added, he would like to see the submarine force make more progress in seabed warfare and seafloor sensors and effects.

https://news.usni.org/2019/11/08/navy-undersea-warfare-priorities-strategic-deterrence-lethality-and-networked-systems

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Defense News (Washington, D.C.)

Here's How a CR Could Hurt America's Nuclear Weapons Modernization

By Aaron Mehta

Nov. 12, 2019

WASHINGTON — A long-term continuing resolution will result in delays for modernizing America's nuclear warheads, while putting at risk an already challenging plan to build plutonium pits needed for the next generation of U.S. intercontinental ballistic missiles, nuclear officials are warning.

The National Nuclear Security Administration is a semiautonomous agency under the Department of Energy that handles the manufacturing and maintenance of America's nuclear warheads. Like other government agencies, NNSA would be limited to fiscal 2019 funding limits under a continuing resolution, and it would be unable to start new contracts.

The current continuing resolution, or CR, is set to end Nov. 21, but there is little expectation that regular budgeting will then resume. Congress is debating the merits of pushing the CR through December, but analysts are concerned the CR could extend into next year.

"We are in a situation right now where we have single-point failures throughout our enterprise," Lisa Gordon-Hagerty, the NNSA administrator, said during a Defense Writers Group breakfast earlier this month. "It's necessary for us, for the NNSA and for the nuclear security enterprise to receive consistent and robust funding to modernize our infrastructure as well as continue ongoing operations."

"We're looking at where we can move funding insofar as CRs will allow us to do so," she added. "We're working very closely with OMB and the administration to see what we can do to continue our important programs to modernize the infrastructure as well as the stockpile and our workforce initiatives and our endeavors."

Gordon-Hagerty did not go into detail about specific CR-related worries, but according to an NNSA source, the agency has identified three main areas of concern under a longer CR.

The first is, broadly, keeping the warhead modernization efforts on schedule. Two of those modernization programs — the B61-12 gravity bomb and W88 submarine-launched ballistic missile warhead — already face program delays thanks to an issue with a commercial part that has to be redesigned.

Gordon-Hagerty said a CR should not impact that particular issue, as the funding for a solution is coming from a realignment of other warhead modernization programs. But a delay to one program caused by a CR "does affect all of the other modernization programs and all of the other work that we have ongoing throughout our nuclear security enterprise," she said.

The second major area of concern is the surplus plutonium disposition program, which is supposed to dispose of 34 metric tons of excess plutonium at a South Carolina facility. That program emerged

as the successor to the controversial MOX program, and has faced opposition from South Carolina Sen. Lindsey Graham. Construction on that facility could be delayed under a CR.

The NNSA source said that the agency requested extra funding for the surplus plutonium disposition program through the budget anomaly process, but was not given the resources it requested.

The third area of concern is a 10-year plan to develop a native plutonium pit in the United States. The NNSA has been charged with producing 80 plutonium pits a year by 2030, a target that Gordon-Hagerty acknowledged is a tight window for the agency to hit, even with stable funding.

"We are again rebalancing, looking at our budget across the entire enterprise to see what it is we need to do to meet the scope and schedule of that 2030," she said. "Am I confident we can get there? Yes. Is it fraught with — probably a bad way of saying it — land mines? It is."

Construction featuring prominently on this list should not be a huge surprise; NNSA officials are quick to point out in public events that they are still using some buildings that date back to the Manhattan Project. According to Gordon-Hagerty, more than 50 percent of NNSA facilities are more than 40 years old, and over a third of those are about 70 years of age.

The looming CR extension comes as the agency launches a number of construction projects, and a CR could lead to major delays in standing up those facilities.

While that's an issue for every agency under a CR, the NNSA is concerned that the specialty construction talent needed to build those facilities may not available if a contract is frozen and then picked up again later.

There could also be high-dollar costs. Responding to a lawsuit by environmental groups trying to halt the construction of the Y-12 facility in Tennessee, NNSA said a six- to 12-month delay in construction at that location could result in almost $1 billion in extra costs for taxpayers and the agency may have to lay off 1,000 construction personnel.

Those numbers, first reported by the Exchange Monitor, likely have resonance with other potential delays at construction sites caused by a CR — meaning construction delays at one or more sites could quickly become costly for an agency whose facilities and construction needs have traditionally been underfunded.

"It's been on schedule and on budget for the last six years. It will be finished in 2025 for approximately $6.5 billion," Gordon-Hagerty said of the Y-12 facility. "If that funding somehow fails to materialize, then we've got over 1,000 crafts [personnel] working at the site right now. Crafts personnel are hard to come by, especially those that are qualified. So if they see a question about funding or funding gets pulled back, they're going to find positions elsewhere."

https://www.defensenews.com/smr/nuclear-arsenal/2019/11/12/heres-how-a-cr-could-hurt-americas-nuclear-weapons-modernization/

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Defense News (Washington, D.C.)

Maintainers under Pressure to Keep 'Doomsday Plane' Flying after Flood Wreaks Havoc

By Valerie Insinna

Nov. 12, 2019

OFFUTT AIR FORCE BASE, Neb. — Earlier this year, the sole hangar for the E-4B Nightwatch airborne command post at Offutt Air Force Base was submerged in water after floods hit Omaha, Nebraska.

Months later, the hangar is now usable but not fully operational, creating a challenge for the maintainers charged with keeping the E-4B operational.

Nicknamed the "Doomsday plane" due to its ability to withstand a nuclear blast, the iconic blue and white E-4B serves two purposes: to transport defense secretaries around the world, and to provide a secure and survivable command center in the event of a nuclear war.

The U.S. Air Force only operates four E-4Bs, all based at Offutt, and at least one of those aircraft must be on alert 24/7 year-round. As one E-4B is usually going through a yearlong depot maintenance period and another is typically receiving modifications, two aircraft are left to fulfill mission requirements.

The flood has made it difficult to keep at least one those planes functional, said Maj. James Hodges, who leads the 595th Aircraft Maintenance Squadron.

Hodges arrived at Offutt on March 18, during the period when the flood hit the base, causing what may add up to $1 billion in damage, according to the Omaha World Herald.

"There's a beautiful change-of-command photo with the hangar underwater in the background," he joked during an October interview.

The 595th AMXS was able to move its equipment and tools to the north side of the base before the flood covered some parts of Offutt in up to 8 feet of water. None of the Nightwatch planes were damaged by the flood, but in the immediate aftermath of the disaster, the squadron was displaced, often having to fly to Wright-Patterson Air Force Base in Ohio to conduct heavy maintenance.

Now, half a year later, maintainers are back at work repairing E-4B aircraft at Offutt, including changing out engines and performing most of the heavy maintenance, Hodges said.

"We do what we can on the ramp. Now the flood waters have receded, so while the buildings still need some work as far as repairing electrical stuff, [the hangar] still works as some overall cover," he said. "We're probably, I'd say, about 50 percent capable with that facility now."

But the hangar isn't yet fit for all maintenance work. Tasks requiring a temperature-controlled environment — like isochronal inspections that occur every 220 days, take 24 days to complete, and require personnel to crawl through the jet and inspect wires, re-lube components and wash the aircraft — must still be done at Wright-Patterson.

"It just makes the scheduling more important," Hodges said. "Because when it's time to do that inspection, we'll send up to about 60 guys … to Wright-Patterson Air Force Base with the jet to do that inspection. So while those 60 bodies are there, I have 60 less bodies here to do day-to-day care and feeding."

The 595th AMXS is comprised of 260 personnel, but 40 of those are either permanently located at Wright-Patterson or focused on scheduling, leaving a core cadre of 220 maintainers. Transferring more than a quarter of them to Ohio for weeks at a time adds another layer of difficulty to an

already complicated task. Furthermore, the squadron is already undermanned and lacks the optimal number of experienced maintainers.

But the Air Force is taking steps to correct the situation, Hodges said. After a study found that the 595th AMXS was short by 130 maintainers, 30 were added to the squadron during this summer.

"While that helped bolster the numbers, those 30 bodies have to be trained," he said, adding that it takes six months to qualify a trained maintainer on the E-4B and another year for them to gain the experience necessary to know the plane.

Meanwhile, the funding to hire the remaining 100 maintainers needed is unavailable, but Hodges hopes that gap will be filled by 2021.

The future of the E-4B

The E-4B was introduced in 1974, and a replacement for the Boeing 747 derivative is still years, perhaps decades, into the future.

In 2018, the Defense Department released a solicitation signaling its interest in recapitalizing the E-4B, E-6B and C-32A platforms and asking industry for information. The NEAT program could replace all three aircraft types with a common airframe or family of planes. NEAT is short for the military's name for the missions conducted by those platforms: National Airborne Operations Center (NAOC), Executive Airlift, Airborne Command Post (ABNCP), and Take Charge and Move Out (TACAMO).

An industry day was held in April, however it's unclear if the effort will materialize into a program of record.

In the meantime, the Air Force is pressing forward with key upgrades for its E-4B fleet, setting aside about $176 million in its fiscal 2020 budget for "enhancements to aircraft structures, [the] propulsion system, fuel system, environmental control system, electrical generation and distribution systems, flight safety and navigation systems" as well as modifications needed to meet Federal Aviation Administration requirements.

Some of the modifications underway or planned include integrating the advanced extremely high-frequency terminal, the low-frequency transmit system and the Mobile User Objective System, as well as technologies necessary to upgrade presidential voice conferencing, according to budget documents.

While the bones of the E-4B are decades old, many of communication and navigation systems have been added or modernized over the years, resulting in a hodgepodge of different equipment that must be mastered by maintainers.

"Typically on a regular jet … we have, let's say, 20-something odd systems that we have to manage or maintain. But now we have something like 113. So it's a bit of a steep learning curve because it's not stuff we're taught [at tech school]. We have to learn it while we're here," said Tech. Sgt. Elden Magnuson, one of the squadron's approximately 50 communications and navigation specialists.

It takes years to build up expertise on so many systems, so the 595th AMXS tends to retain its maintainers longer than most other squadrons. For example, Magnuson — who previously worked on C-130s and C-17s — has clocked in eight years as an E-4B maintainer.

But every day is a challenge, he said, because new systems are continually added to the aircraft. For instance, when Defense News visited Offutt Air Force Base in October, the Air Force had begun flight tests of a new antenna that trails behind the E-4B.

"One of the challenges we've met is when a system comes onboard faster than we are trained to [maintain] it," he said. That's part of why the squadron retains such a large number of communication and navigation specialists — to allow the squadron to constantly cycle maintainers through training.

"We've done a pretty good job with that," he said.

https://www.defensenews.com/air/2019/10/31/maintainers-under-pressure-to-keep-doomsday-plane-flying-after-flood-wreaks-havoc-do-not-post/

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National Defense (Arlington, Va.)

JUST IN: Department of Energy Not Studying Nuclear-Armed Hypersonic Weapons

By Connie Lee

Nov. 7, 2019

Although hypersonic missiles are a top modernization priority for the Pentagon, there are no efforts underway to arm such weapons with nuclear warheads, according to a Department of Energy leader.

"We are currently not undertaking a nuclear hypersonic [project], unlike other nations," Lisa Gordon-Hagerty, undersecretary of energy for nuclear security, told reporters Nov. 7 in Washington, D.C. Gordon-Hagerty also serves as the administrator for the National Nuclear Security Administration, which is responsible for maintaining and overseeing the U.S. nuclear weapons stockpile.

To counter great power competitors such as Russia and China, the Defense Department has marked hypersonic weapons as its No. 1 research-and-development priority. The systems will be capable of traveling at speeds of Mach 5 or faster and be highly maneuverable, making them difficult for enemy air-and-missile defenses to defeat.

Beijing and Moscow have publicly stated their intentions to field these types of weapons and are ramping up their R&D efforts. But unlike the United States, both governments have acknowledged that they are pursuing hypersonic missiles that are nuclear-capable. For example, Russian state media such as Sputnik News has reported that Moscow's Kinzhal air-launched missile system is able to carry both nuclear and conventional warheads. The Congressional Research Service has noted that Russia and China may field an operational hypersonic glide vehicle by 2020.

Gordon-Hagerty said the National Nuclear Security Administration has no current studies underway to examine the possibility of adding nuclear payloads to U.S. hypersonics.

"We were studying it in the '80s and in the past," she said. "There's not a current study."

Because the United States is focusing on conventional payloads, its weapons will need to have "greater accuracy and will be more technically challenging to develop than nuclear-armed Chinese and Russian systems," CRS stated in its September report, "Hypersonic Weapons: Background and Issues for Congress."

Multiple hypersonic weapons development efforts are underway, such as an Army experimental prototyping effort and the Defense Advanced Research Projects Agency's tactical boost-glide system.

Meanwhile, the NNSA is modifying and reusing materials from its current nuclear weapons stockpile, which is aging, she noted.

“We are not building new nuclear weapons,” she said. “We're coming into the 21st century."

Nuclear warheads that were designed to be in the inventory for 15 to 20 years now will have life extensions to keep them viable for decades to come, she noted. The NNSA has completed the life extension of the Navy’s W76-1, which was originally introduced in the 1970s and designed to be integrated with a submarine-launched ballistic missile system.

The administration has also started the W76-2 life-extension program, she noted.

“We will now extend that for another 20 to 50 years in the stockpile,” Gordon-Hagerty said. “We undertook that program within a year of when the president directed us to do so.”

https://www.nationaldefensemagazine.org/articles/2019/11/7/doe-official-say-us-is-not-pursuing-nuclear-hypersonic-weapons

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US COUNTER-WMD

Dallas Business Journal (Dallas, Texas)

DFW Defense Contractor Conducts Successful Test of Missile Defense System

By Evan Hoopfer

Nov. 14, 2019

A key missile defense system made by Lockheed Martin completed a successful test last week, the company said.

The Missiles and Fire Control division of Lockheed Martin, which employs thousands in Grand Prairie, said PAC-3 Cost Reduction Initiative interceptors successfully intercepted two ballistic missile targets during a test at White Sands Missile Range in New Mexico.

The tests support the ongoing program that ensures PAC-3 interceptors' reliability and readiness. This particular test marked the 12th and 13th successful intercept tests in the last seven years, the company said. The test was observed by members of the U.S. Army and foreign military customers of the system.

"Today's global security environment demands reliable solutions," said Jay Pitman, vice president of PAC-3 programs at Lockheed Martin MFC, in a prepared statement. "We expect PAC-3 interceptors to continue serving as an essential element in integrated, layered defense systems."

PAC-3 interceptors feature an uncommon characteristic in that they use 'hit to kill' technology. This means instead of exploding near an incoming missile to stop it from advancing, it makes contact with the missile. Lockheed Martin said 14 nations have procured the missile defense technology.

The PAC-3 missile interceptors are a key product for MFC, which has been the fastest-growing portion of Lockheed Martin for several quarters now.

During the last four quarters, MFC has grown net sales by an average of nearly 23 percent. No other Lockheed Martin division – including Fort Worth-based Aeronautics, the company's largest unit – has grown more than 12 percent in the same time period.

https://www.bizjournals.com/dallas/news/2019/11/14/lockheed-martin-missiles-and-fire-control.html

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US ARMS CONTROL

VOA (Washington, D.C.)

European Signatories Call on Iran to Reverse Actions against Nuclear Deal

By VOA News

Nov. 12, 2019

France, Germany, Britain and the European Union say they are "extremely concerned" about Iran's renewed uranium enrichment activities and what they call "regrettable acceleration of Iran's disengagement" from commitments it made under the 2015 agreement regarding the country's nuclear program.

In a joint statement released Monday, the foreign ministers urged Iran to reverse all of the measures it has taken that go against those imposed in the Joint Comprehensive Plan of Action, which limited Iran's nuclear activity in exchange for sanctions relief.

Iran has restarted enrichment at its Fordow facility, exceeded limits on enrichment levels and the amount of enriched material it is allowed to stockpile, while also announcing work on developing more advanced centrifuges. Iranian President Hassan Rouhani said the steps are reversible if the other signatories to the agreement help Iran work around U.S. sanctions.

In their statement, France, Germany Britain and the EU said their side has "fully upheld" their commitments under the agreement, including lifting the sanctions they had imposed over concerns Iran was working to develop nuclear weapons. Iran says its nuclear program is only for peaceful purposes.

"It is now critical that Iran upholds its JCPOA commitments and works with all JCPOA participants to de-escalate tensions," the statement said.

Iranian Foreign Minister Mohammad Javad Zarif rejected the ministers' characterization of compliance with the agreement.

"'Fully upheld commitments under JCPOA' YOU? Really?" he wrote Tuesday on Twitter. "Just show ONE that you've upheld in the last 18 months."

The deal originally also included China, Russia and the United States. U.S. President Donald Trump withdrew from the agreement last year.

Also Monday, the U.N.'s nuclear monitor said uranium particles have been detected at an undeclared nuclear site in Iran.

In a confidential report obtained by news agencies, the International Atomic Energy Agency (IAEA) confirmed that manmade uranium particles had been discovered, without revealing the location of the undeclared site.

The report also confirmed that Iran is enriching uranium at its underground Fordow facility — a site where, under the 2015 nuclear deal with world powers, it had agreed not to carry out any enrichment or enrichment-related research.

Over the weekend, Iran began pouring concrete for a second nuclear reactor at its Bushehr power plant, which is monitored by the IAEA.

Iran has said it intends to enrich uranium to 4.5%, slightly above the 3.67% limit allowed under 2015 deal. Enriching to 4.5% is far below the level needed to make a nuclear weapon.

https://www.voanews.com/middle-east/european-signatories-call-iran-reverse-actions-against-nuclear-deal

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Defense News (Washington, D.C.)

Is The US about to Test a New Ballistic Missile?

By Aaron Mehta

Nov. 13, 2019

WASHINGTON — The U.S. may be set to test a new ground-launched ballistic missile in the coming weeks, the first test of that particular weapon since the country withdrew from the Intermediate-Range Nuclear Forces Treaty earlier this year.

In March, Pentagon officials told reporters that they intend to test an intermediate range ballistic missile in the November time frame. At the annual Defense News Conference in September, Robert Soofer, deputy assistant secretary of defense for policy for nuclear and missile defense, confirmed that the Pentagon is roughly on track for that test.

“I do believe it is still the plan to conduct a ballistic missile test before the end of the year," he said then.

Asked about Soofer’s comments and whether those tests are still planned, Pentagon spokesman Lt. Col. Robert Carver could not “confirm or deny a test will take place in November. I am unable to provide any details on testing dates, times or locations.”

The test, should it happen as planned, is expected to involve a ballistic missile with a potential range of roughly 3,000-4,000 kilometers. Pentagon officials previously speculated that any deployment of such a weapon, potentially to Guam, would not be likely for at least five years.

The United States exited the INF Treaty on Aug. 2, following through on a decision made late last year that the agreement no longer benefited American interests. The INF Treaty was a 1987 pact with the former Soviet Union that banned ground-launched nuclear and conventional ballistic and cruise missiles with ranges of 500 to 5,000 kilometers. However, the United States and NATO allies have for years declared Russia in violation of the agreement. Russia has denied those accusations.

American officials have stressed they do not plan to build nuclear-capable systems that would have busted the INF Treaty’s limits, but Defense Secretary Mark Esper said his department will “fully pursue the development of these ground-launched conventional missiles as a prudent response to Russia’s actions and as part of the joint force’s broader portfolio of conventional strike options.”

Among arms control advocates, the idea of post-INF weapons are worrisome. Kingston Reif, of the Arms Control Association, said the pursuit of conventional ground-launched intermediate-range missiles is “militarily unnecessary, would force difficult and contentious conversations with and among allies, and likely would prompt Russia and China to take steps that would increase the threat to the United States and its allies.”

"A 3,000- to 4,000-kilometer-range ballistic missile would pose a much more direct threat to the Russian and Chinese homelands," Reif said. "It seems highly unlikely U.S. allies in Europe or Asia would host a missile that could strike deep into Russia and China in a matter of minutes. We could deploy such a missile in Guam, but their survivability wouldn't be assured there, thereby increasing crisis stability."

Tom Karako, of the Center for Strategic and International Studies, countered that the focus shouldn't be on the delivery system itself, nor if it could be done by an air- or sea-based system instead of by land.

"The better question is what posture and what cost-effective mix of capabilities can impose on our adversaries the most vexing set of problems, especially for their surveillance and targeting," he said. "Up against Russia and China, the benefits of ground-based strike systems need to be part of the conversation for answering that question."

The Pentagon is investing in several alternative ground-based systems, such a heavy focus on hypersonic weapons, including the Army's Long Range Hypersonic Weapon program. Investing in several options for that force posture mix is important, Karako said, so that the United States can avoid getting locked into one solution which, if countered, would leave the country vulnerable.

"We can't afford a force structure composed of a small number of silver bullets. It makes good sense to pursue a variety of delivery systems, trajectories, ranges, velocities, propulsion types and basing domains to support broad defense and deterrence goals," he said. "The future form of future strike will almost surely include a mix of UAVs, cruise missiles, ballistics and hypersonic glide vehicles. An IRBM for ourselves and our friends may well have a place in that mix."

Just what the test might look like is unknown at this time. Something like a land-based version of the Standard Missile-3 Block IIA, usually launched from a ship or during the first stage of an ICBM, would fit the rough range target. Another potential option might be modifying and launching a ground-based interceptor, part of the missile defense network; going down that path, Reif warned, would "raise all sorts of complications," as that system was meant to solely serve a defensive purpose.

A cruise missile test in August involved a variant of the Tomahawk land-attack weapon launched from a Mark 41 Vertical Launch System. While the Mark 41 is the same launcher used in the Aegis Ashore missile defense system, the Pentagon said at the time that this was a different variation on the Mark 41 and does not mean that Aegis Ashore could be turned into an offensive capability — something Russia has long claimed in objecting to Aegis basing in Europe.

https://www.defensenews.com/space/2019/11/13/is-the-us-about-to-test-a-new-ballistic-missile/

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Princeton University (Princeton, N.J.)

Nuclear Warheads? This Robot Can Find Them

By John Greenwald and Jeanne Jackson DeVoe, Princeton Plasma Physics Laboratory

Nov. 12, 2019

The detection of neutrons from a radioactive element in the PPPL test capped a two-year project funded by the U.S. Department of State that also contributes to the DOE's Consortium on Verification Technology. The remotely controlled prototype sets the stage for further development of a mobile and fully autonomous swarm. "The demonstration gave total confirmation of the ability of the robot to detect the source of neutrons and provided beautiful data," said PPPL physicist Rob Goldston, a Princeton professor of astrophysical sciences and a principal investigator on the project.

'Everything excellent and promising'

Co-principal investigator Alex Glaser, an associate professor of mechanical and aerospace engineering and international affairs who is co-director of the Princeton Program on Science and Global Security, was equally effusive. "Everything we saw looks excellent and very promising," he said. "PPPL provided great support for this project."

The now-calibrated "inspector bot" consists of a cylinder of polyethylene plastic containing three neutron counters set 120 degrees apart and mounted on a robot with specialized wheels that enable it to move in any direction. The detectors, designed by Goldston and Moritz Kütt, a former postdoctoral Princeton researcher, provides both high sensitivity to the energy of detected neutrons and the direction from which neutrons are coming. Low energy could indicate shielding.

When fully developed the robot could become part of a swarm of devices that carry out inspection tasks in different types of facilities. Proposed applications could include:

• Safeguarding gas centrifuge enrichment plants, facilities that enrich uranium to fuel nuclear power stations. Such plants feed a gaseous form of uranium through centrifuges that upgrade it for later conversion to powder and insertion in fuel rods. Inspector bots could be used to detect undeclared withdrawal of highly enriched uranium from a fraction of the plant diverted to this undeclared use;

• The bots could further detect introduction of low-enriched, rather than natural, uranium into a slightly modified enrichment plant to produce weapons-grade uranium;

• The swarm could also contribute to future disarmament treaties through tasks such as inspecting storage facilities that hold nuclear warheads in preparation for dismantling. The bots could detect whether warheads were actually there and whether the declared number of weapons was correct. They could also be used to determine that declared non-nuclear military facilities do not contain nuclear materials.

Machine learning software

The next step in development includes design of machine learning software to guide the robots, and technology to enable the robots to communicate with one another during inspections. The artificial intelligence (AI) system, led by principal investigator Naomi Leonard, the Edwin S. Wilsey Professor of Mechanical and Aerospace Engineering at Princeton, employs what is called the multi-armed bandit approach — a statistical system named for getting the best results from a series of slot machines. The key challenge in looking for undeclared activities is to make a wise selection between continuing to explore versus stopping to exploit small signals that could be indicative of misbehavior.

The idea for the project dates back to 2014 when Goldston and Mark Walker, then a graduate student in science, technology and environmental policy, heard about another laboratory that installed a ceiling with neutron detectors that all went off when a truck carrying uranium gas for enrichment went by. That led to talk of a robot detection system. "I said, 'what about a robot?'" Goldston recalled, and Walker said, "what about a robot, that sounds crazy!"

But Goldston was encouraged to explore this option in discussions with International Atomic Energy Agency (IAEA) inspectors and plant operators. Glaser submitted a proposal to the U.S. Department of State with a subcontract for PPPL to construct and calibrate a single inspector bot, which is what the team has achieved.

High gear

The project swung into high gear last summer. Harry Fetsch, a physics student at Harvey Mudd College in the Science Undergraduate Laboratory Internship (SULI) at PPPL, ran thousands of computer hours to simulate the detection system. "These simulations informed the design of the experiments we conducted," Glaser said.

Goldston now plans to visit the DOE's Savannah River Site nuclear fuel fabrication plant to explore the possibility of testing the inspector bot in a facility where the output from enrichment plants goes. "We want to see if we can measure the neutrons coming out of the autoclaves," he said of devices used to heat uranium to send it into the fabrication plant.

With further development, the project could demonstrate "that simple and robust autonomous, mobile, directionally and spectrally sensitive neutron detectors could provide a cost-effective means to provide effective and efficient verification," Goldston said.

Support for this work comes from the National Nuclear Security Administration, a semi-autonomous agency within the DOE, and the U.S. Department of State Key Verification Fund. Simulations were performed on the high-performance computer cluster at Princeton University.

PPPL, on Princeton University's Forrestal Campus in Plainsboro, New Jersey, is devoted to creating new knowledge about the physics of plasmas — ultra-hot, charged gases — and to developing practical solutions for the creation of fusion energy. PPPL is managed by the University for the U.S. Department of Energy's Office of Science, which is the single largest supporter of basic research in the physical sciences in the United States and is working to address some of the most pressing challenges of our time.

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COMMENTARY

War on the Rocks (Washington, D.C.)

Hypersonic Weapons: Tactical Uses and Strategic Goals

By Alan Cummings

Nov. 12, 2019

Hypersonic flight is not new. The V-2 rocket and the vast majority of the ballistic missiles that it inspired achieved hypersonic speeds (i.e., speeds faster than the speed of sound or Mach 5+) as they fell from the sky, as did crewed aircraft like the rocket-powered X-15. Rather than speed, today's renewed attention to hypersonic weapons owes to developments that enable controlled flight. These new systems have two sub-varieties: hypersonic glide vehicles and hypersonic cruise missiles. Glide vehicles are the cousins of ballistic warheads: they are lofted on high velocity boosters, separate, then use momentum and control surfaces to skip and glide through the upper atmosphere before crashing onto their targets. The cruise missiles use an advanced propulsion system (a SCRAMJET) for powered flight. While the descriptions are straightforward, the engineering needed to accomplish the guidance and maneuvering (not to mention survivability) of these weapons is far from clear.

Are these weapons and their employment simply an evolution of existing missiles? Or a revolution that threatens to upset the balance of power? The answer still depends on decisions yet to be made. Russia appears closest to fielding hypersonic missiles, as it aspires to deploy the Avangard glide vehicle before the year is out. The United States has ambitious goals for accuracy and precision, but its most viable programs are not expected to reach operational capability until 2022. Meanwhile, China has been characteristically vague on their hypersonic weapons while still letting it be known that they are firmly committed to their development.

For now, it seems hypersonic weapons' predominant value is to give user countries a Clausewitzian capability (i.e., reaching a limited culminating point of victory quickly and decisively) in support of a Sun Tzu-inspired strategy (i.e., to win without fighting).

A trio of questions needs to be considered: What audience can hypersonic weapons be leveraged against, what tactical utility do they provide, and what strategic objectives can be advanced by using them or threatening to use them? Framing the discussion in this way is useful for delving deeper into why nations are pursuing hypersonic weapons as well as making initial assessments on how they may be operationalized. The propositions below are not exhaustive; they are meant to provoke discussion. They pair a particular application with a particular country, but there is nothing stopping Russia, China, or the United States from taking advantage of any application discussed below.

Russia: Imposing Costs to Discredit NATO

Russian hypersonic weapon capabilities are addressed principally to two audiences: the West (especially NATO) and Russia's peripheral nations like Finland, the Baltics, Ukraine, and Georgia. Living under the hypersonic gun makes locations in western Europe as vulnerable to strikes initiated from within Russian territory as the Baltics, Ukraine, and Georgia have been in the sub-sonic age. Consider that Russia's sub-sonic Kalibr cruise missile, if launched from the Gulf of Finland, could range any country on Russia's western border and would take about two hours to hit Sofia Bulgaria, 1,200 miles to the south. An air-launched Kinzhal hypersonic glide vehicle traveling Mach 10 could hit Sofia in 11 minutes from the same location. Re-orienting the firing line to Russia's

western borders, a Kinzhal could reach London, Paris, or Rome equally quickly. To put it another way, hypersonic weapons mean that a hypothetical target 1,200 miles away has the same opportunity for warning as those within roughly 100 miles of a subsonic cruise missile. The Mach 20 Avangard expands the threat umbrella to cover ranges reportedly in excess of 3,700 miles with a flight time of around 20 minutes.

Up until now, the West has been fairly confident that their collective intelligence capabilities would alert them to limited Russian aggression. Even if insufficient to fully interdict a Russian move, it was understood that distance equates to time and thus warning. Russian hypersonic weapons offer a novel way to overcome the tactical depth — the idea of where one's vulnerabilities lie, where those vulnerabilities can be exploited from, and how quickly effects can be inflicted — implicit in European defense thinking. Countries in the Russian periphery feel the loss of depth in a different way: they are now quickly reachable from a vastly increased number of firing locations. For example, sub-sonic munitions would take about 15 minutes to hit Donetsk from the Russian border. Hypersonic weapons with the same flight time could now reach Donetsk from as far away as central (Kinzhal) or eastern (Avangard) Russia.

This makes hypersonic weapons a helpful tool for a fait accompli, a move so decisive (perhaps unexpected) that it instantly achieves the Clausewitzian "culminating point of victory" against opposition that is either unable or unwilling to fight back. A robust hypersonic weapons capability would help Russia quickly seize the initiative in escalating from rhetoric to kinetic action, quickly inflicting damage using units that are well-dispersed and may appear unrelated to each other or to the conflict. Alternatively, the same capabilities can be used to strike targets meant to deter Western leaders from a forceful intervention. A single hypersonic weapon targeting an outlying military airfield may be enough of a "pressure point" to warn without provoking, or without cornering political leaders to respond in kind.

However, combat is not the Kremlin's immediate application for hypersonic weapons in Europe. It is to reinforce the most salient message that Russia hopes to send: NATO cannot protect you. This message preys on the fears of countries who rely on NATO as the guarantor of sovereignty and security norms within the Russian shadow. By showcasing capabilities — as it did in Syria with the use of a Kalibr cruise missile in 2015 — Moscow seeks to simultaneously discredit NATO's security guarantees and coerce deference from its periphery. By emphasizing NATO's physical and psychological vulnerability, Moscow hopes to deter the alliance from confronting Russian aggression. These threats are magnified by the added prospect of nuclear capability, supported by Russian doctrine for the use of low-yield weapons in a regional conflict, which further emboldens Russian aggression. It's worth noting that there is real debate on the credibility of Russia's so-called "escalate to de-escalate" strategy — a misnomer that should be corrected to "escalate to win" or "escalation control." It does, however, illustrate Moscow's willingness to wager a great deal while leaving its adversaries to call the bluff. Real or imagined, Russian hypersonic weapons increase the cost to NATO in organizing a combat response to Russian grey zone aggression.

China: Ambiguous Capabilities, Clear Objectives

The state of China's hypersonic missile program is unclear. What's obvious is that the audience for China's hypersonic weapons is first and foremost the United States, who Beijing seeks to deter from interfering in portions of the Western Pacific that it sees as a privileged sphere of influence. Second are nearby nations and targets of periodic Chinese intimidation — specifically Japan, the Philippines, and Vietnam. Given the maritime nature of China's near abroad, synchronizing kinetic strikes becomes especially relevant and obviates a key reason that militaries historically seized terrain — to ensure that firepower could be leveraged en masse against priority targets.

A hypersonic capability affords Beijing more options for simultaneously striking ships at sea, forces ashore, and command functions using a force posture that appears deceivingly routine. Distance-wise, Chinese weapons can already reach the ranges in question. However, to achieve simultaneous effects with existing subsonic capabilities, China must either forward deploy its missile systems or stagger launches. Either approach would complicate the achievement of a fait accompli by increasing Chinese forces' vulnerable to enemy counterbattery strikes or affording unstruck targets greater opportunity to defend or disperse.

If launched concurrently, a Chinese YJ-83 cruise missile traveling 0.9 Mach would hit its target 100 miles away at the same time a DF-17 hypersonic glide vehicle going Mach 15 hit its target at 1,500 miles. That flight time is just under nine minutes. This means that Chinese forces can position their launchers to impose near-instantaneous strikes anywhere within the first island chain that stretches from Japan through the South China Sea before hooking into Vietnam, as well as much of the second island chain reaching out toward Guam and the Marianas. Weapons launched from Chinese warships and shore batteries could be synchronized to simultaneously cripple U.S. naval assets in the South China Sea, air and amphibious forces on Okinawa, and 7th Fleet Headquarters in Sasebo. While the threat of hypersonic weapons to high value targets like aircraft carriers is concerning, the deeper problem is an improved Chinese ability to hit those high value targets as well as other units simultaneously and with very little warning.

China is probably not preparing this kind of surprise attack — for now. Similar to Russia, China would rather use these weapons to demonstrate backyard dominance without resorting to war. They want the United States to conclude that the benefits to maintaining its regional interests are not worth the costs of armed confrontation. Countries near China are unlikely to conclude that their individual cost-benefit calculations are any better. Indeed, they are much worse given Beijing's added economic leverage.

The possibility of China developing intercontinental hypersonic weapons with nuclear warheads hints at a further strategic use: to impose mutual vulnerability on the United States. Chinese defense planners may see their relatively small nuclear stockpile as vulnerable to a catastrophic first strike. In their nightmares, whatever does survive a first strike could plausibly be intercepted by U.S. ballistic missile defenses, if not now then in the future as defense systems mature. A Chinese nuclear-capable hypersonic weapon thus guarantees mutual vulnerability as a de facto state of affairs between Washington and Beijing. They accept that the United States could deliver overwhelming nuclear force through its strategic triad, and Washington would have no choice but to concede to the practical inability to defend against nuclear-armed hypersonic weapons. Beijing may see this as stabilizing to American-Chinese relations, and certainly would view it as enhancing the credibility of their nuclear deterrent. In doing so, China may perceive further freedom of action versus a United States unwilling to jeopardize nuclear stability over Chinese sovereignty assertions.

United States: Deter Adversaries and Reassure Allies

The majority of defense messaging from Washington can be put in one of two categories: deterring adversaries (especially China and Russia), or reassuring allies (especially the ones confronted by China or Russia). The discussion of hypersonic weapons is no different as the US seeks to navigate competitive great power ties and safeguard the regional allies and partners who provide a key competitive advantage.

To begin with, hypersonic combat capabilities like those already mentioned would also accrue to the United States. A Mach 8 weapon fired from the North Sea could strike military bases 700 miles away in the Kaliningrad oblast within nine minutes. Likewise, hypersonic weapons can enable synchronized fires against Chinese forces from allied platforms deployed in the first and second island chains. The characteristics that make these weapons useful to U.S. adversaries for seizing the

initiative in an offensive action are also useful to the United States and its allies for stalling their momentum with equally rapid and injurious counterattacks.

But the United States has an added opportunity: deploying hypersonic missiles overseas to signal interest and resolve. The U.S. systems that media reports portray as closest to being operational — like the Air Force's Air-launched Rapid Response Weapon or the Army's Advanced Hypersonics Weapon — have theater-level ranges, meaning they will have to be sent to the region beforehand. Since the number of weapons initially available will likely be limited, it makes them all the more potent in illustrating U.S. priorities on interests and redlines. That also makes them useful for diplomatic leverage; a stick for our adversaries and a carrot for our allies. There is of course concern that allies may be unwilling to host these weapons for fear of inviting unwanted attention domestically and from Russia or China. It stands to reason then that low-visibility deployments to existing bases may be beneficial, as well as developing systems that are easily surged and recovered such as High Mobility Artillery Rocket Systems (HIMARS) or ship-based weapons. If developed wisely, these weapons offer a new coin to be used for conventional deterrence and assurance.

Second, a hypersonic weapons program can be used as leverage in pursuing arms control agreements beneficial to the security of the United States and its allies. This would be broadly analogous to the Pershing II missiles which played a central role in the negotiations that led to the Intermediate Range Nuclear Forces Treaty. Hypersonic weapons could serve a similar purpose today in tamping the threats posed by Russian and Chinese weapons or in trade for other strategic interests. It is important to note that to negotiate from a position of strength, the United States would be best served by successfully developing and deploying the same capabilities that it would like to limit; only then will adversaries be forced to consider the negotiations seriously.

Third, hypersonic weapons may provide new response options in the face of adversary counterspace actions. It is near-common knowledge that the United States is disproportionately reliant on space-based assets to enable functions like surveillance, communication, and precision navigation. Accordingly, the United States is especially wary of adversary capabilities that jeopardize those assets. First, a rapid strike capability may allow U.S. forces to disable command uplinks to the anti-satellite weapon before it achieves its effect, especially those targeting higher orbits or designed for co-orbital rendezvous/collision. Second, given the prospect of losing some space-based capability, the short flight times of hypersonic weapons give the United States an option to inflict damage before its own space-based enabler is lost. Both options support a plausible response to anti-space attacks which, if signaled to the adversary, can deter anti-satellite launches in the first place.

An alternative contribution may be ascent-phase ballistic missile defense. The need to put an interceptor in close proximity to the launch site is a recurring challenge with ascent-phase targeting. However, because hypersonic weapons compress the time/speed/distance relationships while also flying at high altitudes, they may be well-suited to this role. Hypersonic cruise missiles would be particularly useful since their powered flight would facilitate maneuvering and are easier to deploy on high mobility platforms like ships and aircraft. Hypersonic weapons may still not be responsive enough for completely unexpected launches, but launch cueing and robust detection capabilities could provide enough of an edge.

Broader Implications

Whether evolution or revolution, and whether used to make or deter war, hypersonic weapons will bring change. Skeptics could reasonably cite historical revolutions in the speed and reach of war like the advent of military aviation in 1909 or subsonic missiles in the 1950s which also reduced tactical depth and were eventually overcome. The difference is that aircraft and subsonic cruise missiles still traveled for hours to reach distant targets. The vulnerability they imposed was

contingent on poor detection capabilities that eventually improved and restored a sense of depth. There is nothing that makes hypersonic weapons inherently undetectable or un-interceptable; yet, even when that becomes technologically possible, the speed of hypersonic weapons increases the distances for which detection is largely moot. Consider a response that requires at least five minutes to implement or launch. For a subsonic weapon to beat that reaction time, it has to be fired from roughly 60 miles away. For a hypersonic weapon flying at Mach 10 to beat that same reaction, it can be fired from around 570 miles. What hope such systems offer would rely on a perfect sequence of instantaneous detection, flawless communication, and immediate response.

Advancements in hypersonic weapons will also motivate developments in other technologies. Space-based defenses may take better advantage of limited flight time, but the formal weaponization of space (despite decades of avoidance) may invite a proliferation of counter-space weapons that jeopardize other interests. The short warning times may eventually incentivize automated interceptor systems to a degree not previously acceptable, up to and including firing without human approval. Confronted with exceptionally challenging post-launch problems, these weapons may increase the attractiveness of pre-emptive attacks to make sure they are neutralized prior to larger hostilities. Finally, Russia or China could line their own pockets by selling export versions of these systems to current customers like India, Iran, Syria, or Turkey and gain the added benefit of complicating the United States' strategic landscape. Perhaps most concerning would be the sale (real or apparent) of a limited quantity of hypersonic weapons to a Western Hemisphere nation like Venezuela or Cuba. While it may not seem economically feasible at first, Russia or China may one day find strategic value in making whatever arrangements necessary to put their weapons on America's doorstep.

Hypersonic Weapons Alone Are Not the Challenge

Hypersonic weapons may lead to a revolution in warfighting if countries produce them at scale. Mass production and deployment of reliable designs would mean that these weapons are no longer a niche capability targeted against a limited number of valuable targets. Rather, inflicting near-instantaneous effects over a multitude of primary and secondary targets could help realize current fears of increased crisis pressures and faster escalation dynamics. In fewer numbers, there may be evolutionary changes at the tactical and operational levels of war without drastically threatening the strategic balance of peer adversaries. In this case, they may herald another iteration of stability-instability dynamics, where states take advantage of high-end warfighting capabilities to enable grey zone aggression. Whether revolution or evolution, hypersonic weapons alone are not the challenge. They will contribute to a 21st-century combined arms dilemma that includes other new technology like cyber activities, advanced anti-submarine warfare, and space operations as well as traditional, but indispensable, maneuver forces like infantry battalions, warships, and air superiority fighters.

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(This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or Lawrence Livermore National Security, LLC. LLNL-JRNL-786217.)

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Defense One (Washington, D.C.)

The Cold War Ended 30 Years Ago. Why Are Things with Russia So Bad?

By Tom Z. Collina

Nov. 9, 2019

On Nov. 9, 1989, the Berlin Wall finally cracked. East and West Germans, together, began to tear down the wall in a peaceful act that came to symbolize the end of the Cold War. No one predicted it. Amazingly, no one stopped it, even those who had the most to lose—like the Soviets and their pioneering leader Mikhail Gorbachev. Two years later, the Soviet Union was gone.

Back then, hopes were high for a huge "peace dividend" that would take U.S. defense dollars formerly aimed at the Soviet threat and spend them on domestic needs. Others expected that nuclear arsenals would decline to zero as the arms race shifted into reverse. With Soviet ideology and society in tatters and the Warsaw Pact defunct, what were the weapons for anymore? Gorbachev said in December 1991, as the hammer and sickle was lowered for the last time from the Kremlin, "The threat of world war is no more." Weeks later, President George H.W. Bush offered a more triumphalist, and in retrospect troubling, take: "The biggest thing that has happened in the world in my life, in our lives, is this: By the grace of God, America won the Cold War."

Fast forward to today. U.S.-Russian relations are at an all-time low, and defense budgets are at all-time highs. The United States and Russia are undermining nuclear arms control treaties such as INF and New START, and spending trillions of dollars to rebuild their strategic arsenals. We are back in a nuclear arms race.

What happened? How did we manage to squander such a rare opportunity to build a new partnership with Moscow?

The tragic collapse of U.S.-Russian relations over the last 30 years has many causes, but one stands out for breaking a fragile trust and steering a potentially cooperative relationship back to competition. On this crucial issue, the United States refused to lend a hand to a struggling Russia, and instead kicked it when it was down.

What was this issue? The expansion of NATO.

In 1996, the Clinton administration decided to invite former Soviet allies Poland, Hungary, and the Czech Republic into NATO, the military alliance formed to oppose the Soviet Union. To Russia, which had just peacefully dismantled an empire built at least in part to prevent yet another ruinous foreign invasion, this would be an encroachment into territory it still viewed as a security buffer of existential importance. Defense Secretary William Perry, who had been slowly building a positive relationship with Moscow, tried to stop the process from the inside but could not. The political momentum was too strong. President Bill Clinton and Vice President Al Gore believed they could manage the problems with Russia. They were wrong.

Many at the time knew this was an historic blunder. In an open letter to President Clinton, more than 40 foreign policy experts —Bill Bradley, Sam Nunn, Gary Hart, Paul Nitze, Robert McNamara, and more — decried NATO expansion as expensive and unnecessary. No one listened.

As Russia expert George Kennan said in 1998, "I think [NATO expansion] is the beginning of a new Cold War. I think the Russians will gradually react quite adversely and it will affect their policies. I think it is a tragic mistake."

"Don't people understand?" lamented Kennan, author of the Cold War doctrine of containment. "Our differences in the Cold War were with the Soviet Communist regime. And now we are turning our backs on the very people who mounted the greatest bloodless revolution in history to remove that Soviet regime."

As predicted, Russia saw NATO expansion as a threat. When the alliance added the Baltic states in 2004, Moscow viewed it as marching that threat up to its border. With a frightful lack of forethought, the United States and NATO essentially acted as if Moscow's concerns did not matter.

When President Obama came into office in 2009, he announced he would try to repair the damage and seek to "press the reset button" on U.S.-Russian relations. For a while it seemed to work, and President Dmitri Medvedev (who took over temporarily from President Vladimir Putin) had a more positive attitude toward Washington. During this brief opening, the New START treaty was signed in 2010. But then Medvedev stepped down to make way for Putin's return.

After Putin's re-election in 2012, U.S.-Russian relations went into free-fall. There were large demonstrations in Russia against Putin after the election, and he apparently believed they were organized and financed by the United States. When the new U.S. ambassador, Mike McFaul, arrived, some Moscow media reported that he was sent by Obama to help overthrow Putin.

By this time, Putin had decided to give up on the West. Instead, he would "make Russia great again," an appeal to Russian nationalism built on rhetoric that was anti-foreigners, but mostly anti-U.S. In 2014, Sochi hosted the Winter Olympics, an impressive event meant to show the world that Russia was back. (Russian athletes were discovered to have used illegal drugs, and were barred from the next Winter Games in South Korea.) Soon after, Russia began military operations in Crimea, and then moved troops into eastern Ukraine. As if to demonstrate its hostility and independence to Americans, the Russian government interfered in the 2016 U.S. presidential elections.

So here we are. What started as a promising courtship, with great potential to improve global security and reduce nuclear dangers, has now crashed into a wall. NATO expansion, compounded by NATO's anti-missile interceptor deployments on Russia's doorstep, played a key role. Together they were seen by Moscow as signs of encroachment and disrespect for Russia and its interests.

Gorbachev, now 88, said in a recent interview, "As long as weapons of mass destruction exist, nuclear weapons, the danger is colossal. All nations should declare, all nations, nuclear weapons must be destroyed. To save ourselves and our planet."

Presidents Trump and Putin are now moving in the opposite direction, rebuilding arsenals while destroying international controls. As we welcome the 30th anniversary of the Cold War's demise, we must learn from the mistakes that squandered such a golden opportunity. We must own the fact that after taming the Russian bear, we found it more convenient to have an adversary. Despite Bush's triumphalism, the United States did not win the Cold War. We both lost, and until we choose a different path we will keep losing.

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Bulletin of the Atomic Scientists (Chicago, Illinois)

The Death of the INF Treaty Has Lessons for Arms Control

By Amy J. Nelson

Nov. 4, 2019

The Intermediate-range Nuclear Forces (INF) Treaty's demise is well-documented: the United States formally withdrew from the treaty in August after Russia violated the treaty by developing, testing, and ultimately deploying intermediate-range missiles expressly prohibited by the treaty, and after the United States' own attempts at persuading Russia to come back into compliance failed. Despite the treaty's failure, there is much to be learned from its undoing, as well as from the current state of arms control.

It would benefit future leaders and arms control experts to keep three lessons in mind. Thanks in part to the INF's collapse, and in part to the experience of watching treaties weather and age in the decades after their implementation, we now know that: we should expect weapons technology to continually change—be it by gradual evolution (as in the case of the INF Treaty) or transformative innovation; treaties are likely to be violated in the course of their lifetime and, as such, verification regimes must be designed and implemented in a manner that anticipates this and is useful in managing violations for the treaty's entire lifespan; and agreements increasingly provide value—or security—as a function of the information they provide. The more access and information a treaty provides, the less likely states will be to withdraw. The INF Treaty lost this value when its verification provisions expired three years after entry into force. Equipped with these lessons, world leaders will be better prepared to think about how to bring the INF treaty—or some version of it—back.

Optimism for arms control. Most recent articles and speeches on arms control smack of nostalgia, teem with regret, or lament its state of crisis. Despite the current climate, however, we are actually in the fortunate position today of having decades of arms control history on which to draw, the benefit of evolving technologies that have already improved verification capacity, and a host of ideas ginned up by experts and analysts. Arms control as a security tool has good scaffolding, but the concepts we layer upon that scaffolding are in need of re-thinking.

No one knows this better than former NATO Deputy Secretary General Rose Gottemoeller. In a refreshing departure from the typical doom-and-gloom analysis, Gottemoeller recently gave a speech about NATO nuclear weapons policy in which she spoke with cautious, informed optimism about arms control in general, and about the idea of a follow-on agreement to the INF Treaty in particular.

In her speech, Gottemoeller highlighted in particular the concept of "the freedom to mix"—to set an absolute limit on missiles for each state, for example, and then allow states to decide which configuration of missiles they will retain toward that limit. This "flexibility" is a feature of the New START Treaty, which allows Russia and the United States to determine their own force structures within ceilings for delivery systems and warheads. The freedom to mix thus allows states to trade off the precision of apples-to-apples comparisons for flexibility and transparency—both of which ultimately stand to increase security and lower uncertainty.

The INF Treaty eliminated all missiles—whether tipped with conventional or nuclear warheads—from Europe entirely, and so lacked this kind of flexibility. Informal discussions in the United States following the ratification of New START examined, among other approaches, the idea of adopting a broadened freedom-to-mix concept as a way to address asymmetric nuclear capabilities that concerned each side. One idea was to set an aggregate ceiling for all residual US and Russian weapons and systems and allow each side to choose how many strategic and non-strategic assets to

retain under that ceiling. Given the diversity of capabilities generated by the United States, Russia, and China, further incorporation of such flexibility into future agreements stands to both facilitate the reaching of an agreement and to make any negotiated agreement more robust to violations. (Whether any such agreement increases co-signers' perception of their own security lays in the balance.)

Gottemoeller also pointed out that the same technology that permitted re-entry vehicle onsite inspection for New START could now be used to verify ground-launched intermediate-range missiles that specifically carry nuclear warheads. Technology to distinguish between intermediate and long-range delivery systems existed at the time the INF Treaty was negotiated, but technology to discern whether intermediate-range delivery systems had nuclear re-entry vehicles was not available. Given the availability of such technology today, the United States and Russia are in a unique position to limit nuclear-only capable missiles—or to "put the 'N' back in INF," as she suggested.

Lessons learned. Gottemoeller's ideas for an INF follow-on demonstrate a clear belief that arms control today needs to be more flexible and able to adapt to new technologies. As I have argued elsewhere with Dr. Justin V. Anderson, arms control agreements, particularly those without expiration provisions, must be crafted in a way that allows them to evolve. Treaties must be adapted to new weapons technologies throughout the course of their lifetimes. We should not only assume new weapons technologies will come into existence, but design agreements to have sufficient provisions and be rigorously maintained for adjusting to these developments.

Second, at the time the INF Treaty was negotiated, it is possible that agreeing to arms limitations with a previously untrusted adversary provided enough of an increase in security to warrant the legally binding agreement. It is also likely that once obstacles to reaching an agreement, including three years of verification through inspections, were overcome, the idea of violations decades into implementation were beyond the scope of imagination. We know now, however, that arms control treaties are likely to be violated and that standing consultative bodies can serve a vital role in managing and resolving violations and disputes from diverging interpretations. We also know that state-level mechanisms for managing arms control violations are not yet sufficient. There is a great deal more to be done here, namely in understanding and codifying varying degrees of violations and establishing responses that "kick in" almost automatically when a consultative body determines that a threshold has been crossed (much like the Joint Comprehensive Plan of Action's "snapback" sanctions).

Third, the INF Treaty's verification provisions for onsite inspections expired three years after the treaty's entry into force, though the agreement itself was designed to be of unlimited duration. As such, the INF treaty decreased in value as it ceased providing information. Our contemporary vantage point reveals that the evolution of arms control has occurred simultaneously—and not coincidentally—with technological strides that can enhance monitoring and verification abilities. As a function of perhaps necessity, design, and the availability of new technologies, arms control increasingly finds its value in the information it provides, not necessarily (or so much) in the limitations it sets. While the INF Treaty was the first to have onsite inspection regimes, the Joint Comprehensive Plan of Action has the most intrusive monitoring provisions of any agreement negotiated to date. Every time this verification bar is moved upward, treaties function better as a tool for increasing security, since offering states greater insight into the arsenals of their adversaries reduces uncertainty.

By highlighting the "freedom to mix" and the value of information from verification, Gottemoeller is, in effect, saying we would do well to broaden the reach and utility of our agreements by making them more flexible and increasing their capacity for providing security-useful information. If we

can succeed at this, arms control as a security tool will remain relevant to contemporary security concerns.

Looking ahead. More broadly, however, we will need to consider the value of individual arms control agreements on their own terms, as well as the broader benefits of agreements that may not be achieved all at once but, over time, are designed to work in concert with one another. Gottemoeller's proposal to negotiate a "nuclear-only" INF Treaty—one that explicitly bans nuclear-capable missies—that also includes China, Russia, and the United States adopts a path-of-least-resistance mentality that could reap benefits decades down the road. It may pave the way for future agreements that could, for example, place limitations on defensive systems or emerging technologies.

This comes with a caveat: if we pursue a nuclear-only agreement (and thus put the "N" back in INF), we will need to consider whether arms control treaties that govern nuclear weapons can remain an effective tool for achieving "strategic stability" given the dynamic, innovative, and uncertain security environment in which we now find ourselves. New destabilizing non-nuclear weapons and technologies stand to tip the balance of power and disrupt whatever equilibrium was achieved previously. Once upon a time, it was easier for the U.S. to adopt a policy of pursuing strategic stability—a balance of nuclear powers—in part through arms control, and the simultaneous development of "offsetting" conventional technologies (as in the Second Offset Strategy) because nuclear and conventional capabilities were, at least conceptually and with respect to potential for causing damage, confined to separate spheres. Today, however, it is not clear that the tension between this simultaneous pursuit of strategic stability and potentially destabilizing novel technologies will be as easily resolved (particularly as these newer technologies "get out"). Thus, the net benefit of a potential nuclear-only agreement may be somewhat diminished in its contribution to strategic stability, although could still serve as a stepping-stone to better times for diplomacy and increased trust.

The long history of arms control is now rich with data that can inform our path forward. A nuclear-only replacement agreement for the INF Treaty stands to provide, at a minimum, the short-term benefit of temporary stability. Any longer-term benefits require the negotiation of a treaty that is sufficiently flexible and dynamic, that anticipates violations, and that affords access to information valuable to security. For the United States, whoever is elected president in 2020 should proceed with this in mind.

The views expressed in this article are those of the author and are not an official policy or position of the National Defense University, the Department of Defense or the U.S. Government.

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ABOUT THE USAF CSDS

The USAF Counterproliferation Center (CPC) was established in 1998 at the direction of the Chief of Staff of the Air Force. Located at Maxwell AFB, this Center capitalizes on the resident expertise of Air University — while extending its reach far beyond — and influences a wide audience of leaders and policy makers. A memorandum of agreement between the Air Staff's Director for Nuclear and Counterproliferation (then AF/XON) and Air War College commandant established the initial personnel and responsibilities of the Center. This included integrating counterproliferation awareness into the curriculum and ongoing research at the Air University; establishing an information repository to promote research on counterproliferation and nonproliferation issues; and directing research on the various topics associated with counterproliferation and nonproliferation.

In 2008, the Secretary of Defense's Task Force on Nuclear Weapons Management recommended "Air Force personnel connected to the nuclear mission be required to take a professional military education (PME) course on national, defense, and Air Force concepts for deterrence and defense." This led to the addition of three teaching positions to the CPC in 2011 to enhance nuclear PME efforts. At the same time, the Air Force Nuclear Weapons Center, in coordination with the AF/A10 and Air Force Global Strike Command, established a series of courses at Kirtland AFB to provide professional continuing education (PCE) through the careers of those Air Force personnel working in or supporting the nuclear enterprise. This mission was transferred to the CPC in 2012, broadening its mandate to providing education and research on not just countering WMD but also nuclear operations issues. In April 2016, the nuclear PCE courses were transferred from the Air War College to the U.S. Air Force Institute for Technology.

In February 2014, the Center's name was changed to the Center for Unconventional Weapons Studies (CUWS) to reflect its broad coverage of unconventional weapons issues, both offensive and defensive, across the six joint operating concepts (deterrence operations, cooperative security, major combat operations, irregular warfare, stability operations, and homeland security). The term "unconventional weapons," currently defined as nuclear, biological, and chemical weapons, also includes the improvised use of chemical, biological, and radiological hazards. In May 2018, the name changed again to the Center for Strategic Deterrence Studies (CSDS) in recognition of senior Air Force interest in focusing on this vital national security topic.

The Center's military insignia displays the symbols of nuclear, biological, and chemical hazards. The arrows above the hazards represent the four aspects of counterproliferation — counterforce, active defense, passive defense, and consequence management. The Latin inscription "Armis Bella Venenis Geri" stands for "weapons of war involving poisons."