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Feature Report

"*What Provokes Putin's Russia? Deterring Without Unintended Escalation*". By Stephanie Pezard and Ashley L. Rhoades. Published by RAND Corporation; June 29, 2020

https://www.rand.org/pubs/perspectives/PE338.html

Deterrence presents an inherent dilemma: While it seeks to prevent aggression, a deterrent effort that is too heavy-handed or appears to represent an existential threat to the potential aggressor might prompt that precise response. In the context of North Atlantic Treaty Organization (NATO)–Russia relations, deterring without provoking requires an understanding of what Russia considers to be "redlines," defined as those triggers that Russian leadership claims cannot be crossed without provoking a major or hostile response on their part.

The authors of this Perspective provide a better understanding of what provokes Putin's Russia. They identify Russia's claimed redlines before examining those developments that prompted Russia to escalate a dispute in the past and comparing them with the identified redlines. Next, they analyze how current and future deterrence efforts on the part of the United States and NATO might collide with Russian stated interests and cross these redlines.

The authors find that predicting Russian reactions to U.S. and NATO movements is a challenging exercise, as some claimed redlines have proven not to be redlines at all, while in other cases, actions taken by the United States and its allies have triggered unexpectedly strong Russian responses. Overall, changes in force posture seem to hold the most potential for effective deterrence if carefully calibrated to minimize the risks of provoking Russia.

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NUCLEAR WEAPONS

Air Force Magazine (Arlington, Va.)

Global Strike Comfortable with GBSD under Sole Contractor

By Rachel S. Cohen

Feb. 4, 2020

VANDENBERG AIR FORCE BASE, CALIF.—Air Force Global Strike Command's No. 2 officer said his organization is comfortable with how the next-generation land-based nuclear missile program is progressing despite having only one company involved in the design competition.

"What we have seen so far is going in an incredible direction, regardless of if we had multiple competitors or not," Lt. Gen. Anthony Cotton, AFGSC's deputy commander and the Air Force's senior missileer, told reporters Feb. 3. "We're not seeing any concern to think that the vendor will try to do something that is out of faith for us. We're really comfortable in the … type of technologies that we've seen, the digital engineering that's being done, the reviews that are being done by the [system program office], and looking at the requirements and looking at what the contractor is going to provide us."

Last year, Boeing announced it would pull out of the Ground-Based Strategic Deterrent development effort, leaving Northrop Grumman as the sole option for providing one-third of America's nuclear triad. Lawmakers and others have expressed concern that move would drive up the cost in the multi-billion-dollar program, but the Air Force has carried on without making the changes Boeing wanted as a condition of its staying in the competition.

If having one contractor is causing problems, Cotton said, "You would have heard about it by now."

Officials argue certain aspects of GBSD, which weren't in play when the Air Force bought its current inventory of Minuteman III missiles, are shaping an affordable program without competition to push cost down. The Air Force plans to own more of the technical rights to its new missiles, letting it perform certain upgrades and maintenance itself instead of relying on contractors. Three-dimensional simulation and modeling are also opening new possibilities for the team to digitally vet its designs without spending as much money on prototyping materials.

USAF plans to buy more than 600 GBSD missiles and wants them to start arriving in silos in the northern U.S. in fiscal 2029.

As the nuclear enterprise further enters the digital age, Cotton said AFGSC has to consider the possibility that algorithms might replace some Airmen. Around 10,600 people currently work for 20th Air Force, the organization that oversees America's 400 deployed intercontinental ballistic missiles and related operations daily.

The Air Force is waiting on Northrop to decide how many people would need to run its system before reviewing manpower needs itself.

"That could be a possibility. We haven't gone down that path yet," he said of a smaller workforce. "How many people does it take to do a task today? And then how many people would it take to do a task tomorrow? We have to recognize that when we say there's efficiencies, you might see efficiencies in manpower as well."

https://www.airforcemag.com/global-strike-comfortable-with-gbsd-under-sole-contractor/

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Santa Fe New Mexican (Santa Fe, N.M.)

Trump to Request 20 Percent Boost in Nuclear Spending

By Scott Wyland

Jan. 31, 2020

President Donald Trump will request a 20 percent budget increase for the nation's nuclear programs next year, which likely would funnel more money toward pit production at Los Alamos National Laboratory and South Carolina's Savannah River Site, according to congressional sources and watchdog groups.

Trump is backing the National Nuclear Security Administration's $20 billion budget request for fiscal year 2021, a hefty bump from this year's $16.7 billion as the agency looks to fulfill the goal of producing 80-plus plutonium pits by 2030 to arm a new generation of missile warheads.

However, when the agency's head, Lisa Gordon-Hagerty, first proposed the beefier funding last week, the president, budget officials and Energy Secretary Dan Brouillette rejected it as too exorbitant and reduced it to $17.5 billion, according to Defense News.

The haggling took place ahead of the agency's scheduled release Feb. 10 of its fiscal year 2021 budget.

Sen. James Inhofe, R-Okla., a strong proponent of expanding U.S. nuclear capabilities, told reporters this week he and other lawmakers persuaded Trump the larger boost in funding was necessary to deter the rising nuclear threats from adversaries such as Russia and China.

Trump, in turn, overruled Brouillette and Mick Mulvaney, who heads the Office of Budget and Management, and will ask Congress to approve the higher spending.

Inhofe's office didn't respond Thursday to emailed questions. The offices of Sens. Tom Udall's and Martin Heinrich and U.S. Rep. Ben Ray Luján declined to comment on the proposed budget until the agency makes it public.

Nuclear watchdogs slammed what they say is excessive spending to launch a new nuclear arms race.

"We maintain a total nuclear weapons arsenal of some 4,000 active weapons," said Geoff Wilson, policy analyst at the nonprofit Center for Arms Control and Non-Proliferation, in an emailed statement. "Perhaps instead of doubling down on an outrageous new nuclear weapons spending plan, we should reengage in our commitments to reduce these weapons through international arms control agreements and treaties."

The Los Alamos lab received $253 million this year to work toward ramping up production of pits, the explosive nuclear cores that detonate warheads. The current goal is for the lab to make 30 of the pits by 2026.

Savannah River Site is slated to manufacture 50 pits by 2030, a more costly endeavor because it involves converting its stalled mixed-oxide fuel plant into a facility that makes weapons-grade plutonium cores. It received almost double the Los Alamos lab's allocation.

Critics say the federal government is throwing more money at two ill-equipped sites with the hope of making them churn out nuclear cores.

The agency's fatter budget would no doubt inject significantly more funding into the lab's pit production, perhaps more than the plutonium operation — with aging facilities and a history of

safety problems — can handle, said Greg Mello, executive director of the nonprofit Los Alamos Study Group.

"It's a staggering increase that the lab can't absorb," Mello said.

Mello, who has tracked the agency's funding for decades, said last year's 11 percent budget increase well surpassed the single-digit increases that were typical in previous years. The current proposal almost doubles that sizable budget hike, he said.

Modernizing the nuclear arsenal will cost about $1.2 trillion over the next 30 years, according to Congressional Budget Office estimates.

The government would not need to spend billions of dollars to produce new pits and could instead use the thousands of pits amassed during the Cold War if it wasn't developing new warheads that require a different sized core, Mello said.

One such warhead is the W87-1, which would be part of a new generation of intercontinental ballistic missiles.

"Will the production of a new warhead necessitate new explosive nuclear testing?" Wilson said. "The further we stray from existing warhead designs, the higher the likelihood that calls for explosive testing will resume."

https://www.santafenewmexican.com/news/local_news/trump-to-request-percent-boost-in-nuclear-spending/article_78133b58-439d-11ea-812e-2bb7452acec3.html

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National Defense (Arlington, Va.)

Military Facing Tight Deadlines to Modernize Nuclear Triad

By Yasmin Tadjdeh

Jan. 31, 2020

All three legs of the United States' nuclear triad are rapidly approaching the end of their planned service lives. Officials from both the Air Force and Navy are racing against tight schedules to bring new platforms online to replace them.

The triad is made up of land-based intercontinental ballistic missiles, long-range bombers and ballistic missile submarines. Legacy systems are reaching retirement age at the same time over the next decade or so. That has officials scrambling to ensure there is no lapse in coverage, particularly as the United States faces threats abroad.

"We go to great lengths to ensure that every one of those weapons systems, regardless of how old they may be or how long they've been in service, will always, always get the job done if ever called upon to do so," said Vice Adm. Dave Kriete, deputy commander of U.S. Strategic Command. "But we can't maintain those standards with the current weapon systems forever." Strategic Command, located at Offutt Air Force Base near Omaha, Nebraska, is in charge of the nation's nuclear forces.

Kriete noted that because of previous decisions, the Defense Department currently finds itself trying to replace several components of its aging nuclear deterrent at the same time.

"We haven't staggered them," he said during a panel discussion at a nuclear modernization seminar hosted by MITRE Corp. and George Washington University. That has presented a challenge to the military.

"We have an accumulated level of risk and we acknowledge that," he said in December.

The Navy is working to replace its Ohio-class submarines with new Columbia-class boomers. The Ohio originally had a service life of 30 years, but the sea service extended that to 42 years, which it will soon reach, said Vice Adm. Johnny Wolfe, director of strategic systems programs for the Navy.

The Columbia is the service's No. 1 acquisition priority and it plans to get the lead boat on patrol by 2031, he said. The Navy plans to buy 12 submarines.

While the program is funded and going well, it is also "line-on-line," he said.

"Every Ohio that we have to pull up, we will get a Columbia just in time," he said. "We pushed that modernization program as far as we can push it."

Wolfe declined to specify exactly how much slack the program has remaining but said there is still margin to get to first delivery on time.

In the meantime, the service must ensure that the Ohio-class is an effective nuclear deterrent.

"We continue to prove for Stratcom the reliability and the accuracy of that system," he said. It does so by conducting periodic missile launches at least four times a year to prove that the system works. In 2019, the Navy launched five missiles to test its capability.

"All five of those flew exactly like we wanted them to fly," Wolfe said. However, at least two of the missiles were the oldest the Ohio-class program has ever flown. "As these systems go to sea, we've got to start modernizing because we all know just from a materiel perspective, things will eventually age out."

The Air Force has responsibility for two legs of the nuclear triad: long-range bombers and land-based intercontinental ballistic missiles. The service is currently working on a program called the ground-based strategic deterrent, or GBSD, to replace its Minuteman III systems.

The ICBM leg of the triad is the most prompt and responsive, said Lt. Gen. Richard Clark, the service's deputy chief of staff for strategic deterrence and nuclear integration. The military has about 400 ICBMs that an adversary would have to take into account if it considered striking the United States.

"If you didn't have those 400 ICBMs that are ready to go at a moment's notice, you could actually cripple our nuclear enterprise with about 10 targets," he said. "You could take out our two sub bases, our three bomber bases, Stratcom, the Pentagon and our three labs ... at Los Alamos, at Sandia and at [Lawrence] Livermore."

However, the weapons are aging. The Minuteman III system is 39 years past its planned service life, he said.

"We've been able to sustain it and we're going to be able to sustain it until we bring GBSD" online, but the margin is very slim, Clark added. "That acquisition is going very well right now … but we have a long way to go and we have to stay consistent. We have to continue to be committed to this. And given the current budgetary situation that we're in, there's always going to be risks to it."

Both Boeing and Northrop Grumman were expected to compete for GBSD, but Boeing dropped out of the competition last year after indicating that it felt Northrop had an unfair advantage due to its better access to the solid rocket motor market through its acquisition of Orbital ATK, which could give it a cost advantage.

In December, the Air Force announced it had only received one bid for the program and would pursue a sole-source contract.

The Air Force is also working to refurbish its fleet of B-52 bombers that can carry nukes with new engines, radars and other systems, he added.

That will bring the platform into the 21st century and for some decades to come, he said. The bombers will also be coupled with the long-range standoff weapon, or LRSO, which will take the place of the air-launched cruise missile, or ALCM.

"ALCM is 25 years past its service life and we have issues with that from an availability [standpoint] as our stockpile drives down," Clark said. "From a reliability standpoint, it's very old and that reliability continues to go down, and from a survivability standpoint, the ALCM is losing some of that because our adversaries have developed air defenses that challenge" it.

The LRSO can also be coupled with a new bomber the Air Force is pursuing known as the B-21 Raider, which will replace the B-2, he said. The Air Force plans to buy more than 100 of the Northrop Grumman-built nuclear-capable platforms.

The first test flight of the B-21 is slated for the end of next year. The Air Force plans to bring the platform online in the mid-2020s.

The Raider will be a "delivery platform that not only will give us some standoff capability, but will also give us the ability to penetrate," he said.

Meanwhile, plans to acquire sea-launched cruise missiles and submarine-launched ballistic missiles armed with low-yield nuclear weapons are moving forward, said John Rood, the undersecretary of defense for policy.

The controversial weapons — which many Democrats oppose — were called for in the Trump administration's Nuclear Posture Review that was released in February 2018.

As part of the review, the administration said there needs to be an increased focus on refurbishing the nation's nuclear triad and adding additional capabilities to the arsenal.

The ballistic missile effort — which utilizes an existing submarine-launched ballistic missile, the D5, and would feature an existing warhead that is modified to be low-yield — is "going well," Rood noted during a meeting with reporters in December.

As for "the submarine-launched cruise missile, we are not as advanced in the development of that," he said. "That's still going through an analysis of alternatives and other work."

The United States has had low-yield nuclear weapons in its arsenal for decades, but those systems were designed to be air delivered, he noted.

However, based on threats from great power competitors Russia and China, there is a need for more delivery options, Rood said.

Washington, Moscow and Beijing have been moving in opposite directions, he said. The United States has been reducing its reliance on nuclear weapons as well as the size of its nuclear stockpile.

At the same time, both Russia and China have been increasing their strategic reliance on nuclear weapons and modernizing their systems.

"The whole point of having a robust, capable nuclear arsenal is to deter behavior by others and aggressive action," Rood said. "In order to restore deterrence where we thought it might be becoming weaker than we like, we have asked for these supplementary capabilities in order to send a signal that we have a variety of means that are more survivable than the existing low-yield nuclear weapons aboard aircraft."

Strategic Command is also working on bolstering nuclear command, control and communications, or NC3.

Kriete said NC3 is so critical to the effectiveness of the nation's nuclear deterrence it may be better to call the triad a quadriad.

Former Defense Secretary Jim Mattis "recognized that if we don't apply a similar level of effort for recapitalizing our nuclear command, control and communication systems in the future, they will age out, they will become vulnerable, they will become ineffective at connecting our senior leadership with our operational forces, rendering our triad less effective than we need it to be," Kriete said.

Stratcom has formed an NC3 enterprise center and brought on a skilled workforce for the effort, he said.

"They're bringing the best talent and the best minds together to start to envision what NC3 should look like in the future," he added.

The fielding of an upgraded nuclear command, control and communication system is a historic opportunity, he said.

"We have for the first time ever to ... envision and then design and ultimately field a system that will get the NC3 part of our nuclear mission done as one cohesive capability, vice what we have today which is essentially a patchwork of … over 150 different individual systems that have been fielded individually and put together over time to get the job done," he said.

Kriete noted that while the current system is safe, secure and effective, it needs to be upgraded.

"We've worked hard on understanding and then maintaining and improving the readiness where we can, but … we can't do that forever," he said.

These efforts come as the United States faces a number of threats globally, Kriete said. Stratcom primarily focuses on Russia, China, North Korea and Iran.

"Looking at the threat is the first thing we do in the morning and it's the last thing we do before we go home at night," he said. "We watch everything from the most tactical movements, the long-term strategic maneuvers and plans [and] doctrine changes — the things that we can observe to best understand what threats we have to face so that we can then tailor our deterrent activities starting with modernization all the way through how we posture and train our forces to make sure that we stay ahead of those threats."

Despite being part of the New START Treaty, Russia has continued to develop a whole range of nuclear weapon capabilities that fall outside the boundaries of the agreement, Kriete said.

"Our goal is not to keep up with Russia. It is not to engage in an arms race. It's really just to field the right deterrent in terms of capabilities and numbers," he said.

China, on the other hand, is not on the same level as Russia and the United States in terms of nuclear weapons capabilities or numbers. However, it is aggressively fielding a new triad, Kriete said.

"In fact, China has in many ways moved much faster than even the United States or Russia has in this area in recent years," he said.

Meanwhile, North Korea has made headlines over the past several years as it builds up its nuclear capability and the United States works to forge a diplomatic path toward denuclearization.

In 2017, there was a steady drum beat of short-range, medium-range and long-range ballistic missile tests by Pyongyang, Kriete said.

"That was a very busy time for Stratcom," he said. "The last year or so, not quite so much. And that's actually a good thing because … we've kind of turned the tables on our relationship with North Korea, with an overarching goal of denuclearization. Our diplomats really have been in the lead and U.S. Stratcom still underpins all the work that they do in support of the denuclearization objective."

Stratcom is also watching Iran closely, he said. The country does not currently have a nuclear weapon capability and the command is aware of indicators that would signal Tehran is planning to go down that path.

Tensions between the United States and Iran have been high in recent weeks following the death of Iranian Maj. Gen. Qassem Soleimani, head of the country's elite Quds Force, in January. The killing was the result of a U.S. drone strike in Iraq. Iran has since stated that it plans to restart its nuclear program.

https://www.nationaldefensemagazine.org/articles/2020/1/31/military-facing-tight-deadlines-to-modernize-nuclear-triad

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Physics Today (College Park, Maryland)

Weapons Labs to Build Costly New Device to Better Understand Plutonium

By David Kramer

Feb. 1, 2020

The pockmarked Nevada National Security Site, where more than 900 nuclear blasts were set off during the Cold War, will be host to a new billion-dollar-plus experimental weapons test facility located more than 300 meters underground. But the observations of how plutonium behaves under the extreme pressures that occur during detonation of a nuclear weapon will be made without those blasts.

The Enhanced Capabilities for Subcritical Experiments (ECSE) facility will capture x-ray images of the dynamics occurring during the implosion of scale models of plutonium pits, which are at the heart of a nuclear weapon's primary stage. When completed in 2025, the ECSE will consist of two major components. The most critical, and by far the most expensive, is Scorpius, a 20 MeV accelerator that will produce x rays from bremsstrahlung radiation generated by decelerating electrons as they hit a heavy metal target. The photons will capture images of the hydrodynamics occurring during the implosions. A second instrument, in an earlier stage of development, will probe the behavior of neutrons as the plutonium samples approach, but never attain, a critical assembly capable of sustaining a chain reaction.

The ECSE will work analogously to how aircraft manufacturers develop new planes, says Los Alamos National Laboratory (LANL) director Thomas Mason: "We can't fly the aircraft, but we can put the model in the wind tunnel." The results will be used to validate the codes that have been developed on high-performance computers to simulate nuclear blasts, "to fly the planes, if you will."

Scientists at LANL and Lawrence Livermore National Laboratory (LLNL) already have several devices for studying implosions. Both labs have aboveground machines that can create x-ray images of imploding targets. LANL's Dual Axis Radiographic Hydrodynamic Test (DARHT) facility is the more advanced of the two, capable of generating four images at 2 MHz of the hydrodynamics of

imploding materials. Scorpius will at a minimum have the same imaging capability, but its design may be upgraded to capture eight images at 5 MHz, says David Funk, LANL senior director for the advanced sources and detectors project in Nevada, of which Scorpius is a part.

The aboveground devices have a major drawback: For environmental and safety reasons, they can experiment only on surrogate materials such as tungsten, lead, copper, and gold. Surrogate materials help validate some model properties, but "in the end, plutonium is a unique metal," Funk says. For example, it has seven phases that can be created in a lab without exotic equipment. "At very high pressures and temperatures its behavior may not be very well represented by surrogates."

Since the US halted nuclear tests in 1992, plutonium implosion experiments have been carried out in the U1a tunnel complex at the Nevada National Security Site. The high-explosive-driven experiments are done within containment vessels with quantities designed to remain subcritical.

Funk says the existing pair of 2.2 MeV accelerators located in the U1a complex produce photons with enough energy to record only the early stages of implosion. "For quantities of interest—I won't say anything about the scale or size of experiments—it's very difficult to look through a dense metal like plutonium with 2.2 MeV. We need much higher energy photons."

The U1a tunnel complex, 330 meters beneath the Nevada National Security Site, will house the Enhanced Capabilities for Subcritical Experiments facility, which will probe the behavior of plutonium under conditions that occur in nuclear detonations.

LOS ALAMOS NATIONAL LABORATORY

Holding the experiments underground avoids generating a new transuranic waste stream, Funk says. Instead, the waste is simply entombed in the U1a complex. The subterranean environment also is inherently safe and secure, he asserts.

The Department of Energy's National Nuclear Security Administration (NNSA) established in 2014 the need for an ECSE-like capability to ensure proper functioning of the weapons stockpile. The ECSE will also likely be used to evaluate new weapons designs. No new warheads have entered the stockpile since the 1980s, but a replacement warhead for US land-based intercontinental ballistic missiles is now in the design phase.

FUZZY COST ESTIMATES

A preliminary ECSE design, expected by March 2021, will include a cost baseline with a confidence level of at least 80%. Until then, the estimate ranges from $500 million to $1.1 billion. Extending the U1a tunnels to accommodate the device will cost another $111 million to $175 million, Funk says. Congress included $145 million for the project in the current fiscal year's appropriations.

Scorpius is named after Scorpius X-1, the first cosmic x-ray source to be discovered, and the brightest. The accelerator will produce x rays sufficient for producing images of the latter, denser phases of implosions. The x rays will also be able to capture images of targets that more closely resemble pits in size and shape compared to current implosion targets. The cameras and other diagnostics at the ECSE will be comparable to those located on DARHT, but with some improvements, he adds.

A second ECSE component, now in the R&D phase, will probe the neutron reactivity of the plutonium as it implodes. In a stand-alone mode, a pulsed-power device known as a dense plasma focus will produce 14 MeV neutrons from a deuterium–tritium plasma. Those neutrons will be directed onto the plutonium target and the decay rate of the reaction measured. Scorpius will serve as the neutron source for combined radiographic–neutronic experiments. That's because neutrons created by the accelerator via photofission will vastly outnumber the neutrons produced by the

dense-plasma-focus device. The ECSE's neutronic components are estimated to cost around $90 million.

A schematic of the U1a tunnels shows the locations of the proposed Scorpius electron accelerator and one of the two existing accelerators. Scorpius will produce x rays to image the hydrodynamics of plutonium as it implodes. The smaller accelerator will generate high-energy neutrons to probe time-dependent neutron reactivity during implosions. Both types of experiments occur inside containment vessels located in the zero room at the lower left. Spent vessels are entombed in the vertical tunnel at the far left. (Courtesy of Los Alamos National Laboratory.)

The combination of radiographic and neutronic experiments "should preclude the need to do any kind of testing in the future of an underground type," Funk says. That same promise was made by the lab directors a quarter century ago. In that light, what's happened since then to justify the ECSE's costly new capabilities?

AGING CONCERNS

Each year since the cessation of nuclear tests in 1992, the directors of the three US weapons labs—LANL, LLNL, and Sandia—have been required to assure the president that the weapons are safe, reliable, and secure. But lab scientists continue to have concerns over the aging of pits and their interactions with other weapon components. That's despite studies that have concluded that the pits, which date to the 1980s, should function properly for decades to come.

For example, researchers at LLNL applied accelerated aging techniques to the primary fissile material in warheads, plutonium-239, which has a half-life of 24 100 years. The study found that the material, will "age gracefully" for at least 150 years. That research discounted concerns that phase changes or helium bubbles caused by alpha decay in the metal's lattice might change the shape or strength of the pits.

A 2007 report by JASON, the secretive group of scientists who advise federal agencies, also found little age-related reason for concern—at least in the unclassified summary. Nonetheless, Congress last year ordered JASON to take another look. The group's November report provided no estimates for pit lifetimes. It recommended that the labs continue with plutonium aging research. Mason says the ECSE will be an important component of the "focused program to understand aging" that the study called for.

Mason says the 2007 JASON review included a number of important caveats that often get lost in the slogan "we don't have to worry about plutonium aging." The report, he says, "has a much more nuanced view of that," although those details are classified.

Apart from assessing aging concerns, Funk says the ECSE will help evaluate whether weapons will be affected by new manufacturing methods and the addition of new safety and security devices.

Mason points out that the NNSA plans to ramp up production to 80 new pits per year by 2030 in response to a directive in the 2018 Nuclear Posture Review. Those pits will be cast instead of wrought, as was the case for manufacturing all but a handful of pits in the current stockpile. The wrought pits were proven to work in full-scale nuclear tests. In the absence of testing, the ECSE will help certify the performance of the new pits to be manufactured at LANL and DOE's Savannah River Site, Mason says.

Critics argue that the ECSE is unnecessary. In fact, LANL manufactured more than two dozen cast pits over a decade ago that were certified for submarine-launched ballistic missiles. "All of this is about the future stockpile and future heavy modifications, if not outright new designs," says Jay Coghlan of the watchdog group Nuclear Watch New Mexico.

Budget documents for the current fiscal year indicate that all 141 pits scheduled to be fabricated from FY 2023 through FY 2030 will be used for a new warhead rather than as direct replacements for aging weapons. Designated W87-1, the new warhead is to replace the W78 that tops most of the US Air Force's Minuteman III intercontinental ballistic missiles. The W87-1 will be the first new warhead design to be certified without the need for underground testing.

Coghlan and others worry that facilities such as the ECSE are being created to support increasingly major modifications to existing weapons systems. The changes are creating "code drift," he says, by moving the remodeled weapons further away from the simulations that were validated by nuclear testing. That will degrade rather than improve their reliability, he argues.

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US COUNTER-WMD

Global Biodefense (Seattle, Wash.)

Glo Germ, Party-Poppers, and a Black Light: Biologists Develop Rad Plan to Test Protective Suits

By Global Biodefense

Jan. 12, 2020

Necessity is the mother of invention. When the U.S. Army Chemical, Biological, Radiological and Nuclear (CBRN) School's Joint Experimentation and Analysis Division (JEAD) needed to find a way to get more mileage out of the expensive protective suits worn by Army Civil Support Teams in radiological environments, they looked for answers from what seemed like a peculiar source – a team of biologists in the Utah desert.

But according to Division Chief Brian Bennett of the U.S. Army Combat Capabilities Development Command's (CCDC) Chemical Biological Center's BioTesting Division, it's not as strange as it sounds.

Researcher with intent look of focus, wearing safety glasses and lab coat, works with her gloved hands inside a large biosafety hooded laboratory bench area.

"Our area of expertise here is handling aerosol clouds, because that's how you launch a biological attack," he explained. "Because radiological fallout consists of aerosolized particles, testing the radiological decontamination techniques fit well within the division's capabilities."

JEAD's Tom Murphy is counting on the BioTesting Division's expertise. "Right now these suits are one-and-done. Given that the suits are hot, and that the work conducted while wearing them is typically strenuous, Civil Support Teams members work/rest cycle requires at least two suits per day per team member."

At $2,000 a pop, the costs add up fast.

So the BioTesting Division was asked by JEAD to devise a test to determine whether the protective suits could be decontaminated and reused, and if so, how many times.

In order to answer this question, the team developed a novel plan that was based on an approach they often use in testing biological aerosols, and tailored it instead to this radiological application.

The plan involved simulating the radiological fallout through controlled release in their Aerosol Simulant Exposure Chamber of a fluorescent dust known as Glo Germ.

"Initially, we're looking at how well the decontamination procedures work," BioTesting Division Microbiologist Scott Jonas explained. "We'll provide that data back to the customer, who may use the data to make some changes to their procedures. Once they have a validated procedure, then we'll be looking at how that procedure impacts the integrity of the suit, and how many times the suit can be subjected to the procedure before it begins to degrade."

Researchers observe samples taken from the protective suits under a fluorescing microscope.

Soldiers from the Alabama National Guard's 690th CBRN Company aided in the execution of the plan by serving as test subjects. The three Soldier volunteers entered the chamber, each wearing a different type of protective suit. Simulant was dispersed as the test subjects walked around the chamber for 5 minutes.

"The key to this test is our ability to create a sustained, measurable cloud of particulates for the Soldiers to move around in," said Kallie Thevenot, a physical sciences technician with the BioTesting Division. "We do that with an initial forceful simulant dispersal and then we sustain the cloud with air currents generated by fans."

"We used party poppers to disperse threat particles into the air," said Patty Low, a BioTesting Division microbiologist. "Activating the [simulant filled] popper within the test chamber produced a cloud of dry simulant which we were able to sustain with air currents."

Evaluators examined the suits under a black light and removed samples from the suits to determine their level of contamination. They further examined and photographed the samples under a fluorescing microscope to provide a more accurate and permanent record of the results.

The researchers then put the Soldiers through decontamination procedures intended to remove the fallout from the protective suits. They inspected the suits again under a black light and resampled, for a second time examining and photographing the samples under a fluorescing microscope. The test was performed five times with dry decontamination procedures and five times with wet decontamination procedures.

Sgt. 1st Class James Martin performs decontamination procedures on Sgt. Brittany Mattison. Both Soldiers are assigned to the 690th CBRN Company, Alabama National Guard. Credit: Jack Bunja

Sgt. 1st Class William Anderson was one of the Soldiers participating in the test, and said he values the opportunity to be part of the tactics, techniques and procedures (TTP) development process. "It gives us an opportunity to provide input and make recommendations," he explained.

Andrew Reichert, a physical scientist with the Homeland Defense/Civil Support Office at the Maneuver Support Center of Excellence, said that TTPs that allow for reuse of the protective suits would give commanders more flexibility in mitigating risk while reducing the consumption of personal protective equipment.

"The BioTesting Division's adaptation of their existing technique is a great example of the contributions made to the Army by the Combat Capabilities Development Command," said Paul Tanenbaum, Ph.D., director of operational applications at the Center. "Our scientists and engineers create innovative, cross-disciplinary solutions, not only in materiel, but to support the TTPs and training, as well."

Article by Richard M Arndt, U.S. Army Combat Capabilities Development Command Chemical Biological Center; edited for context and format by Global Biodefense.

https://globalbiodefense.com/2020/01/12/biologists-develop-rad-plan-to-test-protective-suits-u-s-army-combat-capabilities-development-command-chemical-biological-center/

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CCDC Chemical Biological Center Public Affairs (Aberdeen Proving Ground, Maryland)

Mobile Test Chamber Eases Challenges for Conducting Gas Mask Tests

By Chemical Biological Center Public Affairs

Jan. 21, 2020

Protection factor (PF) testing allows the U.S. Army and other military branches to determine how effective chemical biological protection masks are during use by warfighters. During a test, warfighters don their protective masks, step into a test chamber and are put through a series of movements while aerosol simulants are pumped into the chamber. Each mask receives a score based on how effective it was at protecting the wearer from the simulant. With protective masks in use in all branches of the military, in different parts of the world, conducting protection factor tests is a challenge for researchers when it comes to shooting a weapon while wearing a gas mask.

Steven Yurechko, a chemical engineer at the U.S. Army Combat Capabilities Development Command (CCDC) Chemical Biological Center, decided it was about time to provide a solution to the challenges he and others face when attempting to conduct these types of protection factor tests with the most critical challenge being a way to provide a uniform, consistent aerosol challenge.

Yurechko needed a way to conduct live-fire tests from inside a test enclosure while maintaining the correct concentration of aerosol simulant to ensure proper test results. The enclosure also had to be mobile enough to easily transport to firing ranges or other customer test sites.

Yurechko looked to what was readily available, an off-the-shelf, inflatable paint spray booth.

“It inflates just like a bouncy house you see at a kid’s birthday party,” Yurechko said. “We installed custom ventilation ports into the interior of the chamber so that aerosol simulant can be pumped into the chamber directly through the blower which is used to inflate it. This ensures uniform aerosol concentration throughout the interior which meets the joint service standard for conducting protection factor testing.”

The interior directional air ports concentrate the simulant toward the back of the chamber where the test subject stands while the front chamber door can be fully opened to allow for rifle fire without damaging the enclosure.

After performing extensive chamber mapping tests to confirm that the aerosol dispersion met the current joint service standard for testing, Yurechko then took the inflatable chamber and the scientific instruments needed to conduct a protection factor test to Aberdeen Proving Ground to prove that his inflatable test chamber concept could easily be set up and would actually work for a live fire test.

“The whole set up fits in three ruggedized cases and one of those cases doubles as a table to organize the testing devices,” Yurechko said. “Setup took a total of about 10 minutes with two personnel. Inflating the chamber itself took less than a minute.”

Accompanying Yurechko down range was a group of Center researchers willing to don a gas mask and fire rounds down range from inside the chamber.

“We had concerns that the expended bullet casings would be hot enough to damage the nylon interior of the chamber, causing it to collapse,” Yurechko said. “We installed protective fabric panels

in areas we thought a casing might hit or become lodged which helped, but overall, even casings that did come in contact with the chamber didn't damage it."

Pleased with the overall performance of the chamber, Yurechko is already busy making improvements to the mobility and form factor of the test setup as well as improvements to the data acquisition system.

Yurechko has already received positive feedback from colleagues and interest from several organizations eager to put the portable test chamber to use.

If live-fire testing isn't necessary, the enclosure can also act as a mobile, stand-alone PF chamber. For some tests, customers require that actual end users of the masks act as test subjects.

"Until now, conducting a test was a slight logistical nightmare due, in part, to scheduling travel for multiple warfighters to come to the Static PF Test Facility at CCDC CBC where the test was being held," Yurechko said. "It was time consuming and expensive for the Army."

Zach Chadwick, a chemist at the Center, was recently supporting protection factor testing for pilots of the Rotary Wing Program which was conducted at the Static MIST Facility at the Center.

"This new test chamber that would have been ideal for our purposes because it travels easy and we can take it to the pilots instead of having them come to us," Chadwick said. "The portability factor alone makes this a worthwhile capability, but then you add on the option to test masks while actually firing rounds down range, something that up to this point hasn't been reliable, and you've got something special."

Funding for the project came from the Center's Fiscal Year 2019 Innovative Development of Employee Advanced Solutions Program designed to give researchers with promising new ideas seed money to develop them. It was one of eight projects chosen from a field of 17 to receive funding.

https://www.cbc.ccdc.army.mil/newspost/mobile-test-chamber-eases-challenges-for-conducting-gas-mask-tests/

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US ARMS CONTROL

Bloomberg

North Korea's Next Submarine May Make Nuclear Talks Even Harder

By Jon Herskovitz and Adrian Leung

Feb. 4, 2020

Kim Jong Un has spent much of his time as North Korea's leader developing bigger and more advanced nuclear weapons. This year, he may try to make them harder to find by putting them under the sea.

Recent North Korean reports touting a new submarine and its test of a ballistic missile designed to be launched from one have fueled speculation that a sub may be the "new strategic weapon" Kim promised to unveil this year. While such a vessel would probably be noisy and unable to stray far from the coast without being tracked, it may be enough to serve Kim's needs.

Even one submarine lurking off the Korean Peninsula, beyond the gaze of spy satellites, would give U.S. military planners a dangerous new threat to consider in the event of any conflict. And for Kim, anything that makes it harder for the U.S. to imagine an actual war, brings him closer to a goal that alluded his father: international recognition as a nuclear state.

"In terms of war planning, the U.S., South Korea, and Japan need to take the undersea nuclear threat seriously and plan for anti-submarine warfare contingencies," said Ankit Panda, an adjunct senior fellow at the Federation of American Scientists and author of the upcoming book "Kim Jong Un and the Bomb: Survival and Deterrence in North Korea."

Kim has kept the world guessing since pledging in a Dec. 31 speech to build a more powerful nuclear deterrent. Although a "strategic weapon" could include everything from advanced intercontinental ballistic missiles to multiple warhead payloads and more powerful atomic bombs, the secretive regime has publicly said it was making "big efforts" to expand its missile-carrying submarine fleet.

Launching a nuclear-weapons capable sub would provide the clearest illustration yet of Kim's efforts to bolster his arsenal despite President Donald Trump's June 2018 assertion that North Korea "no longer" posed a nuclear threat. Even before agreeing with Trump to "work toward complete denuclearization," Kim had demonstrated his ability to build hydrogen bombs and missiles capable of carrying them to any city in the U.S.

A flurry of shorter-range missile tests last year showed the regime has since made progress toward developing solid-fuel rockets that are easier to hide, faster to deploy and harder to intercept. Among those was a submarine-launched ballistic missile that flew 910 kilometers (565 miles) into space on Oct. 2, giving it an estimated horizontal range of about 1,900 kilometers.

That could put all of South Korea and Japan -- together home to about 170 million people including some 80,000 U.S. troops -- in range of a submarine hidden off North Korea's eastern coast. There, a vessel could hide among others from the country's fleet of 60 to 80 smaller submarines, leaving the allies unsure which, if any, are nuclear armed.

North Korea sent out a fresh reminder that it's ready for conflict with Japan, warning its mortal enemy in a state media report late Tuesday that "it will fall into the abyss of ruin" if it tries to flex its military might.

Vice Admiral Jon Hill, the head of the U.S.'s Missile Defense Agency, expressed confidence in the allies' ability to counter a nuclear-armed submarine after the latest SLBM test. "We need to keep an eye on it and continue to assess that to make sure the architecture's in place to deal with it," Hill told a Center for Strategic & International Studies gathering in October.

North Korea has already teased the construction of a submarine that may be able to carry the new missile, publishing photos in July of Kim inspecting a large vessel under construction. The photos appeared to show a modified version of the diesel-electric Romeo-class vessels that comprise about one-third of the Korean People's Navy fleet, said Joseph Dempsey, a London-based research associate for defense and military analysis at the International Institute for Strategic Studies.

North Korea acquired seven Romeo-class submarines from China in the mid-1970s and began producing them domestically from kits until 1995, according to a study by the Nuclear Threat Initiative. The newer version appears to have an enlarged "sail" -- the highest part of the vessel -- to accommodate about three missile launch tubes, Dempsey said.

North Korea was thought to have been developing another, more advanced submarine that weapons experts have dubbed the Sinpo C. So far, analysts haven't been able to confirm its existence using publicly available sources such as state-run media reports or satellite images.

The modified Romeo design demonstrates North Korea's commitment to exploiting the limited material it can acquire under strict international sanctions to offset the military advantages of its much wealthier rivals in South Korea and the U.S. The country's submarine fleet -- among the world's largest -- has long been a key part of that strategy.

Most of North Korea's submarines are smaller craft "designed to disrupt sea lanes, lay mines, attack surface vessels, and assist special operations units' infiltration," according to a white paper from South Korea's Defense Ministry. Seoul blamed such a vessel for firing a torpedo that sank its corvette Cheonan in 2010, killing 46 -- a claim denied by North Korea.

That's a very different mission than the U.S. Navy's much larger nuclear-powered Virginia Class attack submarine, which can sit quietly submerged off an enemy's coast until its time to launch missiles from its dozen launch tubes. North Korea's Navy doesn't need to venture so far, be as stealthy or carry as many weapons.

"The scenario of a North Korean submarine creeping out into the Pacific with a nuclear-capable ballistic missile on board might capture the imagination, but it has little basis in reality," said Panda, of the Federation of American Scientists.

The real value in a nuclear-armed submarine may be in its potential to strengthen Kim's position in negotiations with the U.S. Each advance toward a more credible nuclear weapon raises the costs of any American-led military action and reduces Washington's leverage toward eliminating -- rather than reducing or capping -- his nuclear arsenal.

North Korea sees its submarine as an underwater complement to the land-based missile transporters that it has demonstrated with increasing effectiveness in recent years, said Dempsey, of the International Institute for Strategic Studies. They just need another platform to divide the attention of U.S. and South Korean military commanders.

"For the purposes of providing an initial at-sea nuclear capability, this approach could be sufficient," Dempsey said. "All they need to do is avoid being detected," he said, "so they can launch their missile."

(Adds statement from North Korea's state media in paragraph 9.)

https://www.bloomberg.com/news/articles/2020-02-04/north-korea-s-next-submarine-may-make-nuclear-talks-even-harder

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Nature (London, U.K.)

How Quickly Can Iran Make a Nuclear Bomb

By Davide Castelvecchi

Feb. 5, 2020

Iran has accumulated 1,200 kilograms of enriched uranium — more than doubling the stockpile it had just three months ago, according to a statement from a senior official at the Atomic Energy Organization of Iran on 25 January.

That's enough to build one atomic bomb, if the uranium is further refined to make it weapons-grade — a process that could take just two to three months , says David Albright, a nuclear-policy specialist at the Institute for Science and International Security in Washington DC. But building actual weapons would take much longer, he adds.

If confirmed, the rate of Iran's expanding uranium stockpile "shifts things dramatically", Albright adds. But he and others caution that there is no evidence that Iran is rushing to build a bomb — at least not yet.

Tensions between Iran and the United States have escalated in the past month. On 3 January, a US drone strike killed Qasem Soleimani, the key architect of Iran's regional military influence. In response, Iran shot missiles at US bases in Iraq.

The Joint Comprehensive Plan of Action (JCPOA), the 2015 deal between Iran and six global powers that limited its nuclear capabilities in exchange for the lifting of economic sanctions, is now in serious jeopardy. US President Donald Trump pulled out of the deal in May 2018, and Iran announced in May last year that it would resume uranium enrichment.

Nature talked to nuclear experts to find out how soon Iran can build a bomb, and whether this is likely to happen.

Has Iran tried to build nuclear weapons in the past?

Building nuclear weapons is expensive and requires technical expertise, such as enriching uranium. The fissionable isotope uranium-235, which makes up less than 1% of natural uranium, must be separated from uranium-238, which is by far the more common isotope.

Iran has a strong physical-sciences tradition, and has had an active nuclear programme for decades. The country has always maintained that this was purely for peaceful purposes, such as producing isotopes for medical use. But in the early 2000s, Iran appeared to have a crash programme to build at least five uranium fission bombs, according to US intelligence assessments and international observers.

Reports in the mid-2000s by the United Nations' International Atomic Energy Agency (IAEA) suggested that Iran could be actively working to build a nuclear arsenal. That would be a violation of the 1968 Treaty on the Non-Proliferation of Nuclear Weapons (NPT), which Iran has signed. In 2003, bowing to international pressure, the country agreed to cut down its nuclear activities drastically — but not completely.

Did the 2015 deal reduce Iran's nuclear capabilities?

As of 2015, the country had stockpiles of 11 tonnes of a uranium hexafluoride enriched to as much as 20% 235U. Weapons-grade uranium must be enriched to 90%. Uranium is commonly processed as uranium hexafluoride gas, which is separated by isotope in high-speed centrifuges, and Iran had more than 10,000 of these centrifuges. When the JCPOA was signed in July 2015, experts had estimated that the country was months — perhaps weeks — away from producing weapons-grade uranium.

But the JCPOA forced Iran to ship most of its stockpile abroad, and to mothball the majority of its centrifuges. The aim was partly to stretch the time Iran needed to stockpile enough fissile material for a bomb — known as 'breakout time' — to at least a year. The deal also subjected Iran to a stringent regime of IAEA inspections. In the following years, the agency periodically reported that Iran was fully complying with the deal.

The JCPOA was a "big win" not just in slowing Iran's ability to make a bomb, but also for global non-proliferation efforts, says Seyed Hossein Mousavian, who was the spokesperson for Iran's nuclear negotiating team in 2003. "Over 200 nuclear scientists worked on the technical details for years," says Mousavian, now a nuclear-policy specialist at Princeton University in New Jersey. As a consequence, he says, Iran's inspection regime is more detailed than the one described in the NPT, which could make the 2015 deal a precedent and model for future disarmament accords.

What was the impact of the US withdrawal from the nuclear deal?

Despite its reported success at limiting Iran's nuclear capabilities, some opponents of the deal complained that the JCPOA did not go far enough. In 2018, the United States unilaterally withdrew, imposing new, crushing economic sanctions on Iran. Mousavian says that Iranians felt cheated. The perception in the country is now that "you cannot negotiate with or trust the US" and the impact could be much wider. For example, it could make nuclear powers such as North Korea hesitant to come to the negotiating table, he adds.

Does Iran now have enough enriched uranium to build nuclear bombs?

Last November, the IAEA found that Iran had accumulated around 550 kilograms of uranium hexafluoride that was "moderately enriched" to less than 4.5% 235U. It is unclear what material the Iranian official was referring to in his 25 January claim, but it is presumed to be 1,200 kilograms of moderately enriched uranium hexafluoride. If further enriched, this quantity could yield more than 30 kilograms of weapons-grade uranium, enough to build one fission bomb. The IAEA is expected to release its latest report on the Iranian nuclear programme, including its assessment of stockpiles, in early March at the latest.

But how quickly could Iran actually make a bomb once it has enough weapons-grade uranium?

Possessing fissile material is not enough: a country also has to master the design, and manufacture, of a bomb. In particular, uranium hexafluoride must be converted into uranium metal, which is not straightforward, says Richard Johnson, a proliferation specialist at the Nuclear Threat Initiative, a policy research centre in Washington DC.

A study prepared for the US Congress and updated last December suggests that by the time Iran partially froze its weapons development in 2003, it had not yet mastered all the skills necessary to build bombs — and that it probably did not make significant progress in later years.

According to Albright, some intelligence agencies estimate on the basis of this information that it could take the country about two years to make its first two bombs, if it wanted to do this.

If the nuclear deal is scrapped, will Iran be legally entitled to arm itself with nuclear bombs?

No. Because Iran has signed the NPT, it is committed to using nuclear technology exclusively for peaceful purposes. Members of the NPT must allow the IAEA to verify their compliance, or face consequences such as UN sanctions. However, Iran could withdraw from the NPT, as North Korea did in 2003, as it was becoming a nuclear power. Iranian foreign minister Mohammad Javad Zarif said on 20 January that the country is prepared to withdraw if its continued enrichment programme is reported to the UN Security Council.

So is Iran actively working towards a bomb?

"All the signs are that they are not," says Zia Mian, a physicist and nuclear-policy expert at Princeton University. The country has complied with the rigorous IAEA inspection regime set out in the JCPOA, he says. This means that a nuclear-weapons programme is "either hidden so well that no one has been able to find it so far, or that there is no such crash programme", he says. Albright agrees, saying that Iran could be stockpiling enriched uranium to increase its leverage in future negotiations. "You don't see some of the indicators that would imply a well worked-out decision" to actually build bombs, he says.

"I would still maintain that Iran has not started a dash for the bomb,"adds Oliver Meier, an arms-control specialist at the Institute for Peace Research and Security Policy in Hamburg, Germany. "This would require a range of other activities, including on weaponization, that we have not seen."

Iran's officials continue to deny any intention to build nuclear bombs. But stepping away from its JCPOA obligations — and in particular, increasing stockpiles of enriched uranium — brings the country closer to having the capability to do so.

"I still think they are not racing for a bomb," Johnson says, but he adds that the international community should remain vigilant. "The concern is there."

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Arms Control Today (Washington, D.C.)

Russian Perspective: New START and Beyond

By Andrey Pavlov and Anastasia Malygina

Jan/Feb 2020

Unless Russia and the United States choose to extend the 2010 New Strategic Arms Reduction Treaty (New START) for up to five years, the treaty is scheduled to expire in just one year. It represents the last vestige of the Cold War-created arms control foundations that have served to stabilize U.S.-Russian relations, and its collapse could create high levels of uncertainty and unpredictability. A complete collapse of these foundations, coupled with the deepening conflict between Russia and the West, could create a situation of high uncertainty and unpredictability.

Revising the Cold War Legacy

The U.S.-Russian nuclear arms control agreements signed after the Cold War adopted their foundations from the principles and criteria pursued during strategic arms limitation talks in the 1970s. These elements included a general vision of strategic stability, the principle of equal and indivisible security for all, equal limitations of weapons, and the types of nuclear weapons regarded as strategic and to be limited. Today, Russia continues to believe in the first three elements, while the fourth requires revision in changing circumstances.

Russia will reportedly deploy its first Avangard hypersonic glide vehicles atop SS-19 ICBMs, such as this display model photographed in 2016. (Photo: Vitaly Kuzmin)Russia will reportedly deploy its first Avangard hypersonic glide vehicles atop SS-19 ICBMs, such as this display model photographed in 2016. (Photo: Vitaly Kuzmin)Efforts to define strategic stability under the present world order are currently developing quite intensively. Some Russian experts say that the traditional understanding is outdated and has lost its meaning,1 but most officials and analysts in Moscow continue to hold to Russia's long-standing definition of strategic stability as a situation in which no party has an incentive to initiate a nuclear first strike.2 Maintaining parity with the United States in strategic nuclear armament also remains essential to Russian experts and officials.

The list of launchers and delivery vehicles subject to reductions and restrictions was formed during the period of the Strategic Arms Limitation Talks. At that time, the list included intercontinental ballistic missiles (ICBMs), submarine-launched ballistic missiles (SLBMs), and heavy bombers. The same scope was preserved in the New START, but Russia is no longer satisfied with the status quo. Russia's political and military leadership believe that future arms control agreements should account for weapons that are not included in the traditional set, but may be of strategic importance in the present or the near future.

Primarily, Moscow is concerned with the unregulated development of U.S. ballistic missile defenses. In 2002 the United States withdrew from the Anti-Ballistic Missile Treaty and began to develop and deploy previously prohibited missile defense systems. When negotiating New START, Russia tried and largely failed to incorporate missile defenses into the talks. New START's main provisions do not address missile defense, but the two sides agreed to include preambular language on ballistic missile defense: the two sides recognized "the existence of the interrelationship between strategic offensive arms and strategic defensive arms, that this interrelationship will become more important as strategic nuclear arms are reduced, and that current strategic defensive arms do not undermine the viability and effectiveness of the strategic offensive arms of the Parties." The scope of the treaty remained unchanged, and there is no reference to missile defense in the main provisions of New START. In connection with the development of missile defenses, Russian arms control rhetoric also often refers to the dangers posed by U.S. plans to deploy weapons in space.

Moreover, Russia is concerned by the growing strategic importance of non-nuclear offensive weapons and their impact on strategic stability. Although New START's title does not mention nuclear weapons, attention is still directed at them. Only the treaty's preamble stipulates that the parties are to be "mindful of the impact of conventionally armed ICBMs and SLBMs on strategic stability."

Meanwhile, the general relationship between strategic nuclear and non-nuclear weapons is enshrined in Russian military doctrine. The 2010 military doctrine did not mention non-nuclear deterrence, but the latest version published in 2014 offered a clarification of "nuclear and non-nuclear" in brackets after the words "strategic deterrence." The increased range, speed, and accuracy of these weapons, as well as their growing number, dramatically intensify their negative impact on strategic stability.

Not all Russian experts agree on the impact on strategic stability of weapons outside of New START's restrictions, but Russian leaders strongly believe in their negative impact and in the need to take this impact into account in any future arms control agreements.

Expanding the Arms Control Agenda

Even in the most difficult times, Russia has managed to maintain parity with the United States in the field of strategic nuclear arms, in part thanks to U.S.-Russian nuclear arms control agreements. This situation will not change as long as the generally agreed restrictions on offensive strategic nuclear weapons are maintained.

New START is quite convenient for Russia. Unlike the previous two strategic arms reduction agreements, the current treaty does not constrain Russia's ability to determine the structure of its nuclear forces or create new weapons systems. In addition, the verification system established by this treaty is much more favorable for Russia than it was previously.

Russian leaders appear satisfied with New START, but the development of U.S. weapons systems outside of it remains a cause for concern. If the first Strategic Arms Reduction Treaty (START) was seen as the beginning of the process of reducing strategic nuclear weapons, further arms reductions after the implementation of New START seemed very unlikely in Russia. Consequently, when U.S. President Barack Obama announced his 2013 proposal to discuss further arms reductions, the Russian side did not react positively.3

Technicians load a U.S. Ground-Based Interceptor into its silo at Fort Greely, Alaska, in 2004. Russian officials have repeatedly expressed interest in discussing missile defenses at any future arms control talks with the United States. Technicians load a U.S. Ground-Based Interceptor into its silo at Fort Greely, Alaska, in 2004. Russian officials have repeatedly expressed interest in discussing missile defenses at any future arms control talks with the United States.Almost

immediately after New START's entry into force, Russia determined its main direction of further development of policy within the framework of bilateral arms control, which remains relevant to the present day. Unable to match this technological development, Russia has expressed interest in engaging the United States regarding weapons systems that are not on the traditional list. Any form of dialogue is seen as a possible beginning of a complex negotiation process that would allow for more comprehensive agreements that expand the scope of strategic arms control. The main problem for Russia has been that neither the Obama administration nor the Trump administration was interested in such talks, preferring to limit only ICBMs, SLBMs, and heavy bombers.

Russia has employed several different tactics in an attempt to persuade the United States to expand the scope of the arms control conversation. During the Obama administration, implementing and maintaining New START appeared to be very important to the United States. At the time, Russian officials repeatedly said that Russia might consider withdrawing from New START if the U.S. development of weapons systems outside of the treaty restrictions threatened Russia's security. At first, all attention was directed at the development of the ballistic missile defense system. In November 2011, Russian President Dmitry Medvedev made a special statement about a potential response to the further deployment of the U.S. ballistic missile defense system.4 Among the retaliatory measures, he noted the possibility of Russia's withdrawal from New START. Russian officials have persisted with this position for some time. In May 2012, for example, the statement was repeated by the Chief of Russian General Staff General Nikolay Makarov5 and in February 2014 by Michail Ulyanov, the director of the Department for Security and Disarmament of the Russian Foreign Ministry.6 The last known mention of the possibility of leaving New START as a response to U.S. missile defenses was made in May 2016 by Viktor Ozerov, the Chairman of the Committee of the Federation Council on Defense and Security.7

After 2016, Russian officials no longer publicly explored the possibility of unilateral withdrawal from New START. The Trump administration policy increased the chances of the United States itself withdrawing from New START or simply waiting for its expiration date and refusing to renew it. This option is clearly not in Russia's interest, and currently Moscow emphasizes Russia's desire to keep New START in force.

At the same time, this does not mean Russia completely let go of the previous desire to encourage the United States to engage in a broader dialogue on arms control. While responding to the further development of U.S. missile defenses in his State of the Nation address to the Federal Assembly in March 2018, Russian President Vladimir Putin did not mention the possibility of leaving New START. Instead, his message was about new weapons systems that Russia intends to develop and deploy to enable a credible deterrence. In 2011, Medvedev also listed the military systems that Russia intends to use to reduce the destabilizing effect of U.S. missile defenses. At the time, there was nothing new on the list, whereas Putin identified four types of weapons that definitely could be considered as strategic nuclear: the hypersonic glide vehicle Avangard, the heavy ICBM RS-28 Sarmat, the nuclear-powered cruise missile Burevestnik, and the intercontinental, nuclear-armed, nuclear-powered, undersea autonomous torpedo Poseidon.

Sarmat is nothing radically new, so when it comes into operation, it will fall under existing New START limitations. This was less clear for the Avangard vehicle because the reentry vehicle's flight path is not considered ballistic over most of its flight path, but Russia has deployed the weapon on treaty-limited ICBMs, and the Russian leadership has decided not to remove this system from the limitations under the treaty. In November 2019, missiles armed with this warhead were demonstrated to U.S. inspectors conducting inspections in accordance with New START verification procedures.

The other two strategic nuclear systems are not subject to New START restrictions and Russia is not obligated to provide information about them to the United States. The role of these systems in strengthening Russia's strategic nuclear deterrence is quite unclear, but their importance in the development of the U.S.-Russian dialogue on strategic stability and arms control may be significant. Today, it appears that the development of weapons systems not limited by New START may raise concerns in Moscow and Washington. There is one more change in Russia's tactics: During 2011–2016, Russia regarded withdrawal from New START as an extreme measure in case the United States radically improved its missile defense capabilities. Now, Moscow is already willing to proceed in development and deployment of the new strategic nuclear weapons systems.

Today, the United States is calling Russia's attention to the fact that new strategic weapons outside the traditional set of ICBMs, SLBMs, and heavy bombers should be considered somehow. In other words, the United States might now be interested in expanding the dialogue with Russia on strategic arms control beyond the traditional framework. Russian Deputy Foreign Minister Sergei Ryabkov, speaking in November 2019 at the Moscow Nonproliferation Conference, expressed an openness to the new U.S. willingness but only in conjunction with all the other strategic arms "negatively affecting strategic stability."8 In particular, Ryabkov mentioned missile defense, as well as the possible deployment of weapons in space. While appearing on Russian TV recently, Foreign Minister Sergey Lavrov also mentioned U.S. conventional strategic weapons developed in the prompt global-strike programs.9

Arms Control: Bilateral or Multilateral?

Although dodging the question of extending New START, Trump administration officials have often said that bilateral nuclear arms control is outdated and that China should be included in future arms limitation agreements. Russia has historically endorsed the idea of adding partners to arms control talks. Even during the Cold War, the Soviet Union wanted to negotiate not just with the United States, but also with other NATO countries possessing nuclear weapons. At a minimum, Moscow sought to have the nuclear arsenals of other NATO countries taken into account when determining bilateral U.S.-Soviet arms limits. So while the Trump administration aims to multilateralize talks by adding China, Russia has always focused on France and the United Kingdom. In November 2019, for example, Vladimir Ermakov, director of the Russian Foreign Ministry Department of Nonproliferation and Arms Control, confirmed that further reductions in strategic offensive weapons were "unlikely" without the involvement of France and the UK.10 Yet, the modern problem lies in the preservation of the current arms limitations established by New START while further reduction is generally seen as just a possibility.

U.S. President Donald Trump's statements about the need to involve China in future negotiations are perceived by Russia rather skeptically at best. Russia has nothing against China's involvement in the negotiations, but is clearly not going to actively support the initiative. China's position is clear and unchanged: China will not participate in the negotiations as long as there exists such a large quantitative gap between the nuclear arsenals, deployed or in storage, of Russia and the United States on the one hand and China on the other.

Without changes to the scope of arms control, the system that has helped U.S.-Russian stability could disappear in just one year. Expansion of bilateral dialogue beyond the traditional Cold War framework is the main aim of Russia's current arms control policy, and it will remain relevant regardless of whether New START is extended by up to five years as allowed by the treaty. Nevertheless, Russia prefers to participate in such discussions with New START in force.

Russia and the United States have expressed interest in addressing new types of weapons and technologies in future talks, as well as more nuclear-armed nations, but they have disagreed on

which weapons and nations to include. Unless they can agree to a new scope, there is a serious risk that both nations will embark on a dangerous new arms race.

Endnotes

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COMMENTARY

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

If Denuclearization Is a Fantasy, What Can North Korean Negotiations Achieve?

By Ariel (Eli) Levite and Toby Dalton

Jan. 31, 2020

At the end of December, having paid his respects to his ancestral heritage by riding a white stallion to Mt. Paektu, Kim Jong Un returned to Pyongyang to deliver a lengthy address to the North Korean Worker's Party Central Committee. In the speech, Kim laid out his new strategic vision, one that puts little faith in denuclearization talks with President Donald Trump. North Korea, he stated, would no longer be bound by a self-imposed moratorium on nuclear and missile testing, and that soon "the world will witness a new strategic weapon." More ominously, he committed to "reliably maintain the constant readiness for action of the powerful nuclear deterrent," a destabilizing development that increases the likelihood of a nuclear detonation. The bottom line: North Korea will remain a state that possesses a deadly nuclear arsenal and plans to further modernize and expand it. Now what?

The "Big Deal" is Finished…

Kim's speech puts the final nail in the coffin of Trump's policy of seeking a "big deal" of fully verified and irreversible denuclearization in return for economic rewards. Kim's pronouncements reaffirm the centrality of self-reliance and sufficiency in North Korea's strategic doctrine and make clear it will no longer agree in principle to unilateral disarmament. Nor is it any longer committed to the denuclearization path it endorsed in previous agreements.

Instead, North Korea "will steadily develop indispensable and prerequisite strategic weapons for national security until the United States rolls back its hostile policy and [a] lasting and durable peace mechanism is in place." Kim warned his citizens of "tightening our belts" in preparation for a long confrontation with the United States. Judging by this yardstick, denuclearization of the Korean peninsula is a remote possibility, certainly while Kim's regime remains, and no matter how miserable international sanctions make life in North Korea.

In holding out for the big deal, unfortunately, the Trump administration — like its predecessors — sacrificed a more immediate and necessary operational objective: stopping North Korean progress toward a larger and more menacing nuclear arsenal that could reliably target the mainland United States. Pyongyang's progress is worrying. U.S. Vice Chairman of the Joint Chiefs of Staff Gen. John E. Hyten recently observed that "North Korea has been building new missiles, new capabilities, new weapons as fast as anybody on the planet with the 115th most powerful economy in the world. Speed itself is efficiency."

The fruits of North Korea's nuclear labor became evident as diplomacy stalled in mid-2019 with multiple tests of increasingly accurate short-range, solid-fuel ballistic missiles as well as a submarine-launched ballistic missile. Talk of a "new strategic weapon" suggest other improvements, such as a large solid-fuel engine to power longer-range missiles. North Korea has shown it can significantly upgrade its arsenal even if the United States tries to undermine or slow it down — whether through "maximum pressures" sanctions, technology denial, or other covert "left-of-launch" activities.

… But There Are Still Reasons to Negotiate

There are still very good reasons for Washington to continue to seek to constrain further nuclear developments in North Korea, including through negotiations. Despite its progress, the North Korean arsenal is neither fully built nor highly reliable quite yet. It is also worth recalling the threat that North Korea could proliferate missiles or nuclear capabilities for profit or to create offshore production infrastructure. In addition, North Korea's success in advancing its nuclear program while facing massive economic sanctions is a highly disconcerting role model that others (such as Iran) might seek to emulate.

Washington needs a more realistic strategy. Several long-standing U.S. demands and traditional approaches toward denuclearization ought to be set aside for now, with the aim of building toward them over time. These include rollback before rewards, eliminating short-range, conventionally-armed missile capabilities and liquid-fueled long-range missiles, providing a full declaration of facilities and stockpiles, and agreeing to "anytime, anywhere" inspections. It also makes little sense to prioritize a freeze on uranium enrichment. North Korea already has uranium stocks in abundance to feed a growing arsenal.

Realism also requires understanding what North Korea will negotiate. In his speech, Kim Jong Un stated that "the scope and depth of bolstering our deterrent will be properly coordinated depending on the U.S. future attitude to [North Korea]." In other words, what might be negotiable at the outset are prospective arsenal developments, not existing capabilities. Even for modest constraints, however, Pyongyang will seek generous rewards in the form of relief from U.N. Security Council sanctions and additional (perhaps even more difficult) changes in American behavior and the posture of U.S. forces deployed in South Korea.

A New Negotiating Strategy

The primary U.S. negotiating objective should be a comprehensive freeze on those elements of the North Korean program that would greatly enhance its nuclear menace were they to be left unchecked. In effect, the aim would be to cap the North's arsenal, qualitatively and quantitatively, to stop it from becoming even more potent and destabilizing.

The freeze would prioritize further development work and production of solid-fuel missiles, additional long-range nuclear delivery vehicles, and their launch platforms (including transport-launch vehicles and submarines). It should also capture the assembly of miniaturized thermonuclear weapons, and tritium production for its thermonuclear devices. The freeze should additionally cover military exercises with nuclear weapons and other steps that would increase the readiness, survivability, and reliability of the arsenal. The urgency of capping these capabilities derives not only from the threat they pose but also from the fact that they will constitute the upper limits of any interim deal.

To support the freeze objective, Washington and its allies must be prepared to put on the table a modular, multi-disciplinary, and above all credible financial assistance package to North Korea commensurate with whatever modest steps North Korea would agree to undertake. This offer must further be reversible in case North Korea violates its obligations under the deal. Involving multiple partners (China, South Korea, Japan, Russia, and the European Union, for instance) and channels for assistance strengthens the credibility of the United States in being able to deliver promised benefits. An important requirement for this assistance, however, is the need for North Korea to significantly rein in its massive criminal cyber-theft activities. Their restraint in this area can also be monitored and, if implemented, separately rewarded.

Verifying the freeze will be a challenging task, requiring a novel approach that departs from more orthodox systems. The verification of agreed limitations with 100% confidence of compliance with every single proscription is not achievable in North Korea. A more probabilistic method would be

more practical and still yield high confidence with overall compliance while focusing on detecting militarily-significant cheating — activities that together produce a measurable upgrade in nuclear activities, rather than individual activities as such. Washington's goal should be to dissuade North Korea from cheating on its obligations while providing early warning if and when it does. For Pyongyang to agree, verification cannot be so intrusive as to induce security paranoia about transparency or trigger its deep mistrust of inspectors from the International Atomic Energy Agency. The scheme should be tailored to the specific features of the agreement, and narrowly focused on the capping rather than the rollback of its nuclear arsenal, banning proliferation activity, and monitoring imports and exports.

At the outset, Washington could stipulate willingness to discuss a vision for sustaining, and perhaps even augmenting through cooperation, North Korea's future peaceful nuclear and space activities. Negotiations on such cooperation could commence once a nuclear cap is in place, as part of a second-phase agreement. Carefully designed and calibrated space and nuclear cooperation could help ensure it would not be abused for illicit activity, while also providing some transparency into ongoing programs. Positive future technical rewards could be a useful incentive to sustain North Korean cooperation during inevitable bumpy periods.

Peace gestures will be a necessary element of a successful strategy, meaning political and military measures to formally, symbolically, and, where possible, practically ease hostility on the Korean Peninsula. Several ideas have been on the table and both American and North Korean negotiators seem to now assume they are part of a package. In his December speech, Kim made reference to U.S. arms transfers to South Korea as well as U.S.-South Korea military exercises, indicating that they remain a North Korean priority.

Washington also ought to practice diplomatic triangulation to win Chinese and Russian support, which will be key to a successful agreement, but also helpful to sustain pressure on North Korea if it remains intransigent. As North Korea's most important trading partners and hosts of North Korean workers, Beijing and Moscow are integral to shaping North Korea's economic environment and both have been arguing for relaxation of U.N. sanctions. American triangulation should attempt to secure their commitments to sustain and fully implement existing sanctions on North Korea if it balks at more modest U.S. demands.

Finally, gaining traction with North Korea to move beyond its zone of comfort probably requires more than an enticing package, namely the credible, though conditional, potential for inflicting additional pain. U.S. officials could posit, for instance, resumption and even an increase in the tempo of American military exercises in the region, enhanced interdiction of illicit shipping, or more aggressive covert steps. A more belligerent U.S. posture would understandably increase risks of conflict, yet this threat could be an important incentive for North Korea to commit to negotiations. Coordination with South Korea, among others, on managing the risks of this approach would be paramount.

Realism not Naivete

A hardline strategy toward North Korea is baked into Washington foreign policy discourse. The reasons for this are many, found not least in Pyongyang's record of provocation and cheating over decades. Yet, key among them is that it remains relatively cost-free for politicians to make unrealistic demands of others, whereas compromise involves political risks.

But the costs of three decades of failed nonproliferation policies are now clear: The United States faces a nuclear-armed North Korea whose arsenal could soon target more American cities, with greater reliability, accuracy, and lethality. This is a looming threat that requires prevention. There is no room for error or magical thinking in dealing with this problem.

Given North Korea's tepid response to recent U.S. overtures, whether it would negotiate with the Trump administration or a potential successor on this basis is highly uncertain. However, ultimately Kim Jong Un wants and needs the U.N. sanctions to be lifted and therefore has motive to negotiate. His December speech clearly left open this possibility. And if and when he chooses to re-engage, asking of him to freeze rather than give up his nuclear insurance policy is a more realistic path to capping the North Korean threat.

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Council on Foreign Relations (New York, N.Y.)

New START: The Future of U.S.-Russia Nuclear Arms Control

By Brian L. Sittlow

Jan. 28, 2020

February 5, 2020, marks one year left on the U.S.-Russia New Strategic Arms Reduction Treaty, known as New START. Washington and Moscow face three choices: to develop a new treaty, extend the terms of the existing treaty for five more years, or go treaty-less on strategic nuclear arms. In the current foreign policy environment, achieving a new strategic arms treaty with Russia in the next twelve months is very unlikely. To avert the abandonment of New START, an extension appears to be the easy choice.

A five-year extension would provide the United States and Russia with breathing space for future negotiations, project a sense of stability in a volatile world, and support U.S. plans to modernize its land-, air-, and sea-based nuclear systems, often referred to as the nuclear triad. Most importantly, it would maintain the current nuclear deterrence posture, a core national security priority.

New START, which was signed in 2010 and took effect on February 5, 2011, aimed to continue long-standing efforts by the United States and Russia to control the size of their nuclear arsenals. It significantly reduced deployed nuclear warheads down to 1,550 from the 2,200 allowed by the 2003 Strategic Offensive Reductions Treaty (SORT). Before that, the 1994 START I Treaty had capped warheads at 6,000. New START also limits the number of launching systems the nuclear triad is allowed to have, including submarine- and land-based ballistic missiles and strategic bombers.

Unlike the Intermediate-Range Nuclear Forces (INF) Treaty, which recently crumbled due to Russia's noncompliance, New START has been a strong example of bilateral cooperation, compliance, and verification. One underpinning of strategic deterrence is transparency. The United States and Russia have embraced this throughout the New START period by adhering to the treaty verification procedures, highlighted by rigorous and cooperative inspections.

What are the benefits of an extension?

The U.S.-Russia relationship has not been smooth of late. U.S. grievances include election interference, Russian influence in Ukraine, Georgia, and the Baltics, INF violations, cyber threats, and the war in Syria. This has resulted in tensions that likely need to calm before diving into

renegotiating a strategic arms control agreement, and a five-year New START extension would allow for that.

It would also reinforce assurances to U.S. allies, by demonstrating that the U.S. strategic arsenal will continue to protect them, as it has steadfastly over the last three decades. An extension would show the world that Washington and Moscow are committed to a verifiable, effective arms control agreement for the benefit of global stability. And it would allow the United States to continue meaningful leadership roles in other areas of nuclear weapons policy, including with India, Iran, Pakistan, and North Korea.

How do other nuclear powers factor in?

China will continue to be a formidable nuclear-armed adversary, but its current stockpile of nuclear warheads is assessed to be one-fifth the size of that of the United States and Russia—and not likely to approach the New START limit of 1,550 deployed warheads in the next decade. Thus, a New START extension would lead to no numerical disadvantage with regard to China's arsenal. On the contrary, showing China and the rest of Asia that the United States can take a pragmatic approach with Russia could help with future arms control negotiations around the world.

What's the future of U.S. deterrence policy?

The U.S. strategic deterrence modernization plan, expected to run nearly $500 billion over the next ten years, is based on the capabilities and nuclear warhead levels established by New START. This includes the development of the new Columbia-class ballistic missile submarine, an updated intercontinental ballistic missile (ICBM) system called Ground Based Strategic Deterrent, and a new bomber, the B-21. Walking away from New START next year could lead to another strategic nuclear arms race, which will mean higher costs, a higher rate of weapons production and refurbishment for the U.S. Department of Energy, and a defense industrial base that could struggle to meet accelerated production timelines.

As the world bounces from one crisis to another, and with a U.S. presidential election limiting the executive branch's bandwidth for a new arms control regime, time is running out. A five-year extension on New START is the right move.

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

AI, Cyberspace, and Nuclear Weapons

By James Johnson and Eleanor Krabill

Jan. 31, 2020

When it comes to artificial intelligence (AI), cyberspace, and national security, there are more questions than answers. But these questions are important, as they touch on key issues related to how countries use increasingly powerful technologies while, at the same time, keep their citizens safe. Few national security topics are as technical as nuclear security. How might the linkages between AI and cyberspace impact the security of nuclear systems?

A new generation of AI-augmented offensive cyber capabilities will likely exacerbate the military escalation risks associated with emerging technology, especially inadvertent and accidental escalation. Examples include the increasing vulnerability of nuclear command, control, and communication (NC3) systems to cyber attacks. Further, the challenges posed by remote sensing technology, autonomous vehicles, conventional precision munitions, and hypersonic weapons to hitherto concealed and hardened nuclear assets. Taken together, this trend might further erode the survivability of states' nuclear forces.

AI, and the state-of-the-art capabilities it empowers, is a natural manifestation — not the cause or origin — of an established trend in emerging technology. the increasing speed of war, the shortening of the decision-making timeframe, and the co-mingling of nuclear and conventional capabilities are leading states to adopt destabilizing launch postures.

The AI-Cyber Security Intersection

AI will make existing cyber warfare capabilities more powerful. Rapid advances in AI and increasing degrees of military autonomy could amplify the speed, power, and scale of future attacks in cyberspace. Specifically, there are three ways in which AI and cyber security converge in a military context.

First, advances in autonomy and machine learning mean that a much broader range of physical systems are now vulnerable to cyber attacks, including, hacking, spoofing, and data poisoning. In 2016, a hacker brought a Jeep to a standstill on a busy highway and then interfered with its steering system causing it to accelerate. Furthermore, machine learning-generated deepfake (i.e., audio or video manipulation), have added a new, and potentially more sinister, twist to the risk of miscalculation, misperception, and inadvertent escalation that originates in cyberspace but has a very real impact in the physical world. The scale of this problem ranges from smartphones and household electronic appliances, to farming equipment, roadways, and pacemakers — these applications are associated with the ubiquitous connectivity phenomena known as the Internet of Things.

Second, cyber attacks that target AI systems can offer attackers access to machine learning algorithms, and potentially vast amounts of data from facial recognition and intelligence collection and analysis systems. These things could be used, for example, to cue precision munitions strikes and support intelligence, surveillance, and reconnaissance missions.

Third, AI systems used in conjunction with existing cyber offense tools might become powerful force multipliers, thus enabling sophisticated cyber attacks to be executed on a larger scale (both geographically and across networks), at faster speeds, simultaneously across multiple military domains, and with greater anonymity than before.

Many of the ways AI augments cyber capabilities to develop AI-enhanced cyber weapons (or "adversarial AI") may appear relatively benign, for example, enumerating the target space or repackaging malware to avoid detection. However, the speed and scope of the next generation of AI cyber tools will likely have destabilizing effects.

The machine speed of AI-augmented cyber tools could enable even a low-skilled attacker to penetrate an adversary's cyber defenses. It could also use advanced persistent threat tools to find new vulnerabilities. For example, air-gapped, nuclear-powered submarines considered secure when submerged could become increasingly vulnerable to a new generation of low-cost — and possibly black-market — highly automated advanced persistent threat cyber attacks when docked for maintenance.

An attacker could also apply AI machine learning techniques to target autonomous, dual-use early warning and other operating systems (e.g., NC3; intelligence, surveillance, and reconnaissance; early warning; and robotic control networks) with "weaponized software" such as hacking, subverting, spoofing, or tricking. This could cause unpredictable and potentially undetectable errors, malfunctions, and behavioral manipulation to weapons systems, also known as "data poisoning."

This is a problem because AI machine learning systems need high quality datasets to train their algorithms. Injecting "poisoned" data into those training sets could lead these systems to perform in undesired and potentially undetectable ways. Furthermore, as the linkages between digital and physical systems — the Internet of Things — expand, the potential for an adversary to use cyber attacks in both kinetic and non-kinetic attacks will increase.

A significant risk in the operation of autonomous systems is the time that passes between a system failure (i.e., performing in a manner other than how the human operator intended), and the time it takes for a human operator to take corrective action. If the system failure is the result of a deliberate act, this timeframe will be compressed.

How AI and Cyber Could Improve Nuclear Security

AI could actually improve nuclear security. Several U.S. national security officials believe that AI, used as a force multiplier for both defensive and offensive cyber weapons, will have a transformative impact on cyber security. Recent advances in machine learning have significantly contributed to resolving several technical bottlenecks in several fields of AI, which make significant qualitative improvements to a wide range of autonomous weapon systems.

Taken together, machine learning and autonomy could transform nuclear security in a multitude of ways, with both positive and negative implications for cyber security and strategic stability.

On the one hand, AI might reduce a military's vulnerability to cyber attacks. AI cyber-defense tools (or "counter-AI"), designed to recognize changes to patterns of behavior in a network, detect anomalies and software code vulnerabilities, and apply machine learning techniques, such as "deep learning," to identify deviations from normal network activity, could form a more robust defense against cyber intrusions. For example, if certain code fragments mimic existing malware structures, machine leaning algorithms might be used to locate vital evidence to ascertain the identity of an attacker.

With this goal in mind, the Defense Department's Defense Innovation Unit is prototyping an application that leverages AI to decipher high-level strategic questions, map probabilistic chains of events, and develop alternative strategies. This could make Defense Department systems more resilient to AI-augmented cyber attacks and configure and fix errors faster than humans.

On the other hand, autonomy itself will likely increase a military's vulnerability to cyber attacks. AI will increase the anonymity of attacks in cyberspace, which rely on stealth, deception, and stratagem. An adversary could, for example, use malware to take control, manipulate, or fool the behavior and pattern-recognition systems of autonomous systems, as a team of Chinese white hatters wirelessly and remotely did against a Tesla Model X.

Similar attacks against modern weapons systems would be relatively easy to execute but very difficult to detect and attribute, and therefore to counter. Ironically, the use of machine learning to strengthen cyber security might simultaneously increase the points at which an attacker can interact, and thus potentially manipulate, or otherwise interfere with, a network.

New Risks to the Security of Nuclear System

During the early stages of a cyber operation, it is generally unclear whether an adversary intends to collect intelligence or prepare for an offensive attack. The blurring of cyber offense-defense will likely compound an adversary's fear of a preemptive strike and increase first-mover incentives. In extremis, strategic ambiguity caused by this issue may trigger use-them-or-lose-them situations.

Open-source research suggests, for example, that Chinese analysts view the vulnerability of China's NC3 to cyber infiltrations — even if an attacker's objective was limited to cyber espionage — as a highly escalatory national security threat. By contrast, Russian analysts tend to view Russia's nuclear command, control, communications, and intelligence (C3I) network as more isolated, and thus, relatively insulated from cyber attacks.

To be sure, even a modicum of uncertainty about the effectiveness of AI-augmented cyber capabilities during a crisis or conflict would, therefore, reduce both sides' risk tolerance, increasing the incentive to strike preemptively.

Furthermore, any potential advantages from enhanced reassurances premised on comprehensive intelligence would require equal access to intelligence and analysis systems between great and rising powers. Shared confidence in the accuracy and credibility of these systems would also be needed. Most optimistically, the intentions of all rival states would need to be genuinely benign. In a world of "revisionist" rising powers, the prospects of such a rosy outcome seems improbable.

Against the backdrop of a competitive strategic environment in which states are inclined to assume the worst of others' intentions, one state's efforts to enhance the survivability of its strategic forces may be viewed by others as a threat to their nuclear retaliatory capability or second-strike capacity.

During crisis conditions, for example, an offensive AI cyber tool that succeeds in compromising an adversary's nuclear weapon systems — resulting in an "asymmetric information" situation — could cause either or both sides to overstate (or understate) their retaliatory capabilities, and in turn, be more inclined to act in a risky and escalatory manner.

It is now thought possible that a cyber attack (i.e., spoofing, hacking, manipulation, and digital jamming) could infiltrate a nuclear weapons system, threaten the integrity of its communications, and ultimately (and possibly unbeknown to its target) gain control of both its nuclear and non-nuclear command and control systems.

AI has not yet evolved to a point where it could credibly threaten the survivability of a state's nuclear second-strike capability. However, recent reports of successful cyber attacks against dual-use, early-warning systems suggests that cyber intrusions against NC3 is fast becoming a reality. Irrespective of the technical feasibility of "left of launch" operations (i.e., a preemptive operation to prevent an adversary launching its missiles) against NC3 systems, the perception alone that this capability exists would be inherently destabilizing. Moreover, while the veracity of these counterforce capabilities remains highly contested, several states, including the United States, have

already shifted their strategic force postures and doctrine to reflect these emergent threat perceptions.

Somewhat paradoxically, AI applications designed to enhance cyber security for nuclear forces could simultaneously make cyber-dependent nuclear weapon systems (e.g., communications, data processing, or early-warning sensors) more vulnerable to cyber attacks.

Pathways to Escalation

AI-enhanced cyber attacks against nuclear systems would be almost impossible to detect and authenticate, let alone attribute, within the short timeframe for initiating a nuclear strike. According to open sources, operators at the North American Aerospace Defense Command have less than three minutes to assess and confirm initial indications from early-warning systems of an incoming attack. This compressed decision-making timeframe could put political leaders under intense pressure to make a decision to escalate during a crisis, with incomplete (and possibly false) information about a situation.

Ironically, new technologies designed to enhance information, such as 5G networks, machine learning, big-data analytics, and quantum computing, can also undermine its clear and reliable flow and communication, which is critical for effective deterrence.

Advances in AI could also exacerbate this cyber security challenge by enabling improvements to cyber offense. Machine learning and AI, by automating advanced persistent threat (or "hunting for weaknesses") operations, might dramatically reduce the extensive manpower resources and high levels of technical skill required to execute advanced persistent threat operations, especially against hardened nuclear targets.

Information Warfare Could Lead to Escalation

Machine learning, big data analytics, and sensing technologies, supported by 5G networks, could alert commanders of incoming threats with increased speed and precision. This could result in fewer accidents in the sensitive command and control environment. However, this technological coalescence will also amplify risks of escalation in two ways: First, AI machine learning used as a force multiplier for cyber offense — e.g., data poisoning spoofing, deepfakes, manipulation, hacking, and digital jamming — would be considerably more difficult to detect, especially if an attacker used advanced persistent threat tools in the spectrum-contested environment. Second, in the unlikely event that an attack was successfully detected, threat identification (or attribution) at machine speed would be virtually impossible. In short, the key security challenge lies not in making more convincing fakes, but in detecting the spread of false information.

AI machine learning techniques might also exacerbate the escalation risks by manipulating the digital information landscape, where decisions about the use of nuclear weapons are made. Given current tensions between the United States and other nuclear powers — China, Russia, and North Korea — it is possible to imagine unprovoked escalation caused by a malicious third-party (or state-proxy) clandestine action.

During a crisis, the inability of a state to determine an attacker's intent may lead an actor to conclude that an attack (threatened or actual) was intended to undermine its nuclear deterrent. For example, an AI-enabled, third-party-generated deepfake, coupled with data-poisoning cyber attacks, could spark an escalatory crisis between two (or more) nuclear states.

As demonstrated at a recent workshop hosted by the International Institute for Strategic Studies, malign manipulation of input data received by early-warning systems might not only subvert the output of AI systems in a specific situation, but also undermine the reliability of an entire algorithm network environment if executed during the program's training phase.

Consider the following fictional scenarios, in which the use of deepfakes and spoofing by nefarious third-party, non-state, or state-proxy actors triggers unintentional and unprovoked escalation.

Fictional Example #1: Deepfakes

To incite conflict between two rival states, State A uses proxy hackers to launch deepfake video or audio material, which depicts senior military commanders of State B conspiring to launch a preemptive strike on State C. Then, this deepfake footage is deliberately leaked into State C's AI-augmented intelligence collection and analysis systems, provoking State C to escalate the situation with strategic consequences. State B responds to the threat of preemption with a retaliatory strike.

Escalation in this case would, of course, be deliberate. Thus, increased escalation risk as a result of technology is not always inadvertent or accidental. For example, escalation risks caused by the aggressive U.S.-Soviet expansion of counterforce technology during the Cold War reflected shifting nuclear doctrines on both sides (i.e., away from assured mutual destruction), not the pursuit of these technologies themselves. Moreover, AI technology could enable an adversary to pursue a predetermined escalatory path. In fact, AI may be developed precisely for this purpose.

Fictional Example #2: Spoofing

State A launches a malicious AI-enhanced cyber attack to spoof State B's AI-enabled autonomous sensor platforms and automated target recognition systems, in such a way that the weapon system (a human-supervised automated target recognition system) is fooled into interpreting a civilian object (a commercial airliner, for example) as a military target. State B, based on subverted information and the inability of human supervisors to detect the spoofed imagery in time to take corrective action, accidentally (and unintentionally) escalates the situation.

In this example, the spoofing attack on the weapon systems' algorithm is executed in such a way that the imagery appears to the recognition system as indistinguishable from a valid military target, escalating the situation based on a false premise that would be unlikely to fool the human eye. AI experts have proven that even when data appears accurate to AI image recognition software, these systems often hallucinate objects that do not exist.

The explainability (or "black box") problem associated with AI applications may further compound these dynamics. Insufficient understanding of how and why AI algorithms reach a particular judgment or decision would complicate the task of determining if datasets had been deliberately compromised to manufacture false outcomes — such as attacking incorrect targets or misdirecting allies during combat.

Furthermore, as humans and AI team up to accomplish particular missions, the opacity associated with how AI systems reach a decision may cause an operator to have either too much or too little confidence in a system's performance.

Consequently, unless the system's machine learn-ing algorithm is terminated, once deployed at the end of the training phase it could potentially learn something it was not intended to, or even perform a task or mission that its human designers do not expect it to do. This issue is one of the main reasons why the use of AI machine learning in the context of weapon systems is, for now, confined to mostly experimental research.

Even if nuclear early-warning systems might eventually detect the subversion, heightened levels of uncertainty and tension caused by an alert may impel the respective militaries to put their nuclear weapons on high alert status. This skewed assessment in the context of nuclear weapons, ready to launch at a moment's notice, would likely precipitate worst-case scenario thinking that may spark inadvertent escalation.

Therefore, AI-augmented cyber intelligence gathering tools (or espionage) used during a crisis could easily be misinterpreted by an adversary as a prelude for a preemptive attack on its nuclear force.

Conclusion

Rapid advances in military-use AI and autonomy could amplify the speed, power, and scale of future attacks in cyberspace via several interconnected mechanisms — the ubiquitous connectivity between physical and digital information ecosystems; the creation of vast treasure troves of data and intelligence harvested via machine learning; the formation of powerful force multipliers for increasingly sophisticated, anonymous, and possibly multi-domain cyber attacks.

AI systems could have both positive and negative implications for cyber and nuclear security. On balance, however, several factors make this development particularly troublesome. These include the increasing attacks vectors which threaten states' NC3 systems, a new generation of destabilizing, AI-empowered cyber offensive capabilities (deepfakes, spoofing, and automated advanced persistent threat tools), the blurring of AI-cyber offense-defense, uncertainties and strategic ambiguity about AI-augmented cyber capabilities, and not least, a competitive and contested geo-strategic environment.

At the moment, AI's impact on nuclear security remains largely theoretical. Now is the time, therefore, for positive intervention to mitigate (or at least manage) the potential destabilizing and escalatory risks posed by AI and help steer it toward bolstering strategic stability as the technology matures.

The interaction between AI and cyber technology and nuclear command and control raises more questions than answers. What can we learn from the cyber community to help us use AI to preempt the risks posed by AI-enabled cyber attacks? And how might governments, defense communities, academia, and the private sector work together toward this end?

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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."