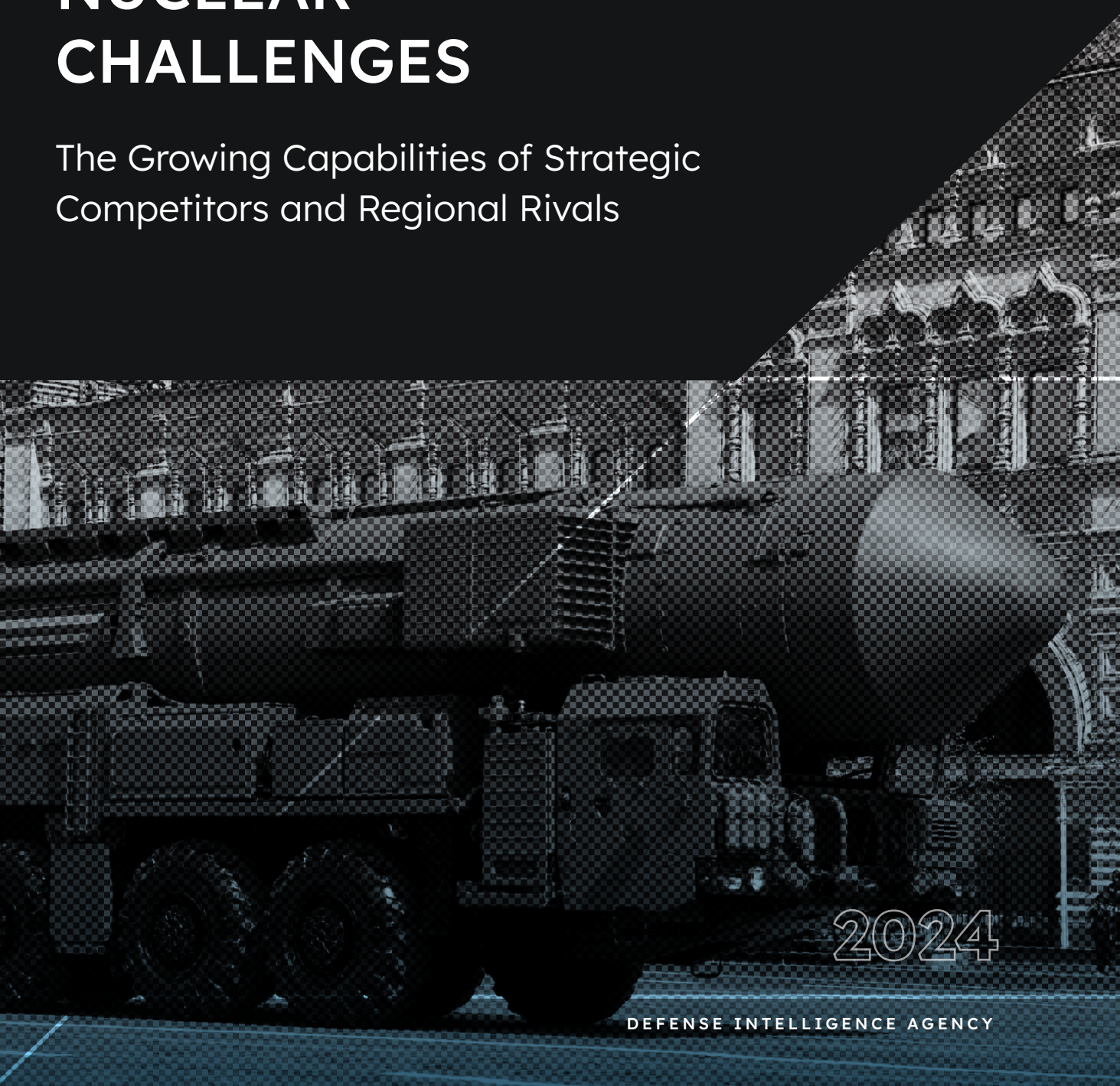
ADVANCED CAPABILITIES

NUCLEAR CHALLENGES

The Growing Capabilities of Strategic Competitors and Regional Rivals



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Cover image: An SS-27 ICBM travels through Red Square as part of a May 2023 Military Parade.

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Scope Note

Global Nuclear Landscape was first published in early 2018 to address the nuclear programs of China, Russia and North Korea, and nuclear developments in Iran. This second edition, titled *Nuclear Challenges: The Growing Capabilities of Strategic Competitors and Regional Rivals*, provides an updated, unclassified overview of the nuclear programs of Russia, China, North Korea, and Iran.

The United States continues to face challenges from strategic competitors and regional rivals who have and are developing new nuclear-capable delivery systems. The threats from more advanced cruise missiles, ballistic missiles, hypersonic glide vehicles, and other novel delivery systems, coupled with growing nuclear arsenals, are threatening U.S. military advantages.

Since Russia expanded its war on Ukraine in February 2022, Russian leaders have employed rhetoric evoking Russian nuclear weapon capabilities in order to influence Western action. Beijing continues to outfit hundreds of intercontinental ballistic missile (ICBM) silos built to support the largest nuclear expansion in Chinese history.

North Korean forces remain active, performing simulation drills to load and launch nuclear weapons to threaten the United States and its allies in the region; in 2022, they performed more than 150 missile tests. Tehran continues to stockpile enriched uranium far in excess of the Joint Comprehensive Plan of Action (JCPOA) limits—shortening the time that Tehran would require to produce sufficient weapons-grade uranium for a single nuclear device, should Tehran decide to do so.

In addition to ongoing state nuclear programs, the proliferation of weapons of mass destruction-applicable goods, knowledge, and technology continues to be a focus area for the Defense Intelligence Agency. Specialized procurement networks (and potential state-to-state cooperation) can provide procurement pathways for dual-use goods, materials, technologies, and expertise for weapons of mass destruction programs and their delivery systems. The proliferation of delivery systems include both countries of concern, such as China, Iran, North Korea, and Russia, and other countries interested in acquiring these technologies. These networks remain resilient and adaptable in the face of a robust international framework of sanctions, export controls, and other prohibitions which limit the purchase or transfer of weapons of mass destruction, including applicable goods, to specific countries or entities. Such efforts directly support the advancement, development, expansion, and survivability of weapons of mass destruction capabilities around the world.

Selected Nuclear Capable Delivery Systems

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Class of Nuclear Weapon	Inventory
Chinese Nuclear Military Capability	
Air-Launched Ballistic Missile (ALBM)	●
Hypersonic Glide Vehicles (HGVs)	●
Intercontinental Ballistic Missiles (ICBMs)	●
Intermediate-Range Ballistic Missiles (IRBMs)	●
Medium-Ranged Ballistic Missiles (MRBMs)	●
Submarine-Launched Ballistic Missiles (SLBMs)	●
Russian Nuclear Military Capability	
Air-Launched Cruise Missiles (ALCMs)	●
Air-Launched Ballistic Missile	○
Air-to-Surface Missiles (ASMs)	●
Air-to-Air Missiles (AAMs)	●
Anti-Ballistic Missile (ABMs)	●

● System Deployed ○ System Under Development

Selected Nuclear Capable Delivery Systems (Cont'd.)

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Class of Nuclear Weapon	Inventory
Russian Nuclear Military Capability	
Antiship Cruise Missiles (ASCMs)	●
Antisubmarine Weapons (ASWs)	●
Close-Range Ballistic Missiles (CRBMs)	●
Coastal Defense Cruise Missile	○
Depth Charges	●
Gravity Bombs	●
Ground Launched Cruise Missiles (GLCMs)	●
Hypersonic Glide Vehicles (HGVs)	●
Intercontinental Ballistic Missiles (ICBMs)	●
Nuclear-Armed, Nuclear-Powered Underwater Vehicle	○
Nuclear-Powered Ground Launched Cruise Missile	○
Ship-Launched Cruise Missile (SCLM)	●
Short-Range Ballistic Missiles (SRBMs)	●
Submarine-Launched Ballistic Missiles (SLBMs)	●
Surface-to-Air Missiles (SAMs)	●
Torpedoes	●
North Korean Nuclear Military Capability	
Intercontinental Ballistic Missiles (ICBMs)	○
Submarine-Launched Ballistic Missiles (SLBMs)	○
Intermediate-Range Ballistic Missiles (IRBMs)	○
Medium-Ranged Ballistic Missiles (MRBMs)	●
Short-Range Ballistic Missiles (SRBMs)	●
Close-Range Ballistic Missiles (CRBMs)	○

● System Deployed ○ System Under Development

Executive Summary

Countries with mature nuclear weapons programs are increasing stockpiles and/or program capabilities. Russia, China, and North Korea are modernizing their legacy stockpiles by incorporating advanced technologies to penetrate or avoid missile defense systems. Countries are also developing nuclear weapons with smaller yields, improved precision, and increased range for military or coercive use.

China. Beijing has far surpassed earlier growth estimates assessed in 2018, and is currently exceeding 500 deliverable nuclear warheads in its stockpile. By 2030, we estimate that China will have more than 1,000 operational nuclear warheads—most of which will be fielded on systems capable of ranging the continental United States. China probably also seeks lower-yield nuclear warhead capabilities to provide proportional response options that its high-yield warheads cannot deliver. For example, China is increasing its stockpile of theater-range delivery systems, such as the DF-26 intermediate-range ballistic missile (IRBM).

Approximate Nuclear Weapon Stockpiles

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	2018	2024
China	200 warheads	More than 500 warheads
Russia	About 1,500 deployed strategic warheads; up to 2,000 non-strategic warheads	About 1,550 deployed strategic warheads; up to 2,000 non-strategic warheads

President Putin announced Russia would suspend participation in New START on 21 February 2023.

Russia. Over the past 4 years, Russia has maintained the largest foreign nuclear stockpile in the world. Moscow maintains about 1,550 deployed strategic nuclear warheads on ICBMs and submarine-launched ballistic missiles (SLBMs), as well as a force of heavy bombers which are capable of carrying long-range air-launched cruise missiles (ALCMs). Under the New Strategic Arms Reduction Treaty (New START) counting rules, the heavy bombers count as one warhead each, but each bomber is capable of carrying eight or more air-launched cruise missiles. Russia also maintains a stockpile of up to 2,000 nuclear weapons which are designed to be incorporated into delivery systems with ranges shorter than those laid out in the New START treaty; these are commonly referred to as non-strategic nuclear weapons.

North Korea. North Korea has demonstrated the capability to produce plutonium and highly enriched uranium, and continues to increase the stockpile of these materials to support its nuclear weapons program. In early 2021, Kim Jong Un laid out a 5-year defense plan that emphasized developing tactical nuclear weapons, and further highlighted the importance of developing "smaller and lighter nuclear weapons," and "ultra-large nuclear warheads."[1]

Iran. Currently, Iran almost certainly does not have nuclear weapons and has agreed not to seek, develop, or acquire nuclear weapons. However, since 2019, Iran has exceeded several of the JCPOA's limits, including the limits on the quantity and enrichment levels of its uranium stockpile, the locations where Iran enriches uranium, the number and types of enriching centrifuges, and the research and development with uranium metal.

Delivery Systems

Strategic competitors and regional rivals to the United States continue to develop new nuclear weapon-capable delivery systems. These new systems often have longer range, better accuracy, and in some cases, a greater capability to defeat missile defenses.

China. The PLA Rocket Force is developing new ICBMs that will significantly improve its nuclear-capable missile forces and will require increased nuclear warhead production for multiple independently targetable reentry vehicle capabilities

and general force growth. The PLA Rocket Force also continues to grow its inventory of road-mobile DF-26 IRBMs, which can conduct both conventional and nuclear precision strikes against ground targets as well as conventional strikes against naval targets. China has also fielded two more Type 094 JIN-class submarines for a total of six nuclear-powered ballistic missile submarines (SSBNs)—providing a capability for continuous peacetime deterrence patrols. Beijing has established a nascent air leg of a nuclear triad with the H-6N bomber which is capable of both aerial-refueling and carrying a nuclear-capable air-launched ballistic missile. In addition, China's test of a global-range nuclear-capable hypersonic glide vehicle (HGV) in July 2021 has demonstrated its technical ability to field a Fractional Orbital Bombardment System (FOBS).

Russia. In early 2018, President Putin announced new advanced nuclear weapons he claimed were capable of evading current U.S. countermeasures. These weapons were the Sarmat ICBM, Avangard hypersonic glide vehicle, Kinzhal hypersonic missile, Skyfall nuclear-powered cruise missile, and the Poseidon nuclear-powered underwater vehicle. Both the Sarmat ICBM and the Avangard fall under the auspices of New START. Additionally, Russia is currently developing new ballistic missile submarines and has armed its heavy bombers with high-precision cruise missiles. Moscow continues to support the SSC-8 ground-launched, intermediate-range, nuclear-capable cruise missile program.

North Korea. North Korea established the Strategic Force (previously known as the Strategic Rocket Forces) in 2012 and has described this organization as a nuclear-armed ballistic missile force. The Strategic Force includes units operating SRBMs, MRBMs, IRBMs, and ICBMs, each of which represent a nuclear-capable system class as stated by North Korea. North Korea continues to violate UN Security Council Resolutions and conducts launches of ballistic missile systems. In 2022, North Korea conducted dozens of missile tests—including its first IRBM and ICBM launches since 2017—to accelerate long-term missile and nuclear research and development (R&D) goals.[2,3,4,5,6,7,8] In 2022, North Korea also indicated that the army performed drills to simulate the loading and launching of nuclear weapons in order to threaten the United States and its regional allies.[9,10,11,12,13,14,15,16]

Iran. While Iran does not have a nuclear weapon, it continues to develop ballistic missile systems to increase their accuracy and lethality. Currently, the Iranian missile force is the largest in the Middle East and serves as Iran's primary conventional deterrent, capable of striking targets 2,000 kilometers from its borders. Iran continues to develop space-launch vehicles with boosters that could be capable of ICBM ranges if configured for that purpose.

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China

China is undergoing the most rapid expansion and ambitious modernization of its nuclear forces in history—almost certainly driven by an aim for enduring strategic competition with the U.S. and a goal to actualize intensified strategic concepts that have existed for decades but are now being realized.[17,18,19,20]

China is fielding and developing a range of new nuclear capabilities that include its largest buildup of nuclear missile silos; ground-mobile, air-launched, and submarine-launched weapons; nuclear-capable HGVs; as well as C4ISR capabilities to support a launch-on-warning posture.[21,22,23,24,25,26] China probably will introduce new capabilities which carry the potential to destabilize the status quo over the next decade as it develops concepts for new systems' use and integrates them into its broader warfighting and deterrence doctrine.

Rapidly Expanding Nuclear Warhead Stockpile

China is fielding new nuclear capabilities at a faster pace than any time in its history.[27,28] In 2020, the DoD estimated China's operational nuclear warhead stockpile was in the low 200s and was expected to at least double by 2030. Beijing probably accelerated its nuclear expansion as its stockpile is now more than 500 operational nuclear warheads and is on track to exceed previous projections. While China's nuclear stockpile is well below U.S. and Russian inventories, it has not declared an end goal nor acknowledged the scale of its expansion, and continues to limit engagement in substantive arms control discussions.[29,30]

By 2030, we estimate that China will have over 1,000 operational nuclear warheads, most of which will be fielded on systems capable of ranging the continental United States.[31,32] Most of this stockpile growth is likely to come from the following PLA Rocket Force developments:

- A silo-based solid-propellant missile project likely consisting of about 300 silos.[33,34] These silos are capable of fielding both DF-31 and DF-41 class ICBMs.[35,36,37]
- Silo-based liquid-propellant missile expansion; increasing the number of brigades while simultaneously increasing the number of launchers per brigade.[38,39,40,41]
- Mobile ICBM expansion; establishing additional mobile ICBM brigades while increasing the number of launchers per brigade from 6 to 12.[42,43,44]
- Theater capabilities expansion; establishing additional brigades of nuclear and conventional-capable DF-26 IRBMs.[45,46,47]

Nuclear Strategy and Force Posture

China's nuclear strategy is based on PLA deterrence of an enemy first strike and counterstrike when deterrence fails, threatening retaliation against an adversary's military capability, population, and economy.[48,49,50,51] PLA

DF-26 IRBM. China continues to field the dual-capable DF-26 IRBM that constitutes its first ever precision-strike nuclear capability. The comingling of nuclear and conventional capabilities raises the potential for inadvertent escalation during a conflict. Note the hinged payload access compartment, (inset) which is unique among China's nuclear capable systems. | Image Source: DoD

planners very likely intend to avoid a protracted series of nuclear exchanges, and state that the scale and intensity of retaliatory force needs to be carefully controlled.[52] China's public declaratory "no first use" (NFU) policy is consistent with this approach to using nuclear force.[53]

- China's nuclear strategy probably includes consideration of a nuclear strike in response to a nonnuclear attack threatening the viability of China's nuclear forces or C2, or that approximates the strategic effects of a nuclear strike, despite the NFU policy.[54] Beijing probably would also consider using its nuclear force if a conventional military defeat in Taiwan gravely threatened the regime's survival.[i]

i For additional details, please see DOD's Military and Security Developments Involving the People's Republic of China 2023: Annual Report to Congress

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China's Inconsistent Message and Action

Chinese officials have rejected claims that their nuclear weapons stockpile is undergoing substantial increases despite a body of evidence demonstrating otherwise:

2016 President Xi elevates Rocket Force to a service to act as a core force of strategic deterrence.[55]

2018 President Xi: "Our sea-based nuclear force needs to develop greatly."[56]

Launch-on-Warning

The PLA is implementing a launch-on-warning (LOW) posture where it would be able to, upon warning of missile strike, launch a counterstrike before an enemy first strike can detonate. PLA writings suggest multiple manned C2 organs are involved in this process, warned by space- and ground-based sensors, and that this posture is broadly similar to the U.S. and Russian LOW posture. The PRC probably seeks to keep at least a portion of its nuclear force, especially its new silo-based units, on a LOW posture, and since 2017, the PLARF has conducted exercises involving early warning of a nuclear strike and launch-on-warning responses.

The PLA likely seeks a diverse nuclear force, comprised of systems ranging from lower-yield precision-strike missiles to ICBMs with multi-megaton yields.[63,64] This force is intended to ensure China can inflict unacceptable damage with both proportionate and overwhelming retaliatory capabilities, thus denying an adversary victory if a conflict escalates to the nuclear domain.[65]

China's nuclear modernization almost certainly is an expansion of a longer-running trajectory of nuclear development, probably intensifying and expanding—rather than reinventing—early strategic concepts. The modernization is driven by multiple factors, including strategic ambitions, near- and medium-term security interests, technological capabilities, and parochial interests of military and industrial stakeholders. These factors include the following:

- In the 1980s, Chinese senior leadership abandoned a number of nuclear modernization initiatives because China lacked the technical base to attain them and because they judged the international environment much more benign than before.[66] By around 2010, with an improved manufacturing technology base, the PLA sought to build a larger nuclear force than it fielded during the 20th century.[67] Portions of that force revived previously shelved concepts to be actualized over the 2010s and 2020s, to include "early warning counterstrike" (the PLA term for launch-on-warning), regional

2019

China's Foreign Ministry states that all nuclear weapon states should diminish the role of nuclear weapons in national security doctrines, abandon launch-on-warning strategies, and refrain from developing low-yield nuclear warheads.[57]

China's defense white paper highlights nuclear capability as strategic cornerstone and calls for enhanced strategic deterrence capability.[58]

China unveils its "triad" at its National Day Parade.[59,60]

2021

President Xi puts forward 14th Five-Year-Plan national defense requirements during a speech at the National People's Congress, calling to accelerate the creation of high-level strategic deterrence.[61]

2022

China's Foreign Ministry states "On the assertions made by U.S. officials that China is expanding dramatically its nuclear capabilities, first, let me say that this is untrue."[62]

precision nuclear strike, and advanced missile defense penetration capabilities.[68,69]

- China continues to pursue at least qualitative or technical parity with an increasing scope of U.S. and Russian capabilities.[70] This effort is part of a drive to have a "world class" military appropriate for a "great modern socialist country" by mid-century.[71] Beijing views the United States as increasingly determined to contain China. It is increasingly willing to confront the United States and other countries in areas where interests diverge.[72]

- China is developing capabilities to "counterbalance"—directly counter or strategically obviate—assessed U.S. military advantages.[73] Beijing's perception of U.S. military superiority almost certainly reinforces its commitment to develop and field advanced conventional and nuclear capabilities, as well as improve warfighting capabilities in emerging domains like cyber and space.[74,75,76]

Recently Fielded Capabilities and Ongoing Improvements

In addition to its nuclear expansion, the PLA is conducting a sweeping modernization and improvement campaign.[77,78] Over the last 5 years, China has probably achieved the following nuclear force milestones:

- Established a air leg of a newly formed triad—composed of PLA land, sea, and air forces—with the H-6N bomber capable of aerial refueling and carrying a nuclear-capable air-launched ballistic missile.[79,80] China publicly displayed this bomber during its 2019 National Day parade.[81]

DF-41 road mobile ICBM. China continues to field its first road-mobile ICBM with MIRV capability. This system likely has improved range and accuracy over DF-31 class ICBMs.
| Image Source: DoD

- Fielded DF-26 IRBMs, China's first precision-strike nuclear capability.[82] Chinese officials claim the "U.S. withdrawal [from the Intermediate Range Nuclear Forces Treaty] will have a direct negative impact on global strategic stability."[83] Concurrent with this criticism, it fielded thousands of weapon systems, including the DF-26, that would be covered by the treaty if China were to participate.[84]

- Fielded two more Type 094 JIN-class submarines for a total of six SSBNs—providing enough capability for continuous peacetime deterrence patrols.[85,86] Additionally, China has improved upon the JL-2 SLBM by fielding the more capable and longer-range JL-3, allowing China to range CONUS from protected bastion areas such as the South China Sea.[87,88]

- Fielded DF-31 class transporter-erector-launcher (TEL)-based road mobile ICBMs, that likely have improved survivability and lethality over previous versions.[89,90]

- Fielded the DF-41, China's first road-mobile ICBM with MIRV capability.[91] This system likely is intended to carry no more than three warheads per missile and has improved range and accuracy over DF-31 class ICBMs.[92,93]

Future Nuclear Capabilities

China almost certainly plans to continue substantial upgrades to all three legs of its nuclear triad, including: upgrades to existing weapons classes such as single and multiple warhead versions of the DF-5 liquid-propellant ICBM; a new SSBN class probably intended to field MIRVed SLBMs, judging from past developmental trends; and a strategic stealth bomber, according to Chinese state media.[94,95,96,97]

China very likely is also working to introduce a variety of completely new nuclear capabilities to its arsenal, some of which will be fielded in the near future, if not already fielded. These include the following

- A new "early warning counterstrike" posture similar to launch-on-warning or launch-under-attack supported by an array of space-based and ground-based sensors.[98] At a minimum, China will likely incorporate its silo-based ICBM forces into this posture.[99] President Putin has stated that Moscow is aiding China's ballistic missile early warning system.[100]

- ICBM-range nuclear-armed HGVs. On 27 July 2021, China conducted a test of an HGV that traveled 40,000 kilometers. China likely intends to field this capability to evade U.S. missile defenses.[101,102,103,104]

- China probably seeks lower-yield nuclear warhead capabilities to provide proportional response options that its high-yield warheads cannot deliver, judging from a variety of sources. These sources include Chinese military

DF-31AG Road Mobile ICBM. China is fielding DF-31 class TEL-based road mobile ICBMs that likely have improved survivability and lethality over previous versions. | Image Source: DOD

writings, Chinese strategist publications, a defense industry publication, China's 2019 defense white paper (which called for a world-class military), and subsequent President Xi guidance (which calls for enhanced and accelerated strategic deterrence).[105,106,107,108] China announced in 2019 that all nuclear-weapon states should diminish the role of nuclear weapons in their national security doctrines and refrain from developing low-yield nuclear warheads.[109] However, China likely initiated a low-yield nuclear warhead development program prior to this statement.[110]

- China's global-range test of a nuclear-capable HGV in July 2021 demonstrates its technical ability to field a FOBS. China probably will pursue an operational FOBS capability judging from its long-term concerns about U.S. missile defense capabilities.[111,112,113]

- Beijing continues evaluating the utility and feasibility of developing and fielding other novel nuclear delivery systems.[114,115,116,117]

Nuclear Materials Production and Testing Activity

China is establishing new nuclear materials production and reprocessing facilities which are very likely intended to support its nuclear force expansion.[118,119] While these efforts are consistent with China's goals to increase nuclear energy generation and to close its nuclear fuel cycle, Beijing likely also considers this dual-use infrastructure as crucial to supporting its military goals, judging from Chinese nuclear industry reporting and think tank publications.[120] Despite China's public support for a fissile material cutoff treaty, China probably intends to use this infrastructure to produce additional nuclear warhead materials for its military in the near-term.[121,122]

- **Plutonium.** China is constructing two CFR-600 sodium-cooled fast breeder nuclear reactors at Xiapu, each capable of producing enough plutonium for dozens of nuclear warheads annually from blankets surrounding the core, according to think tank estimates and suggestions in Chinese state media and Chinese nuclear industry reporting.[123,124] China originally planned to use Russian-sourced mixed-oxide (MOX)[ii] fuel for these reactors, but changed the order to use highly enriched uranium (HEU) fuel through 2030, according to nuclear industry reporting.[125,126,127] By using HEU fuel, the reactors have the potential to generate additional weapons-grade plutonium. China is constructing multiple new reprocessing plants that could extract this plutonium, according to a Western think tank.[128]

- China has reduced transparency in its nuclear program as its capabilities are increasing. China is capable of producing plutonium in existing reactors and separating it at its only operational reprocessing plant in Jiuquan, judging from Chinese state media.[129] Since 2015, China has removed this reprocessing facility from its annual publication of civilian nuclear fuel production, fabrication, storage, and reprocessing facilities. Additionally, it ceased reporting its stockpile of separated plutonium to the International Atomic Energy Agency (IAEA) in 2017.[130]

i Blankets refer to uranium placed around the fuel core for the purpose of breeding plutonium.
ii MOX fuel is a blend of uranium and plutonium.

- **Uranium and Tritium.** In the past several years, China's organization traditionally associated with military uranium enrichment has expanded production capacity and likely will continue to do so.[131] China is also working to expand and diversify its capability to produce tritium by methods such as using tritium production targets in reactors and extraction from tritiated heavy water, according to Chinese nuclear industry reporting. Tritium is used to enhance the efficiency and yield of nuclear bombs.

In recent years, China's possible preparation to operate its Lop Nur nuclear test site year-round and lack of transparency on its nuclear testing activities have raised concerns regarding its adherence to the U.S. "zero yield" standard also adhered to by the United Kingdom and France in their respective nuclear weapons testing moratoria.[132,133]

Outlook

Beijing's pursuit of enhanced nuclear deterrence over the next decade probably will increase leadership confidence—and the risk of miscalculation—as the PLA makes gradual improvements in its ability to signal and counter the U.S. The PLA's accompanying doctrinal concepts for employing these new nuclear capabilities probably remain nascent, which may introduce a period during the next several years of escalatory risks because of insufficiently established and predictable tactics, techniques, and procedures. Coupled with PLA officers' downplaying the risks of imperfect information

Building Air Based Nuclear Capabilities. The improved H-6N bomber constitutes the nascent air leg of China's nuclear triad. Distinct from the H-6K pictured above and other variants, the H-6N has an air-to-air refueling capability and a recessed fuselage that can carry a nuclear armed air-launched ballistic missile. China intends to surpass this capability with the H-20 stealth strategic bomber that is under development. | Image Source: AFP

President Xi Jinping has stated China's "sea-based nuclear force needs to develop greatly." Here he is commissioning a Type 094 SSBN in April 2021. With six SSBNs now in service, China has enough to establish continuous peacetime deterrence patrols. These submarines have SLBMs with the capability to range the United States from Chinese waters. | Image Source: Navalpost

management during crises, inexperience managing nuclear crises, and their perceptions that they can elicit intended adversary responses while maintaining sufficient battlefield awareness, Beijing may accept greater risks as its nuclear doctrine and capabilities mature.[134] As China continues its effort to accelerate nuclear modernization and expansion, we expect to see the following developments—listed in no particular order—that will blur conventional and nuclear boundaries:

- **Nuclear Deterrence in Conventional Crises.** Beijing probably will seek to increasingly integrate nuclear deterrence during conventional crises as part of a unified multidomain crisis-management framework. The PLA continues to discuss conventional and nuclear signaling, war control, counterspace, and cyberspace operations as a means for crisis management.[135]

- **Lower-Yield Warhead.** Chinese military writings have noted that the introduction of new precise small-yield nuclear weapons could allow for the controlled use of theater-range nuclear weapons for warning and deterrence.[136] Such discussions provide PLA's doctrinal basis for limited nuclear employment on the battlefield, suggesting Chinese nuclear thinkers could be reconsidering their long-standing view that nuclear war is uncontrollable.[137]

Chinese Expansion of Nuclear and Warning Capabilities

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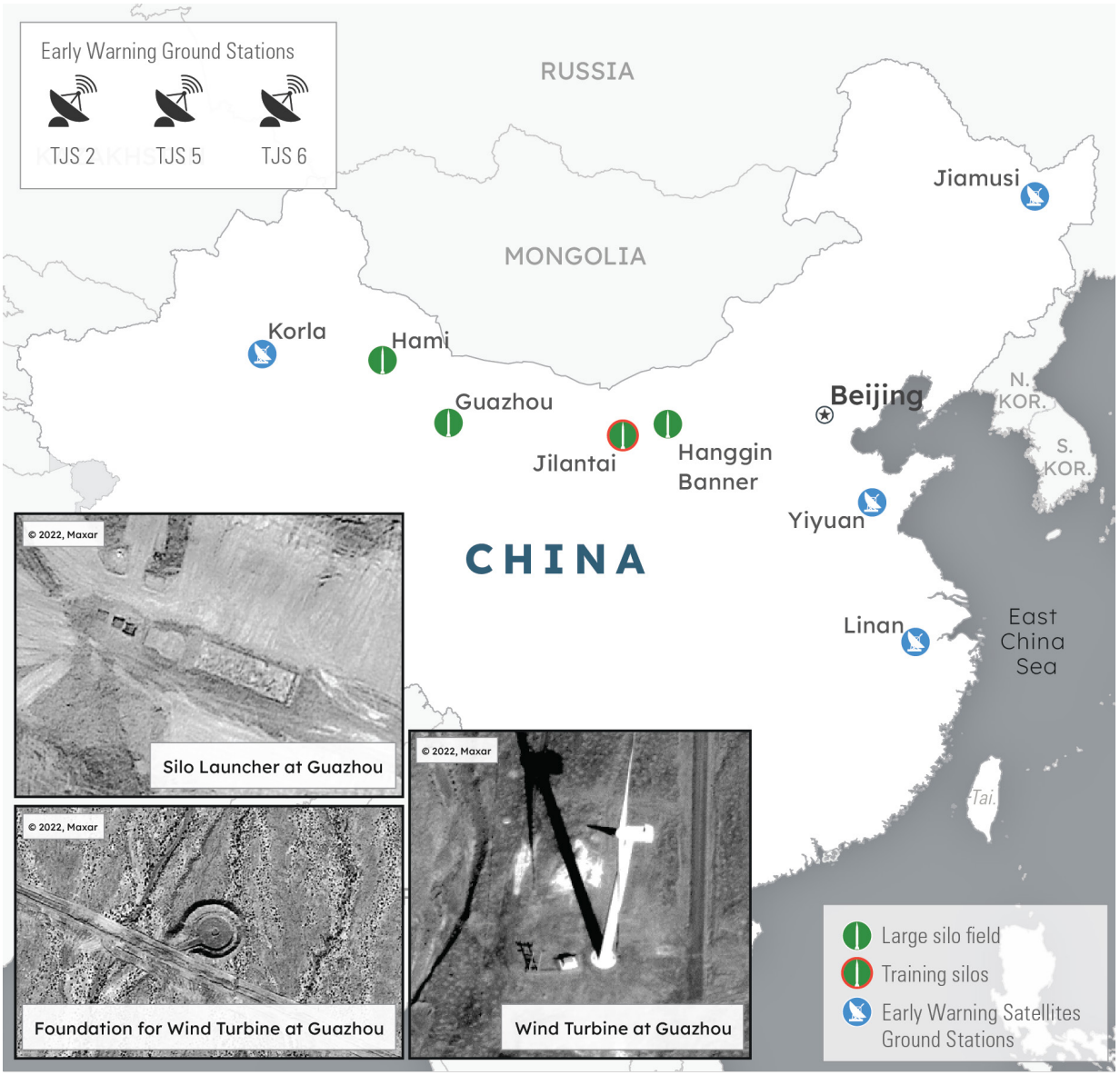

China is investing immense resources into a nuclear expansion including air-, sea-, and land-based nuclear capabilities. This graphic depicts the locations of three large solid-propellant missile silo fields representing a portion of China's land-based nuclear expansion. When complete, these fields likely will comprise over 300 silos capable of fielding DF-31 and DF-41 class ICBMs and alone represent the largest expansion of China's arsenal in history. Chinese state media has attempted to depict this silo buildout as construction for wind turbine farms. China likely will tie at least these forces to a developing launch-on-warning posture.

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Russia

Overview

Russia is nearing the completion of the current round of modernization of its strategic nuclear forces. This has been one of Moscow's top budgetary priorities over the past decade. It has successfully introduced new intercontinental ballistic missiles, ballistic missile submarines, and long-range air-launched cruise missiles. Russia also is adding new military capabilities to its large stockpile of nonstrategic nuclear weapons (NSNWs), including those employable by ships, aircraft, and ground forces. Russia currently has a stockpile of up to 2,000 NSNWs.

History/Origin

Russia inherited its nuclear weapons program from the former Soviet Union. During the Cold War period, the Soviet Union developed the largest and most sophisticated foreign nuclear weapon program in the world. By 1986, the Soviet Union's nuclear warhead stockpile reached a total of more than 40,000 warheads in its inventory.[138,139,140]

Arms Control

Since the inception of nuclear weapons, several treaties have placed limitations on Soviet—now Russian—nuclear testing and weapon stockpiles. The Partial Test Ban Treaty, signed by the Soviet Union, United States, and the United Kingdom in 1963, prohibited all nuclear explosions in environments other than underground. Underground testing was subsequently limited to no more than 150 kilotons by the Threshold Test Ban Treaty (TTBT), signed in July 1974 and entered into force in December 1990. Under Section IV, paragraph 2, of the June 1990 Protocol to the TTBT, each party is required, by no later than June 1 of each year, to inform the other of the number of underground nuclear weapons tests by specified category that it intends to conduct in the following calendar year.

The Intermediate-Range Nuclear Forces Treaty, signed in 1987, eliminated missiles and launchers for ground-launched ballistic and cruise missile systems with ranges between 500 km and 5,500 km; however, the United States withdrew from this treaty in 2019, citing Russian noncompliance.[141]

The Comprehensive Nuclear Test Ban Treaty, which Russia signed in 1996 and ratified in 2000, would ban any nuclear weapon test explosion in any environment. Russia rescinded its ratification in November 2023, but remains a signatory to the treaty.

The U.S.-Soviet Strategic Arms Reduction Treaty, known as START I, was signed in 1991 and was the first treaty to mandate deep reductions in both countries' strategic nuclear weapons. In 2002, President Bush and President Putin signed the Treaty Between the U.S. and the Russian Federation on Strategic Offensive Reductions, reducing the number of accountable strategic nuclear warheads to 1,700-2,200 per country. New START was signed by the U.S. and the Russian Federation on 8 April 2010, further limiting the number of strategic warheads each country is allowed to deploy to 1,550.[142,143,144,145,146] In 2021,

New START was renewed for another five years (until 4 February 2026).[147] In August 2022, Moscow announced it would not allow any U.S. inspections under New START, and in February 2023, Moscow announced that participation in the treaty would be suspended. Russia also announced in February 2023 it would abide by the central limits.

Doctrine

Russia views the use of nuclear weapons as primarily for deterrence but maintains the right to use such weapons in response to what it views as an existential threat. Russia's military and deterrence doctrine states it would consider using nuclear weapons under conditions including imminent threats from ballistic missiles and other weapons of mass destruction, or massed conventional strikes that constitute an existential threat against the Russian state.

The main function of Russia's strategic forces is effective, reliable deterrence. Scenarios for the use of strategic nuclear forces fall into three main categories: first strike, counterstrike (launch on warning, prior to impact in-country), and retaliatory strike (response after impacts in-country). The retaliation option imposes the most difficult situation on the strategic forces—which must respond even after an enemy's strategic strike has impacted and disabled elements of the force. Therefore, strategic forces, weapons, and battle management systems are designed and built to be hardened, stealthy, redundant, and reliable—and trained to function in a WMD-degraded environment.[148]

Russia spent approximately 8.6 billion USD in 2021 to upgrade the capacity of its strategic nuclear triad (ICBM, SLBM, and heavy bombers).[149] Russia's nuclear force modernization goals include: replace Soviet-legacy nuclear weapons with modern nuclear weapons and platforms, maintain rough parity with the U.S.' strategic nuclear arsenal, improve the survivability and efficiency of its nuclear weapons, and maintain prestige on the international stage. Russia's nuclear modernization includes both strategic and non-strategic nuclear weapons (NSNWs).[150,151,152,153]

Nuclear Capability/Stockpile

New START (as entered into force on 5 February 2011) stipulates that both sides must meet treaty limits by February 2018 and maintain them through the treaty's expiration (currently in February 2026). The central treaty requirement is a limit of 1,550 deployed nuclear warheads on three strategic platforms: ICBMs, SLBMs, and heavy bombers. Each heavy bomber capable of delivering nuclear weapons is counted as a single warhead. There is also a combined limit of 800 deployed and non-deployed ICBM and SLBM launchers and heavy bombers equipped for nuclear armaments, and a separate limit of 700 deployed strategic systems overall.[154] Russia declared under New START on 1 September 2022 1,549 warheads on 540 deployed ICBMs, SLBMs, or heavy bombers.[155] President Putin announced that Russia would suspend participation in New START on 21 February 2023, but the Russian Ministry of Foreign Affairs announced it would continue to abide by the central limits.[156]

NSNWs are any nuclear weapons that are not covered by New START. Russia currently has an active stockpile of up to 2,000 NSNWs. These items include ASMs, SRBMs, gravity bombs, depth charges for medium-range bombers, tactical bombers, and naval aviation, as well as anti-ship, anti-submarine,

Russian Nuclear Rhetoric

Starting prior to the Russian invasion of Ukraine in February 2022, Russian leadership used nuclear rhetoric to emphasize the potential for Russian escalation should NATO directly intervene in the assessed forthcoming conflict. Both President Putin and former President Dmitry Medvedev repeatedly made comments that either explicitly or implicitly indicated that Russia would use nuclear weapons in response to a threat to Russia's existence.

One specific example is from September 2022, when President Putin claimed that he was not bluffing when he threatened to use nuclear weapons to defend Russia.[157,158]

Russian President Vladimir Putin in late September 2022 insinuated that Russia would use nuclear weapons to defend the territorial integrity of the soon-to-be annexed Ukrainian territory. | Image Source: AFP

and anti-aircraft missiles and torpedoes for surface ships and submarines, and Moscow's antiballistic missile system.[159,160,161]

Nuclear Weapons Complex

Rosatom is the state corporation in charge of Russia's nuclear complex. In addition to its civil nuclear power responsibilities, Rosatom develops, tests, manufactures, and dismantles nuclear munitions at the facilities seen below. As part of Russia's nuclear modernization program, Rosatom is updating its warhead production complex[162,163] and is producing new nuclear warheads each year. As an example, in 2015, Russian President Putin claimed more than 40 ICBMs/SLBMs would be produced that year.[164] Each missile can carry up to 6 warheads, indicating Russia probably produced more than 200 warheads in 2015.

Budget

Moscow's 2018-27 State Armaments Program gives priority to the modernization of Russia's strategic nuclear forces as well as delivery systems in the Russian naval, air, and ground force inventories.[165] Russia's 2022 defense budget allocated an estimated $3–18 billion USD for nuclear military programs; these programs include the research, development, and acquisition of nuclear warheads; air, land, and sea-based delivery systems; and supporting infrastructure.[166]

Delivery Systems

Russia's strategic nuclear weapons triad consists of the Strategic Rocket Force (SRF), SSBNs belonging to the Russian Naval High Command, and Long-Range Aviation (LRA).

Moscow has several Borey class SSBNs in service, and future construction will likely replace existing Delta-IV SSBNs.
| Image Source: AFP

SRF

The SRF's missile inventories are equally split between road-mobile and silo-based ICBMs. Russia recently began to modernize the Strategic Rocket Forces' capabilities and thus phase out Soviet-era legacy systems.[167] Russia expected that by the end of 2023, advanced weapons would account for approximately 95 percent of the SRF's overall capabilities. Russia aspires to have 100 percent modernization by the end of 2024.[168,169] According to the Russian press, the Avangard HGV, which began development in 2003, was successfully tested in 2018.[170] The Avangard has been integrated into the SS-19 Mod 4 ICBM. Russia continues to field the SS-27 (RS-24, IOC 2010) ICBM while the Rubezh road mobile ICBM (RS-26) remains in development, and is probably suffering from delays.[171,172,173] Russian press reporting at the end of 2022 indicated the Sarmat missile would enter into service in 2023, but seems to be delayed.[174,175]

Russian Nuclear Weapon Related Facilities

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SSBNs

The sea-based leg of Russia's triad contains at least 10 SSBNs under operational control of the Naval High Command. Russia appears to have phased-out the liquid-fueled SS-N-18 (first deployed in 1978) deployed on Delta III-class submarines, with the last such submarine now serving in a multi-role capacity.[176,177,178,179,180,181] The remaining systems are the liquid-fueled SS-N-23 (IOC 2005 for the Sineva variant), deployed on Delta IV-class submarines, and the solid-fueled SS-N-32 (IOC 2014) deployed on Borey-class submarines. These missiles have the capability to carry four and six multiple independently targetable re-entry vehicles (MIRVs), respectively. The Russian Strategic Navy is modernizing by adding new Borey-class submarines, and building and deploying more of the new SS-N-32 SLBMs.[182,183,184,185]

LRA

Russia's fleet of strategic bombers constitutes the air element of its strategic nuclear triad. Like other components of the triad, the LRA's main strategic assets—Tu-95 Bear and Tu-160 Blackjack bombers—are being modernized to continue operating beyond 2030. Russia has announced that it will resume production of Tu-160M2 bombers, and will complete development of a new generation bomber (Russian designation: PAK-DA) within a decade, but timelines for both programs may slip if financial difficulties persist. The new bomber design is expected to have some stealth capabilities, short- or rough-runway capabilities, and to employ both conventional and nuclear armament.[186,187]

Russia will restart production of Blackjack bombers (pictured above) as a stop-gap measure until the PAK-DA bomber is ready to be fielded. | Image Source: AFP

Russia is developing the Tsirkon hypersonic missile that may have a nuclear delivery mission. The Tsirkon is a hypersonic missile that can be launched from multiple platforms, and boasts speeds of up to Mach 9 with a range between 500 and 1,000 km. The speed and short flight time leave little time for air defenses to shoot them down. Moscow claimed the first deployment of the conventional version of the missile in 2023.

Outlook

Moscow will continue to emphasize nuclear weapons in its national strategy, while building new delivery systems and modernizing its nuclear stockpile, primarily by replacing Soviet-legacy non-strategic nuclear weapons with new weapons having new capabilities. The escalation of conflict with Ukraine and Russia's suspension of the New START Treaty represent two key areas of continuing risk.

Putin's Big Six [188]

In early 2018, Russian President Vladimir Putin announced new advanced weapons with the ability to evade current U.S. countermeasures. Five of the announced weapons were nuclear delivery systems: the Sarmat ICBM, Avangard HGV, Kinzhal hypersonic missile, Skyfall nuclear-powered missile, and Poseidon nuclear-powered underwater vehicle – the sixth announced weapon was Peresvet anti-satellite laser deployed to Russian forces starting in 2018. Both the Sarmat ICBM and the Avangard HGV fall under the auspices of New START. The Avangard hypersonic glide vehicle is currently deployed and the conventional version of the Killjoy has been used against Ukraine.

- **Sarmat ICBM.** The Sarmat ICBM, also known as Satan 2, began development in 2016. Russia conducted a successful first launch in 2022. It can carry different types of nuclear weapons up to the megaton class. The Sarmat ICBM will have the range to hit any target in the world. In the video simulation shown during Putin's address to the Duma, in March 2018, the Sarmat was shown ranging over the South Pole to reach the U.S. In October 2023, President Putin stated that work was almost complete on the Sarmat.

- **Avangard.** The Avangard HGV, which has already been integrated into the SS-19 Mod 4 ICBM, functions as a hypersonic weapon and is designed to eliminate U.S. homeland ballistic missile defenses. The system uses an ICBM booster to reach an altitude of 100 kilometers, staying below the reach of ballistic missile defenses, and then descends to the target at 33,000 km/hr.

- **Kinzhal.** The Kinzhal hypersonic missile, also known as the Killjoy, is an air-launched ballistic missile (ALBM). It has a speed of 12,231 km/hr, and has the ability to make in-flight maneuvers. The Kinzhal has a range of up to 2,000 kilometers. The conventional version of the Kinzhal has been used against a variety of targets, including underground targets, in Ukraine.

- **Skyfall.** The Russian MoD presented this cruise missile as having a nuclear-powered engine, which would theoretically give it intercontinental range, in addition to the ability to fly for several days. A Russian press release stated that the Skyfall's nuclear reactor was successfully tested in early 2019. The missile remains in the testing phase and underwent a catastrophic failure in 2019, which killed 5 scientists during the missile recovery operation. All tests prior to 2019 were reported to have resulted in a crash. The 2023 season was hailed as a success by President Putin, claiming in October 2023 that "a final successful test has been held." The system has not yet been formally certified for combat.

- **Poseidon.** The Poseidon nuclear-powered underwater vehicle is an unmanned, underwater system that carries a megaton-class nuclear warhead to target enemy ports. Testing was conducted in early 2021. The Poseidon likely can travel at high speeds underwater due to its nuclear propulsion.

A new strategic delivery system, the Sarmat heavy ICBM (see text box), will replace the Soviet-legacy SS-18 heavy ICBM. Russia will also continue to produce Borey-class SSBNs and associated Bulava SLBM to replace the aging Delta-IV submarines. Moscow will also replace Soviet-era non-strategic systems with more modern and accurate systems, although the scale and pace of this modernization effort will be impacted by the conflict in Ukraine as many of these delivery systems are capable of carrying both conventional and nuclear warheads.

North Korea

Overview

North Korea's national security strategy revolves around two key objectives: to maintain political legitimacy and to deter external attacks. Additional aspirations include the attainment of regional power and the peninsula's reunification. Since the mid-2000s, North Korea has prioritized developing the capability to strike adversaries with conventional- or WMD-armed ballistic missiles, while maintaining a conventional military capable of inflicting enormous damage to South Korea.[189] North Korea has demonstrated the capability to produce plutonium and highly enriched uranium, has conducted nuclear tests, and has developed new ballistic missile systems intended to strike regional and CONUS targets.[190,191,192,193,194,195,196,197,198]

Pyongyang's current strategic priorities are reflected in several trends observed over the course of Kim Jong Un's leadership to date.[199]

- Routinization of ballistic missile flight tests and training launches;[200]
- Expansion of the numbers and types of nuclear-capable delivery systems;[201]
- Public emphasis on the linkage between North Korea's nuclear weapons program and its ballistic missiles, along with rhetoric seeking to persuade international audiences that North Korea has the capability for nuclear-armed ballistic missile strikes against the United States and regional allies.[202]

History

The North Korean nuclear program began in the late 1950s with research cooperation agreements from the Soviet Union. North Korea's first research

Joint Declaration on the Denuclearization of the Korean Peninsula

In 1992, North and South Korea signed a declaration which provided that:

- Neither shall test, manufacture, produce, receive, possess, store, deploy, or use nuclear weapons.
- Both shall use nuclear energy solely for peaceful purposes.
- Neither shall possess nuclear reprocessing and uranium enrichment facilities.

Both sides exchanged instruments to bring the declaration into force by 19 February 1992. Implementation actions ultimately became part of the Agreed Framework process, but North Korea overtly conducted nuclear reprocessing, uranium enrichment, and nuclear test activities inconsistent with the declaration which led to the breakdown of the Agreed Framework in 2002.[203]

Six-Party Talks and Leap Day Arrangement

Because of concerns about North Korea's covert enriched uranium program following the breakdown of the Agreed Framework, the Six-Party Talks were held from 2003 to 2007. The talks included North and South Korea, China, Russia, Japan, and the U.S.[204] During the fifth round of talks, North Korea agreed to shut down its nuclear facilities in exchange for fuel aid and steps towards the normalization of relations with the U.S. and Japan.[205,206] However, in April 2009, North Korea's failed satellite launch triggered condemnation from the UN Security Council. North Korea then used this condemnation to justify a nuclear test in May of that year.[207]

On 29 February 2012, the U.S. and North Korea announced a "Leap Day" arrangement where the United States would provide substantial food aid in return for North Korea agreeing to a moratorium on uranium enrichment and missile testing, and a return of IAEA inspectors to Yongbyon; this lead to a resumption of the Six-Party Talks. On 6 April 2012, North Korea attempted another satellite launch, which failed to enter into orbit. The launch was described by the U.S. as a provocative test of missile technology, and the United States subsequently announced the suspension of food aid to North Korea.[208,209]

reactor, supplied by the Soviet Union, began operating in 1967, and North Korea later built a nuclear reactor at Yongbyon with an electrical power rating of 5 electrical megawatts. This reactor began operating in 1986 and is capable of producing about 6 kg of plutonium annually. Later that same year, high-explosives testing and a reprocessing plant to separate plutonium from the reactor's spent fuel were detected. Construction of additional nuclear reactors could provide North Korea with additional sources of plutonium for a larger-scale nuclear weapons program.[210]

Nuclear Arms Control

The Nonproliferation Treaty and Agreed Framework. North Korea joined the Nonproliferation Treaty (NPT) in 1985, but inspections under the NPT's safeguards regime only started 7 years later. This gap invited questions from the U.S. about North Korea's plutonium production. In 1994, North Korea pledged to freeze and eventually dismantle its plutonium programs under the Agreed Framework with the United States. At that time, a number of sources estimated that North Korea had separated enough plutonium for one or two nuclear weapons. North Korea complied with the framework, allowed the IAEA to place seals on spent fuel from the Yongbyon reactor, and allowed remote monitoring and onsite inspections at its nuclear facilities.[211]

Breakdown of the Agreed Framework. In 2002, negotiators from the U.S. confronted North Korea with evidence of a clandestine uranium enrichment program, a claim that North Korean officials publicly denied. The conflict over whether North Korea had a uranium enrichment program led to the breakdown of the Agreed Framework, including

North Korea's January 2003 announcement that it was withdrawing from the NPT; North Korea withdrew from the treaty in April 2003.[212] North Korea also responded to a halt of fuel oil shipments by removing the international monitors and seals at the Yongbyon facility and restarting its plutonium production infrastructure.[213]

Doctrine

The steady development of modern ballistic missile systems highlights North Korea's intention to develop and maintain a survivable nuclear weapon delivery capability.[214,215,216,217,218,219] This capability, along with high-level statements of nuclear usage at the first sign of a U.S. or South Korea strike, suggests potential for usage at any stage of a crisis or conflict.[220,221,222] Regime statements suggest that as its force size increases and capabilities improve, North Korea's nuclear weapons rationale is shifting from a sole focus on deterrence with limited battlefield effect to limited/discretionary nuclear use on the Korean peninsula with the goal of managing escalation and ending a conflict quickly.[223,224] Additionally, regime statements suggest North Korea's use options and target selection will evolve as its nuclear force grows, potentially lowering its nuclear use threshold in the coming years.[225]

Nuclear Capability/Stockpile

North Korea established a Strategic Force (previously known as the Strategic Rocket Forces) in 2012 and has described this organization as a nuclear-armed ballistic missile force. The Strategic Force includes units identified to operate SRBMs, MRBMs, IRBMs, and ICBMs, each of which North Korea has stated represents a nuclear-capable system class. For example, North Korea claimed that the ballistic missile launched in April 2022 was developed as part of its nuclear deterrent system.[226] In early 2021, Kim Jong Un laid out a 5-year defense plan that emphasized developing tactical nuclear weapons, and further highlighted the importance of developing "smaller and lighter nuclear weapons," and "ultra-large nuclear warheads."[227]

Infrastructure and Testing

North Korea has demonstrated the capability to produce kilogram-quantities of plutonium for nuclear weapons and has claimed to possess the ability to produce enriched uranium for nuclear weapons.[228,229] This contextualizes North Korea's establishment, and subsequent expansion, of an enrichment facility at Yongbyon, as well as concerns raised by North Korea regarding its ability and intention to product uranium-based nuclear weapons.[230,231]

North Korea has conducted six underground nuclear tests since 2006, according to seismic detections and public claims by North Korean media.[232,233] Each successive test has demonstrated higher explosive yield, according to seismic data.[234] North Korea claimed the September 2017 test was a test of a "hydrogen bomb" intended for use on an ICBM. North Korea has exclusively used the underground nuclear test facility in the vicinity of Punggye-ri for these nuclear tests. In early 2018, some parts of this facility were disabled as North Korea announced that it no longer needed to conduct nuclear tests.[235] However, press reporting from 2022 suggests North Korea has taken steps to restore the test site and it could now be ready to

conduct a nuclear test.[236] Additionally, North Korea publicly stated its intention to diversify its nuclear payload options.[237]

Delivery Systems

North Korea is committed to developing long-range, nuclear-armed missiles that are capable of posing a direct threat to the U.S. In January 2021, Kim Jong Un laid out a 5-year defense plan stating Pyongyang's objective to enhance its "nuclear long-range striking capabilities." Since then, North Korea has flight-tested multiple long-range systems to include two new ICBMs (HS-17 and -18) and claimed to have flight-tested theater-range HGVs, according to North Korean state media reporting.[238,239,240,241,242,243,244,245] North Korea publicly unveiled testing of the Hwasong-17 ICBM on 24 March 2022,[246] a system that it paraded in October 2020.[247]

North Korea officials observe the demolition ceremony at the Punggye-Ri nuclear test facility in May 2018. | Image Source: AFP

North Korea has several different SRBM and MRBM systems available for use in strikes against targets on the Korean Peninsula and Japan. In the past 5 years, North Korea has diversified its ballistic missile force to include solid-fueled systems. Solid-propellant missiles offer operational advantages over liquid-fueled systems, eliminating the time required to fuel a missile before firing it.[248] In September 2021 and January 2022, North Korea test-launched solid-propellant SRBMs from a rail-based TEL, describing this system as a railway-borne missile.[249] In October 2021, North Korea tested a new solid-propellant SLBM that is smaller than the solid-propellant SLBM Pukguksong-3 that it flight tested in October 2019, and closely resembles previously launched SRBMs.[250,251] In 2022, North Korea conducted dozens of missile tests—including its first IRBM and ICBM launches since 2017—to accelerate long-term missile and nuclear R&D goals.[252,253,254,255,256,257,258] In 2022, North Korea also indicated that the army performed drills to simulate the loading and launching of nuclear weapons to threaten the U.S. and its regional allies.[259,260,261,262,263,264,265,266] In April 2023, North Korea flight-tested its first solid-propellant ICBM, the Hwasong-18.

Efforts to Improve Capability

North Korea aims to continue development of its nuclear weapons and delivery options. This was highlighted during the 8th Workers' Party Congress held in January 2021 when Kim Jong Un called for the advancement of nuclear capabilities to include "ultra-large" and "smaller and lighter" tactical nuclear weapons.[267] Since then, North Korea has conducted a large number of missile test launches to include a new system Pyongyang stated as enhancing its tactical nuclear operation; additionally, North Korea has started reconstitution efforts at the Punggye-ri nuclear

test site.[268,269,270,271,272,273,274,275,276] During the April 2022 military parade celebrating the 90th anniversary of the Korean People's Revolutionary Army, Kim expressed the need to rapidly modernize its nuclear forces at the "fastest possible speed."[277]

The entrance to a tunnel at the Punggye-Ri nuclear test site prior to the May 2018 demolition ceremony. | Image Source: AFP

North Korean Nuclear Developments

Kim claimed, during a January 2021 update to the Eighth Congress of the Workers Party of Korea, that North Korea advanced its capabilities to "make nuclear weapons miniaturized, light-weight, standardized, and tactical weapons" and completed the development of "super-large hydrogen bombs."[278] DIA interprets this is a reference to creating smaller diameter, single-stage fission devices and completing the design of its thermonuclear weapon. These new developments may be driving the need for a nuclear test to validate its performance.[279]

Nuclear Proliferation

Pyongyang probably would be willing to proliferate nuclear expertise or technology if it believed it could keep the relationship covert, deniable, or claim it was supporting a peaceful civilian nuclear program.[280] Prior to 2007, North Korea provided Libya with uranium hexafluoride (UF6), the form of uranium used in the uranium enrichment process to produce fuel for nuclear reactors and nuclear weapons, through the proliferation network of Pakistani nuclear scientist Abdul Qadeer Khan.[281,282,283,284] North Korea also provided Syria with nuclear reactor technology until 2007.[285,286]

Iran

Overview

Iran almost certainly does not have nuclear weapons and has publicly agreed not to seek, develop, or acquire nuclear weapons.[287,288] However, Iran's strategic goals of strengthening deterrence, prestige, and nuclear energy capabilities have led Tehran to develop a civilian nuclear program with the ability to build missile-deliverable nuclear weapons following a decision to do so.[289,290]

History

Iran's interest in nuclear technology dates back to the 1950s under the Shah, when it began receiving assistance through the U.S. Atoms for Peace program. This initiative later included the Tehran Research Reactor, a 5-megawatt thermal research reactor. Iran signed the NPT as a non-weapons state, and ratified the agreement in 1970.[291,292] However, in what may have been an attempt to intimidate regional adversaries, the Shah once said Iran would have nuclear weapons "without a doubt and sooner than one would think."[293] In the mid-1970s, Iran unveiled ambitious plans to expand its nuclear power program.[294] These plans were halted following the 1979 Islamic Revolution.[295,296]

In the late 1980s, Iran established an undeclared nuclear program as managed through the Physics Research Centre (PHRC) and overseen through a scientific committee by the Defense Industries Education Research Institute. The PHRC was subordinate to the Ministry of Defense and Armed Forces Logistics (MODAFL).[297] In the late 1990s, the PHRC was consolidated under the "Amad Plan," which was essentially Iran's coordinated and comprehensive effort to develop a nuclear weapon.[298] However, in late 2003, Ayatollah Ali Khamenei declared that Iran is "against any production of weapons of mass destruction in any form," and Iran halted its nuclear weapons program. This action was primarily in response to increasing international scrutiny and pressure resulting from the exposure of Iran's previously undeclared nuclear work and Operation ENDURING FREEDOM in Afghanistan and Operation IRAQI FREEDOM in Iraq.[299,300] After the halt, Iran continued its efforts to develop uranium enrichment technology, which it first declared to the IAEA in early 2003, when it stated it was constructing two uranium enrichment facilities at Natanz.[301] Iran also constructed an uranium enrichment facility near the city of Qom, where it began enriching uranium to near-20-percent levels in mid-2011.[302,303,304]

4 March 2023 – DG Rossi of the AIEA and Eslami, the head of AEOI | Image Source: AFP

Joint Plans

In April 2015, a framework was announced to limit Iran's nuclear program that built on an initial 2013 agreement—the interim Joint Plan of Action—which, among other restrictions on Iran's nuclear program, curbed Iran's production of near-20 percent enriched uranium.[305,306] On 14 July 2015, Iran and the the United States, United Kingdom, France, Germany, China, and Russia, along with the EU, finalized the Joint Comprehensive Plan of Action (JCPOA), whereby Iran agreed to significantly curtail its nuclear program in exchange for sanctions relief. Iran and the P5+1 implemented the JCPOA, with its associated limits, on 16 January 2016.[307]

The United States withdrew from the JCPOA in May 2018. A year later, Iran began expanding its nuclear program beyond JCPOA limits to compel sanctions relief, build negotiating leverage, and respond to perceived Israeli covert attacks against its nuclear program.[308,309,310,311,312,313] Since 2019, Iran has exceeded several of the JCPOA's limits, including limits on: the quantity and enrichment of its uranium stockpile, the locations where Iran enriches uranium, the number and types of enriching centrifuges, and conducting R&D with uranium metal.[314] On 23 February 2021, Iran also halted all inspections beyond its IAEA Comprehensive Safeguards Agreement, as part of implementing a law passed by Iran's Parliament in December 2020 titled the "Strategic Action Plan to Lift Sanctions and Protect Iranian Nation's Interests."[315,316] As part of a temporary technical understanding between the IAEA and Iran, Iran allowed JCPOA surveillance and monitoring equipment to continue operating and be serviced, but would only share the data with the IAEA after it gained sufficient

sanctions relief. This scenario would allow the IAEA to recover continuity of knowledge of the activities covered by the monitoring equipment if (and when) Iran resumed implementation of its nuclear-related commitments under the JCPOA.[317] In June 2022, Iran informed the IAEA that it would remove all surveillance and monitoring equipment not required by Iran's Safeguards Agreement; this action was taken in response to an IAEA resolution passed by the IAEA's Board of Governors which criticized Iran for its failure to cooperate with ongoing safeguards investigations at three sites where undeclared nuclear activities occurred in 2003.[318,319]

Missile Developments

The Iranian missile force is the largest in the Middle East and can strike targets up to 2,000 km from Iran's borders.[320] Domestic industry-led accuracy improvements have enabled Tehran to routinely use conventionally armed ballistic missiles in strikes against regional adversaries over the past few years; this is a trend that will almost certainly continue in 2024. Iran continues to improve the accuracy and effectiveness of its ballistic missiles; these efforts include increasing the lethality and anti-ship capabilities of SRBMs and also the accuracy and warheads of MRBMs.[321,322,323]

Since at least 2016, Iran has also revealed land attack cruise missiles (LACMs) that could complicate regional missile defense.[324,325,326,327] Iran continues to develop space launch vehicles (SLV) with boosters that could be capable of ICBM ranges if configured for that purpose.[328] In early November 2022, Iran claimed it conducted a suborbital test of a staged, solid-propellant SLV.[329,330,331]

Nuclear Challenges: Outlook

Our competitors and potential adversaries are investing heavily in new nuclear weapons and associated delivery systems. Events over the past year have emphasized the continuing importance countries place on nuclear capabilities. The ongoing growth of China into a near-peer nuclear competitor will continue to be an essential DIA focus area. The weakness exhibited by Russia's conventional forces in their invasion of Ukraine may increase Moscow's reliance on nuclear capabilities going forward. Both Russia and China are likely to field weapons with improved accuracy and ability to circumvent missile defense. North Korea continues to expand nuclear and missile delivery capabilities in defiance of United Nation Resolutions. Tehran is stockpiling enriched uranium far in excess of JCPOA limits while continuing to test missiles that hold much of the Middle East region at risk.

As the global geopolitical environment becomes more competitive, additional countries may investigate nuclear proliferation. Growing questions about security guarantees, heightened regional pressures, and the continued development of nuclear technology and its knowledge-sharing may create a geopolitical scenario in which countries that previously had declined the pursuit of nuclear weapons reconsider their options. This dynamic possibility could create additional nuclear challenges.

Opposite page: Iranian Foreign Minister Hossein Amir-Abdollahian meets with Director General Rafael Grossi of the International Atomic Energy Agency in March 2022 to discuss undisclosed activities at three Iranian facilities | Image Source: AFP

Glossary and Explanation of Terms

Term	Acronym	Description
Agreed Framework		The Agreed Framework between the United States of America and the Democratic People's Republic of Korea was a 1994 agreement designed to freeze North Korea's nuclear program and replace portions of it with more proliferation-resistant light water reactor power plants.
Air-launched ballistic missile	ALBM	A ballistic missile fired from an aircraft. An example is the Russian Kinzhal missile.
Air-launched cruise missile	ALCM	A cruise missile launched from an aircraft.
Air-to-air missile	AAM	A missile fired from an aircraft designed to shoot down an aircraft or cruise missile.
Air-to-surface missile	ASM	A missile fired from an aircraft at a ground target.
Antiballistic missile	ABM	A missile designed to shoot down an incoming ballistic missile.
Antiship cruise missile	ASCM	A cruise missile that targets surface vessels.
Anti-submarine warfare	ASW	Weapons designed to target submarines.
Ballistic Missile	BM	A missile that is guided during powered flight and unguided during free flight when the trajectory that it follows is subject only to the external influences of gravity and atmospheric drag.
Close-range ballistic missile	CRBM	A ballistic missile with a range less than 300 km.
Cruise Missile	CM	A missile that flies through the Earth's atmosphere, sustaining its flight through constant propulsion and aerodynamic lift.
Fractional Orbital Bombardment System	FOBS	An ICBM that enters into orbit and travels the long way around the Earth (such as over the South Pole) to avoid early warning systems and missile defenses. In the March 2018 Russian video introducing the Sarmat, it was shown in a simulation to strike the United States after passing over the South Pole.
Hypersonic		A weapon that travels at Mach 5+.

Glossary and Explanation of Terms (Cont'd.)

Term	Acronym	Description
Hypersonic glide vehicle	HGV	A maneuverable aerodynamic body that achieves sustained hypersonic glide (Mach 5+), typically at altitudes of 15-50 km.
Intercontinental Ballistic Missile	ICBM	A ground-based missile with a range exceeding 5,500 km.
Intermediate-range ballistic missile	IRBM	A ground-based missile with a range from 3,000 to 5,500 km.
Joint Comprehensive Plan of Action	JCPOA	A nuclear plan between the United States, Iran, China, France, Germany, Russia, the United Kingdom , and the European Union.. Under the JCPOA, Iran was limited in the number of centrifuges it could operate, the amount of uranium it could enrich, and had to convert some facilities to limit proliferation risks.
Launch-on-Warning	LOW	Launch-on-warning (LOW) is a posture where warning of an incoming missile strike allows a counterstrike to be launched before an enemy first strike can detonate.
Long-Range Aviation	LRA	The Russian military command that operates strategic heavy bombers as well as non-strategic medium bombers.
Maneuvering reentry vehicle	MaRV	A reentry vehicle capable of performing maneuvers in the atmosphere to avoid missile defense or improve accuracy.
Medium-range Ballistic Missile	MRBM	A ground-based missile with a range from 1,000 km to 3,000 kilometers.
Multiple independently targetable reentry vehicle	MIRV	A collection of nuclear-armed reentry vehicles carried on a single missile (typically an ICBM or an SLBM). Each reentry vehicle can be guided to a different target.
New Strategic Arms Reduction Treaty	New START	Treaty signed in April 2010 limiting U.S. and Russian strategic delivery systems and deployed strategic warheads. The three central limits of the treaty are: 1) no more than 700 deployed delivery systems (ICBMs, SLBMs, and heavy bombers equipped for nuclear delivery), 2) no more than 800 total delivery systems, and 3) no more than 1,550 deployed strategic warheads (counting heavy bombers as one warhead each, and counting re-entry vehicles on ICBMs and SLBMs). New START was extended in 2021 and currently will expire on 5 February 2026.

Glossary and Explanation of Terms (Cont'd.)

Term	Acronym	Description
No First Use	NFU	No first use is a pledge or a policy by a nuclear power not to use nuclear weapons as a means of warfare unless first attacked by an adversary using nuclear weapons.
Non-Proliferation Treaty	NPT	The Treaty on the Non-Proliferation of Nuclear Weapons, commonly known as the Non-Proliferation Treaty; it was signed starting in 1968, entered into force in 1970, and extended indefinitely in 1995. The treaty defines five countries as nuclear-weapon states: The United States, China, France, Russia, and the United Kingdom. Today, the NPT has 191 State Parties.
People's Liberation Army	PLA	The principal military force of the People's Republic of China.
People's Liberation Army Air Force	PLAAF	The aerial service branch of the People's Liberation Army.
People's Liberation Army Navy	PLAN	The maritime service branch of the People's Liberation Army.
People's Liberation Army Rocket Force	PLARF	The strategic and tactical missile force of the People's Liberation Army; formerly known as the Second Artillery Corps.
Reentry Vehicle	RV	A subsystem, usually conical in shape, carried by a ballistic missile and used to deliver a weapon through atmospheric reentry to a target location.
Road-mobile		A missile system transported, erected and launched from a self-propelled wheeled or tracked land vehicle.
Short-range ballistic missile	SRBM	A ballistic missile with a range between 300 and 1,000 kilometers.
Silo		An underground facility typically holding a ballistic missile, vertically designed to protect the missile and the launching equipment from attack.
Strategic Rocket Forces	SRF	The Russian military command that operates the ICBMs from both TELs and silos.
Submarine-launched ballistic missile	SLBM	Ballistic missiles, typically carrying nuclear warheads, launched from a submarine.
Surface-to-air missile	SAM	A missile launched from the ground (or from a naval vessel) designed to strike aerial targets.

Glossary and Explanation of Terms (Cont'd.)

Term	Acronym	Description
Transporter-Erector-Launcher	TEL	A self-propelled vehicle used in transporting, erecting, and launching mobile ballistic missiles. Use of mobile launchers rather than fixed facilities such as pads and silos can frustrate the ability of an adversary to locate and destroy missiles before they're launched.
Triad		A nuclear triad is a three-pronged military force structure that consists of land-launched nuclear missiles, nuclear missile-armed submarines, and strategic aircraft with nuclear bombs and missiles.
Weapons of Mass Destruction	WMD	Systems capable of a high order of destruction and/or of being used in a manner so as to destroy large numbers of people; typically considered to be nuclear, chemical, or biological weapons.

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