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NUCLEAR NOTEBOOK

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ABSTRACT

The Nuclear Notebook is researched and written by Hans M. Kristensen, director of the Nuclear Information Project with the Federation of American Scientists, and Matt Korda, a research associate with the project. The Nuclear Notebook column has been published in the Bulletin of the Atomic Scientists since 1987. This issue's column examines Russia's nuclear arsenal, which includes a stockpile of nerarly 4,500 warheads. Of these, some 1,600 strategic warheads are deployed on ballistic missiles and at heavy bomber bases, while an additional 985 strategic warheads, along with 1,912 nonstrategic warheads, are held in reserve. The Russian arsenal is continuing broad modernization intended to replace most Soviet-era weapons by the mid- to late 2020s. To see all previous Nuclear Notebook columns, go to https://thebulletin.org/nuclear-risk/nuclear-weapons/nuclear-notebook/.

KEYWORDS

Ballistic missiles; ballistic missile submarines; bombers; delivery systems; nuclear weapons; Russia; Nuclear Notebook

Russia is in the middle of a decades-long modernization of its strategic and nonstrategic nuclear forces to replace Soviet-era weapons with newer systems. In December 2020, President Vladimir Putin reported that modern weapons and equipment now make up 86 percent of Russia's nuclear triad (Russian Federation 2020a), compared to the previous year's 82 percent (Russian Federation 2019). He additionally noted that he expects that number to rise to 88.3 percent in 2021. As in previous years, Putin's remarks emphasized the need for Russia's nuclear forces to keep pace with Russia's competitors: "It is absolutely unacceptable to stand idle. The pace of change in all areas that are critical for the Armed Forces is unusually fast today. It is not even Formula 1 fast – it is supersonic fast. You stop for one second and you start falling behind immediately" (Russian Federation 2020a).

Putin also noted his disappointment with the "deterioration" of the US-Russia arms control regime, and declared that the United States withdrew from the Anti-Ballistic Missile Treaty, the Intermediate-Range Nuclear Forces Treaty, and the Open Skies Treaty under "contrived pretexts." He also addressed the "uncertainty" around New START: "We have repeatedly stated our readiness to extend the treaty but there has been no response" (Russian Federation 2020a).

Russia's nuclear modernization programs, combined with an increase in the number and size of military exercises and occasional explicit nuclear threats against other countries, contribute to uncertainty about Russia's long-term intentions and growing international debate about the nature of its nuclear strategy. These concerns, in turn, stimulate increased defense spending, nuclear modernization programs, and political opposition to further nuclear weapons reductions in Western Europe and the United States.

As of early 2021, we estimate that Russia has a stockpile of nearly 4,500 nuclear warheads assigned for use by long-range strategic launchers and shorter-range tactical nuclear forces. This number is a little higher than last year due to the addition of the fourth Borei-class nuclear-powered ballistic-missile submarine (SSBN) and an increase in non-strategic warheads. At the same time, we have lowered the estimate for strategic bomber weapons to better match the number of operational bombers. Of the stockpiled warheads, approximately 1,600 strategic warheads are deployed: just over 800 on land-based ballistic missiles, about 624 on submarine-launched ballistic missiles, and 200 at heavy bomber bases. Another 985 strategic warheads are in storage, along with about 1,912 nonstrategic warheads. In addition to the military stockpile for operational forces, a large number – approximately 1,760 – of retired but still largely intact warheads await dismantlement, for a total inventory of approximately 6,257 warheads.[1] (See Table 1.)

Russia has significantly reduced the number of warheads deployed on its ballistic missiles to meet the New START limit of no more than 1,550 deployed strategic warheads. Russia achieved the required reduction by the February 5, 2018 deadline, when it declared 1,444 strategic warheads attributed to 527 launchers (Russian Federation Foreign Affairs Ministry 2018). The most recent data, declared on September 1, 2020, listed

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Table 1. Russian nuclear forces, 2021.

Type/name	Russian designation	Launchers	Year deployed	Warheads x yield (kilotons)	Total warheads
Strategic offensive weapons					
ICBMs					
SS-18 M6 Satan	RS-20V	46	1988	10 x 500/800 (MIRV)	460[a]
SS-19 M3 Stiletto	RS-18 (UR-100NUTTH)	0	1980	6 x 400 (MIRV)	0[b]
SS-19 M4	? (Avangard)	4	2019	1 x HGV	4
SS-25 Sickle	RS-12M (Topol)	27	1988	1 x 800	27
SS-27 Mod 1 (mobile)	RS-12M1 (Topol-M)	18	2006	1 x 800?	18
SS-27 Mod 1 (silo)	RS-12M2 (Topol-M)	60	1997	1 x 800	60
SS-27 Mod 2 (mobile)	RS-24 (Yars)	135	2010	4 x 100? (MIRV)	540[c]
SS-27 Mod 2 (silo)	RS-24 (Yars)	20	2014	4 x 100? (MIRV)	80
SS-X-29 (silo)	RS-28 (Sarmat)	-	(2022)	10 x 500? (MIRV)	-
Subtotal		**310**			**1,189**[d]
SLBMs					
SS-N-18 M1 Stingray	RSM-50	1/16	1978	3 x 50 (MIRV)	48[e]
SS-N-23 M1	RSM-54 (Sineva)	6/96	2007	4 x 100 (MIRV)[f]	384[g]
SS-N-32	RSM-56 (Bulava)	4/64	2014	6 x 100 (MIRV)	384[h]
Subtotal		**11/176**[i]			**816**[j]
Bombers/weapons					
Bear-H6/16	Tu-95MS6/MS16/MSM	55	1984/2015	6-16 x AS-15A ALCMs or 14 x AS-23B ALCMs	448
Blackjack	Tu-160/M	13	1987/2021	12 x AS-15B ALCMs or AS-23B ALCM, bombs	132
Subtotal		**68**[k]			**580**[l]
Subtotal strategic offensive forces		**554**[m]		**2,585**[n]	
Nonstrategic and defensive weapons					
ABM/Air/Coastal defense					
S-300/S-400 (SA-20/SA-21)		750	1992/2007	1 x low	~290
53T6 Gazelle		68	1986	1 x 10	68[o]
SSC-1B Sepal (Redut)		8[p]	1973	1 x 350	4
SSC-5 Stooge (SS-N-26) (K-300P/3M-55)		60	2015	(1 x 10)[q]	25
Land-based air					
Bombers/fighters (Tu-22M3(M3M)/Su-24M/ Su-34/MiG-31K)		~300	1974-2018	ASMs, ALBM, bombs	~500
Ground-based					
SS-26 Stone SSM (9K720, Iskander-M)		144	2005	1 x 10-100	70[r]
SSC-7 Southpaw GLCM (R-500/9M728, Iskander-M)[s]					
SSC-8 Screwdriver GLCM (9M729)[t]		20[u]	2017	1 x 10-100	20
Naval					
Submarines/surface ships/air				LACM, SLCM, ASW, SAM, DB, torpedoes	~935
Subtotal nonstrategic and defensive forces					**1,912**[v]
TOTAL STOCKPILE					**4,497**
Deployed					1,600
Reserve					2,897
Retired warheads awaiting dismantlement					**1,760**
Total inventory					**6,257**

ABM = antiballistic missile; ALCM = air-launched cruise missile; AS = air-to-surface; ASM = air-to-surface missile; ASW = antisubmarine weapon; DB = depth bomb; GLCM= ground-launched cruise missile; ICBM = intercontinental ballistic missile; LACM = Land-Attack Cruise Missile; MIRV = multiple independently targetable reentry vehicle; SAM = surface-to-air missile; SLBM = submarine-launched ballistic missile; SLCM = sea-launched cruise missile; SRAM = short-range attack missile; SSM = surface-to-surface missile

[a]It is possible that the SS-18s have been downbloaded from ten to six warheads each to meet the New START limit for deployed strategic warheads. It is also possible that a fourth regiment at Dombarovsky is operational.

[b]It is thought that all SS-19 ICBMs have been retired, although activities continue at some former regiments.

[c]It is possible that the SS-27 Mod 2s now carry only three warheads each to meet the New START limit on deployed strategic warheads.

[d]Only about 800 of these warheads are deployed. The rest are in storage for potential loading.

[e]The Delta III-class SSBNs are in the process of being retired, with possibly only one remaining fully operational.

[f]The Sineva is a modified SS-N-23 and probably carries four MIRVs. In 2006, US intelligence estimated that the missile could carry up to 10 warheads, but it lowered the estimate to four in 2009.

[g]At any given time, only 320 of these warheads are deployed on five operational Delta IV submarines, with the sixth boat in overhaul. Often two boats are out.

[h]It is possible that Bulava SLBMs have been downloaded to carry only four warheads each for Russia to meet the New START limit on deployed strategic warheads.

[i]The first figure is the number of operational SSBNs; the second is the total number of missiles (launchers) on the SSBNs. Note that one or several SSBNs may be in overhaul at any given time.

[j]At any given time, one or two SSBNs are in overhaul and do not carry nuclear weapons, so not all 816 warheads are deployed - perhaps only around 624.

[k]Only about 50 of the bombers are thought to be deployed.

[l]The total bomber force can theroretically carry more than 800 nuclear weapons, but weapons are probably only assigned to deployed bombers. Bomber weapons are not deployed on the aircraft under normal circumstances, but we estimate a couple hundred weapons are present at the two bomber bases, with the remainder in central storage.

[m]This number of total deployed strategic launchers is higher than the 510 listed in the New START aggregate data as of September 1, 2020, because some bombers are not counted as deployed. This is the total number of operational launchers (ICBMs, SLBMs, and bombers) in service. Russia also has more than 250 non-deployed launchers, many of which are mothballed or in the process of being dismantled.
[n]Only about 1,600 of these warheads are deployed on missiles and at bomber bases. New START counts fewer deployed warheads because it does not weapons in storage on bomber bases and because at any given time, some SSBNs are not fully loaded.
[o]We assume that the warheads for the Gazelle interceptors are kept in central storage under normal circumstances. All previous 32 Gorgon missiles have been retired.
[p]It is assumed that all SSC-1B units, except a single fixed site in Crimea, have been replaced by the K-300P by now.
[q]The US National Air and Space Intelligence Center lists the ground-, sea-, and sub-launched 3M-55 as "nuclear possible."
[r]This estimate includes warheads for both SS-26 and SSC-7.
[s]The US National Air and Space Intelligence Center lists the R-500/9M728 as "Conventional, Nuclear Possible."
[t]It is possible that the SSC-8 launchers are co-located with some of the Iskander brigades.
[u]This figure assumes five SSC-8 battalions, each with four launchers. Each launcher has four missiles for a total of 80 missiles. It is assumed there is at least one reload for at least 160 missiles.
[v]All nonstrategic warheads are thought to be in central storage. The 1,912 listed make up the estimated nominal load for nuclear-capable delivery platforms. Only some of these may be available for deployment by operational forces. It is possible there are more unreported nuclear-capable non-strategic systems.

Russia with 1,447 deployed warheads attributed to 510 strategic launchers (US State Department, Bureau of Arms Control, Verification and Compliance 2020a). These numbers differ from the estimates presented in this Nuclear Notebook because the New START counting rules artificially attribute one warhead to each deployed bomber, even though Russian bombers do not carry nuclear weapons under normal circumstances, and because this Nuclear Notebook counts weapons stored at bomber bases that can quickly be loaded onto the aircraft.

Russia (like the United States) could potentially upload several hundreds of extra warheads onto their launchers, but is prevented from doing so by the New START treaty limit, which has been extended for an additional five years to 2026. The treaty provides for important transparency of Russian (and U.S.) strategic nuclear forces: As of December 2020, the United States and Russia have completed a combined 328 on-site inspections and exchanged 21,293 notifications (US State Department, Bureau of Arms Control, Verification and Compliance 2020b). Due to the ongoing Covid-19 pandemic, there have been no on-site Type One or Type Two inspections since April 1st, 2020.

Due to New START limitations, Russia appears to have been forced to reduce the warhead loading on some of its missiles to less than maximum capacity. We do not know the breakdown of the loading because Russia, unlike the United States, does not publish an unclassified overview of its strategic forces. However, the reduction may have involved scaling back the number of warheads on each SS-18 and SS-27 Mod 2 intercontinental ballistic missile (ICBM), as well as on each SS-N-32 submarine-launched ballistic missile (SLBM). This demonstrates that New START places real constraints on Russia's deployed strategic forces. The result appears to be an increased reliance on a strategic reserve of non-deployed warheads that can be loaded onto missiles in a crisis to increase the size of the force – a strategy similar to the one the United States has relied on for several decades.

Overall, Russia's nuclear modernization effort will present the international arms control community with new challenges. Unless a new arms reduction agreement is reached in the future to replace New START, the shrinking of Russia's strategic nuclear arsenal that has characterized the past two decades will likely come to an end, with the force leveling out at around 530 launchers with roughly 2,500 assigned warheads. However, Russia's financial crisis represents a significant challenge to maintaining this force level, as exemplified by delays in production of several major weapon systems such as the Sarmat ICBM (SS-29) and the RS-26 Rubezh (SS-28), the cancellation of the once highly-touted Barguzin rail-based ICBM, and delays to the strategic bomber replacement program.

Russia's nuclear modernization program is motivated in part by Moscow's strong desire to maintain overall parity with the United States, but also by the Russian leadership's apparent conviction that the US ballistic missile defense system constitutes a real future risk to the credibility of Russia's retaliatory capability. Policy and strategy aside, the development of multiple weapon systems also indicates the strong influence of the military-industrial complex on Russia's nuclear posture planning.

What is Russia's nuclear strategy?

The international debate about Russia's nuclear strategy has reached a new level of intensity, particularly after the Trump administration published its Nuclear Posture Review in February 2018. The Nuclear Posture Review claims that "Russian strategy and doctrine emphasize the potential coercive and military uses of nuclear weapons. It mistakenly assesses that the threat of nuclear escalation or actual first use of nuclear weapons would

serve to 'de-escalate' a conflict on terms favorable to Russia" (US Defense Department 2018, 8). Specifically, the document claims, "Moscow threatens and exercises limited nuclear first use, suggesting a mistaken expectation that coercive nuclear threats or limited first use could paralyze the United States and NATO and thereby end a conflict on terms favorable to Russia." This so-called "escalate to de-escalate" doctrine "follows from Moscow's mistaken assumption of Western capitulation on terms favorable to Moscow" (US Defense Department 2018, 30).

The former head of the US Strategic Command, Gen. John Hyten, reacted to "Russia's destabilizing doctrine on what some call escalate to deescalate" by saying: "I really hate that discussion. I've looked at the Russian doctrine. I've looked at Russian writings. It's not escalate to deescalate, it's escalate to win. Everybody needs to understand that" (Hyten 2017). Some have suggested that Russian leaders are signaling a willingness to use nuclear weapons even before an adversary retaliates against a Russian conventional attack by "employing the threat of selective and limited use of nuclear weapons to *forestall opposition to potential aggression*" (emphasis added) (Miller 2015). The implication is that Russia would potentially use nuclear weapons first to scare an adversary into not even defending itself.

Such characterizations conflict with Russia's publicly stated policy. In June 2020, President Putin approved an update to the "Basic Principles of State Policy of the Russian Federation on Nuclear Deterrence," which notes that "The Russian Federation considers nuclear weapons exclusively as a means of deterrence." The policy lays out four conditions under which Russia could launch nuclear weapons:

(1) "arrival of reliable data on a launch of ballistic missiles attacking the territory of the Russian Federation and/or its allies;
(2) use of nuclear weapons or other types of weapons of mass destruction by an adversary against the Russian Federation and/or its allies;
(3) attack by adversary against critical governmental or military sites of the Russian Federation, disruption of which would undermine nuclear forces response actions;
(4) aggression against the Russian Federation with the use of conventional weapons when the very existence of the state is in jeopardy" (Russian Federation Foreign Affairs Ministry 2020).

The document's emphasis on deterrence by punishment, as well as the "defensive" nature of Russia's nuclear weapons is likely intended to be a response to the aforementioned US claims of a Russian "escalate-to-deescalate" policy. The updated policy is also consistent with remarks that President Putin made to the Valdai Club in October 2018, when he stated that "Our nuclear weapons doctrine does not provide for a pre-emptive strike." Rather, he went on, "our concept is based on a reciprocal counter strike … This means that we are prepared and will use nuclear weapons only when we know for certain that some potential aggressor is attacking Russia, our territory" (Russian Federation 2018a). This is additionally consistent with previous iterations of Russian nuclear policy, which has largely remained unchanged since President Putin came to power in 2000 (Russian Federation 2014, 2010). Although some initial reports interpreted Putin's 2018 Valdai Club comments to mean that Russia might be adopting a nuclear no-first-use policy, this does not seem to be the case; his remarks were more likely meant to respond to the US Nuclear Posture Review's claim that Russia has lowered its threshold for first use of nuclear weapons in a conflict (Stowe-Thurston, Korda, and Kristensen 2018). Because Putin's comments imply that Russia would only use nuclear weapons in retaliation against an existential threat, independent analysts have challenged the Nuclear Posture Review's characterization of the Russian strategy as overblown and a misreading of Russia's nuclear doctrine.[2]

Whatever Russia's nuclear strategy is, Russian officials have made many statements about nuclear weapons that appear to go beyond the published doctrine, threatening to potentially use them in situations that do not meet the conditions described. For example, officials explicitly threatened to use nuclear weapons against ballistic missile defense facilities, and in regional scenarios that do not threaten Russia's survival or involve attacks with weapons of mass destruction (The Local 2015).

Moreover, the fact that Russian military planners are pursuing a broad range of upgraded and new versions of nuclear weapons suggests that the real doctrine goes beyond basic deterrence and toward regional warfighting strategies, or even weapons aimed at causing terror. One widely-cited example involves the so-called Status-6 – known in Russia as "Poseidon" and in the United States as "Kanyon" – a long-range nuclear-powered torpedo that a Russian government document described as intended to create "areas of wide radioactive contamination that would be unsuitable for military, economic, or other activity for long periods of time" (Podvig 2015). A diagram and description of the proposed weapon, first revealed in a Russian television broadcast, can still be seen on YouTube (YouTube 2015). The weapon, which is under development,

appears designed to attack harbors and cities to cause widespread indiscriminate collateral damage in violation of international law.

Intercontinental ballistic missiles

Russia's Strategic Rocket Force currently deploys several variants of silo-based and mobile ICBMs. The silo-based ICBMs include the SS-18, SS-19, SS-27 Mod 1, SS-27 Mod 2, and the mobile ICBMs include the SS-25, SS-27 Mod 1, and SS-27 Mod 2. In December 2020, Defense Minister Sergei Shoigu declared that 95 percent of Russia's strategic missile forces are continuously ready for combat use (Russian Federation 2020a).

Based on what we can observe via satellite images, combined with information published under New START by various US government sources, Russia appears to have approximately 310 deployed ICBMs, which we estimate can carry up to 1,189 warheads. (See Table 2.) The size of the force that we can observe, however, is difficult to square with statements made by Russian officials. Since 2016, and again most recently in December 2019, the commander of the country's Strategic Rocket Forces, Col. Gen. Sergei Karakaev, has stated that Russia had approximately 400 ICBMs on combat duty (TASS 2016; Andreyev and Zotov 2017; Karakaev 2019). But since Russia declared 510 deployed strategic launchers in total as of September 2020, a force of 400 ICBMs would mean Russia only deployed 110 SLBMs and bombers, which seems unlikely (US State Department, Bureau of Arms Control, Verification and Compliance 2020a). It is possible Karakaev is referring to all ICBMs in the inventory, not just those that are deployed. Modernization of the ICBM force also involves equipping upgraded silos with new air-defense systems, and the new Peresvet laser has been deployed with five road-mobile ICBM divisions for the purpose of "covering up their maneuvering operations" (Russian Federation Defense Ministry 2019a).

The ICBMs are organized under the Strategic Rocket Forces in three missile armies with a total of 11 divisions consisting of approximately 39 missile regiments (see Table 2). The 40th regiment in the 12th division at Yurya is not nuclear-armed. The ICBM force has been declining in number for three decades, and Russia claims to be 81 percent of the way through a modernization program to replace all Soviet-era missiles with newer types by the early 2020s on a less-than-one-for-one basis (Krasnaya Zvezda 2020a). Currently, the remaining Soviet-era ICBMs include the SS-18, the SS-19, and the SS-25.

The SS-18 (RS-20 V or R-36 M2 Voevoda) is a silo-based, 10-warhead heavy ICBM first deployed in 1988. It is reaching the end of its service life, with approximately 46 SS-18s with up to 460 warheads remaining in the 13th Missile Division at Dombarovsky and the 62nd Missile Division at Uzhur. We estimate the number of warheads on each SS-18 has been reduced for Russia to meet the New START treaty limit for deployed strategic warheads. The SS-18 is scheduled to begin retiring in the next one or two years, when the SS-29 (Sarmat or RS-28) ICBM will begin to replace it at the Uzhur missile field.

The silo-based, six-warhead SS-19 (RS-18 or UR-100NUTTH) entered service in 1980 and might finally have been retired and replaced by the silo-based SS-27 Mod 2 (RS-24). It is possible that the SS-19 has been retired from combat duty, but two regiments that used to be armed with the missile still show significant activity. A small number of converted SS-19s are being deployed with two regiments of the 13th Missile Division at Dombarovsky as the SS-19 Mod 4 with the new Avangard hypersonic glide vehicles (see below).

Russia continues to retire its SS-25 (RS-12 M or Topol) road-mobile missiles at a rate of one or two regiments (nine to 18 missiles) each year, replacing them with the SS-27 Mod 2 (RS-24). There remains some uncertainty about how many SS-25s are fully operational. Garrison upgrades used to involve significant rebuilding, but satellite images indicate that Russia has started to upgrade the garrisons by simply replacing the SS-25s with the new SS-27 launchers and their service vehicles, which are maintained under camouflage nets. We estimate that as few as 27 (possibly only 18) SS-25s remain in the active force.

The new ICBMs include two versions of the SS-27: the Mods 1 and 2. We estimate that these two versions now carry more warheads than all the remaining SS-18s. The SS-27 Mod 1 is a single-warhead missile, known in Russia as Topol-M, that comes in either mobile (RS-12 M1) or silo-based (RS-12 M2) variants. Deployment of the SS-27 Mod 1 was completed in 2012 with a total of 78 missiles: 60 silo-based missiles with the 60th Missile Division in Tatishchevo, and 18 road-mobile missiles with the 54th Guards Missile Division at Teykovo. Russian officials indicated in 2019 that the Topol-M units eventually will be upgraded to RS-24 Yars as well.

The focus of the current and bigger phase of Russia's modernization is the SS-27 Mod 2, known in Russia as the RS-24 (Yars), which is a modified SS-27 Mod 1 (or Topol-M) that can carry up to four multiple independently targetable reentry vehicles (MIRVs). During an interview with Col. Gen. Sergei Karakaev in December 2020, the Russian Defense Ministry's TV channel declared that approximately 150 mobile and

Table 2. Estimated Status Of Russian ICBM Forces 2021.

Locations	Divisions	Regiments (Coordinates)	Missiles*	Status
Barnaul	35th MD	307th MR (53.3128, 84.5080)	(9 SS-27 Mod 2 TEL)	Upgrading
		479th GMR (53.7709, 83.9580)	9 SS-27 Mod 2 TEL	Active[a]
		480th MR (53.3054, 84.1459)	(9 SS-27 Mod 2 TEL)	Upgrading
		867th GMR (53.2255, 84.6706)	9 SS-25 TEL	Active
Dombarovsky	13th MD[b]	368th MR (51.0934, 59.8446)	6 SS-18 Silos	Active
		494th MR (51.0628, 60.2119)	6 SS-18 Silos	Active
		767th MR (51.2411, 60.6069)	6 SS-18 Silos	Active
		621st MR (51.0618, 59.6081)	4 SS-19 Mod 4 silos[c]	Active/upgrading
Irkutsk	29th GMD	92nd GMR (52.5085, 104.3933)	9 SS-27 Mod 2 TEL	Active
		344th GMR (52.6694, 104.5199)	9 SS-27 Mod 2 TEL	Active
		586th GMR (52.5505, 104.1584)	9 SS-27 Mod 2 TEL	Active
Kozelsk	28th GMD	74th MR (53.7982, 35.8039)	10 SS-27 Mod 2 silos	Active
		168th MR (54.0278, 35.4589)	10 SS-27 Mod 2 silos	Active
		214th MR (53.7641, 35.4866)	(10 former SS-19 silos)	Upgrade starts in 2021
Novosibirsk	39th GMD	357th GMR (55.3270, 82.9417)	9 SS-27 Mod 2 TEL[e]	Active
		382nd GMR (55.3181, 83.1676)[d]	9 SS-27 Mod 2 TEL	Active
		428th GMR (55.3134, 83.0291)	9 SS-27 Mod 2 TEL	Active
Nizhny Tagil	42nd MD	308th MR (58.2298, 60.6773)	9 SS-27 Mod 2 TEL	Active
		433rd MR (58.1015, 60.3592)	9 SS-27 Mod 2 TEL	Active
		804th MR (58.1372, 60.5366)	9 SS-27 Mod 2 TEL	Active
Tatishchevo	60th MD[f]	31st MR (51.8792, 45.3368)	10 SS-27 Mod 1 silos	Active
		104th MR (51.6108, 45.4970)	10 SS-27 Mod 1 silos	Active
		122nd MR (52.1589, 45.6404)	10 SS-27 Mod 1 silos	Active
		165th MR (51.8062, 45.6550)	10 SS-27 Mod 1 silos	Active
		322nd MR (52.0449, 45.4458)	10 SS-27 Mod 1 silos	Active
		626th MR (51.7146, 45.2278)	10 SS-27 Mod 1 silos	Active
Teykovo	54th GMD	235th GMR (56.7041, 40.4403)	9 SS-27 Mod 1 TEL	Active
		285th GMR (56.8091, 40.1710)	9 SS-27 Mod 2 TEL	Active
		321st MR (56.9324, 40.5440)	9 SS-27 Mod 1 TEL	Active
		773rd MR (56.9167, 40.3087)	9 SS-27 Mod 2 TEL	Active
Uzhur	62nd MD[g]	229th MR (55.2453, 89.9194)	6 SS-18 silos	Active
		269th MR (55.2077, 90.2526)	6 SS-18 silos	Active
		302nd MR (55.1147, 89.6311)	6 SS-18 silos	Active
		735th MR (55.2720, 89.5783)	10 SS-18 silos	Active
Vypolsovo	7th GMD	41st MR (57.8620, 33.6500)	(9 SS-27 Mod 2 TEL)	Upgrading[h]
		510th GMR (57.7889, 33.8660)	9 SS-25 TEL	Active
Yoshkar-Ola	14th MD	290th MR (56.8328, 48.2370)[i]	9 SS-27 Mod 2 TEL	Active
		697th MR (56.5601, 48.2144)	9 SS-27 Mod 2 TEL	Active
		779th MR (56.5821, 48.1550)[j]	9 SS-27 Mod 2 TEL	Active
11 Divisions[k]		**39 regiments**	**310 ICBMs**[l]	

GMD = Guards Missile Division; GMR = Guards Missile Regiment; MD = Missile Division; MR = Missile Regiment; TEL = Transporter Erector Launcher.
* Uses US/NATO missile designations. SS-18 (RS-20 V), SS-19 (RS-18), SS-25 (Topol), SS-27 Mod 1 (Topol-M), SS-27 Mod 2 (RS-24).
[a]RMOD reported in Dec 2019 that a "ceremony of interception on combat duty of the first regiment" had taken place.
[b]It is possible that the 175th Missile Regiment (51.2708, 60.2992) is also active, but it is not thought to be armed. The unit is a potential candidate for the second SS-19 Mod 4 regiment.
[c]A total of 12 silos (two regiments) are planned to be operational by 2027.
[d]The 328th regiment is based at this temporary open-air location until its permanent garrison (55.3181, 83.1676) is completed.
[e]Described by Russian Ministry of Defense as Yars-S.
[f]It is possible that one or two SS-19 regiments are active, but they are not thought to be armed. They are potential candidates for upgrade to the SS-19 Mod 4 (Avangard) in the future.
[g]The 62nd MD at Uzhur is scheduled to receive the SS-29 (Sarmat) in the near future. Some former SS-18 silos will also be converted to the SS-19 Mod 4 (Avangard).
[h]During 2019, "preparatory work" began for upgrading to SS-27 Mod 2 (RS-24).
[i]It is potentially possible that the 290th regiment will move south to the new garrison (56.5658, 48.4515) that is under construction closer to the supply base and other garrisons of the division.
[j]The 779 MR garrison is being rebuilt. Until completion, the launchers and support vehicles are temporarily based near the supply base (56.5587, 48.0558).
[k]A 12th division at Yurya has one SS-25 regiment that does not carry warheads but serves as a back-up ICBM launch code transmitter.
[l]Upgrading regiments sometimes go on experimental combat alert with only a few launchers ready.

silo-based Yars had been deployed by the Strategic Rocket Force (Zvezda 2020). SS-27 Mod 2 upgrades now appear to be complete at the 39th Guards Missile Division at Novosibirsk, the 42nd Missile Division at Nizhny Tagil, the 14th Missile Division at Yoshkar-Ola, and the 29th Guards Missile Division at Irkutsk. According to Defense Minister Sergei Shoigu, three missile regiments were equipped with SS-27 Mod 2 ICBMs in 2020, including the completion of the scheduled upgrade at Irkutsk, which was announced in September 2020 (Russian Federation 2020a; TASS 2020a). Although these divisions now all have been equipped with the SS-27 Mod 2, many of the garrisons are not equipped to accommodate all the vehicles required to support the launchers and will continue to undergo construction for several years.

The next mobile ICBM divisions to be upgraded are the 35th Missile Division at Barnaul and the 7th Missile

Division at Vypolsovo. The first regiment at Barnaul (the 479th Guards Missile Regiment) went on preliminary combat alert duty with the Yars in September 2019 and full combat duty in December 2019 (Russian Federation Defense Ministry 2019c). The Barnaul division formally accepted its second Yars regiment (the 480th Missile Regiment) in December 2020 (RIA Novosti 2020). The Strategic Rocket Force is expected to put 13 additional Yars and Avangard systems on alert in 2021 (Russian Federation 2020a); it is expected that a portion of these Yars systems will be used to upgrade the third Barnaul regiment, with upgrades to the fourth regiment following a year or two later (Podvig 2020a). The Vypolsovo division started early preparations for the upgrade in 2019 (Tikhonov 2019), and it is possible that one of its two regiments has already stood down its SS-25 launchers. Col. Gen. Karakaev confirmed in December 2020 that neither the Barnaul nor Vypolsovo division had completed their scheduled upgrade to the SS-27 Mod 2 by the end of the year (Krasnaya Zvezda 2020). Satellite images confirm this status.

Col. Gen. Karakaev confirmed in December 2020 that the 28th Guards Missile Division at Kozelsk remains one of only three divisions that have not yet completed their scheduled upgrade to the SS-27 Mod 2 (Krasnaya Zvezda 2020). However, work at Kozelsk proceeds: The first regiment (the 74th Missile Regiment) officially began combat duty with its full complement of 10 missiles in November 2018, after initially being declared operational (likely with just six missiles) in 2015 (Russian Federation Defense Ministry 2018b). Satellite pictures show that upgrades are well underway, and possibly complete, at all the silos of a second regiment (the 168th Missile Regiment). According to Defense Minister Sergei Shoigu, two additional SS-27 Mod 2 missiles were loaded into their silos at Kozelsk in September 2020 (Russian Federation Defense Ministry 2020b), and by the end of 2020, Col. Gen. Karakaev declared that "the reequipment of the missile regiment in the Kozelsk missile formation for the silo version of this complex has been completed . . . " (TASS 2020o). Apart from the missiles themselves, the upgrade involves extensive modification of external fences, internal roads, and facilities. Each site is also receiving a new fixed air-defense system, probably to defend the silo against cruise missiles and drones.

The Russian Defense Ministry says the completion of all preparatory infrastructure for Yars bases across the country is scheduled for completion by 2021 (TASS 2019a), although full completion is likely to take longer than that. The entirety of the Yars upgrade is expected to be completed by 2024 (TASS 2020a). Yet Col. Gen. Karakaev also stated that the military in 2021 will "begin [to] re-equipthe next regiment of the Kozelsk missile formation," apparently the third regiment of the 28th Guards Missile Division (TASS 2020o). This is probably the 214th regiment. Given the time it took to complete the upgrades of the first two regiments at Kozelsk, it seems unlikely that the Yars upgrade can be completed by 2024.

Final development and deployment of a compact SS-27 version, known as Rubezh (Yars-M or RS-26), appears to have been delayed at least until the next armament program in the late 2020s (TASS 2018a). A rail-based version known as Barguzin appears to have been canceled.

Russia is also developing the heavy SS-29, or Sarmat (RS-28), which will begin replacing the SS-18 (RS-20 V) at Uzhur in 2021 or 2022. Three ejection tests were conducted in December 2017, March 2018, and May 2018 at the Plesetsk Space Center, involving cold launch and test firing of the Sarmat's first stage and booster engine. These tests were originally scheduled for 2016 but were delayed because of difficulties that appeared during the missile's strength tests. The closing test stages, which will include a test launch with the 62nd Missile Division at Uzhur, was supposed to be completed by the end of 2020; however, this has been delayed, likely due to the ongoing Covid-19 pandemic. In December 2020, Defense Minister Shoigu suggested that Sarmat flight tests would take place during the summer of 2021 at the new Severo-Yeniseysky proving ground (Russian Federation 2020a). Following the success of these tests, Sarmat will officially be handed over to the military and serial production will begin. As of March 2020, Sarmat's industrial production line has apparently completed all the necessary upgrades to prepare for serial production, which is expected to begin in 2021, barring any unforeseen delays (TASS 2020c; Safronov and Nikolsky 2019).

There are many rumors about the SS-29, which some in the media have dubbed the "Son of Satan" because it is a follow-on to the SS-18, which the United States and NATO designated "Satan" – presumably to reflect its extraordinary destructive capability. Rumors that the SS-29 could carry 15 or more MIRV warheads, though, seem exaggerated. We expect that it will carry about the same number as the SS-18 plus penetration aids. It is possible that a small number will be equipped to carry the Avangard hypersonic glide vehicle, which are currently being installed on a limited number of SS-19 Mod 4 boosters at Dombarovsky. If the SS-29 replaces all current SS-18s, it will be installed in a total of 46 silos of the three regiments at the Dombarovsky missile field

and four regiments at the Uzhur missile field (six regiments of six missiles, and one regiment of 10 missiles). In December 2020, Col. Gen. Sergei Karakaev announced that the first Sarmat missiles would be "put on alert" at Uzhur sometime in 2022 (Krasnaya Zvezda 2020).

The new Avangard hypersonic glide vehicle is designed to evade missile defenses and is initially being fitted atop modified SS-19 missiles (SS-19 Mod 4) at Dombarovsky and possibly later on SS-29 missiles at Uzhur. Russia is currently deploying the new weapon at a rate of two per year: the first two missiles at Dombarovsky began combat duty on December 27th, 2019, followed by another two in December 2020 (TASS 2019i; Russian Federation Defense Ministry 2020a). The regiment is expected to receive the next two missiles – thus achieving a full complement of six missiles – by the end of 2021 (TASS 2020b). A second regiment of six missiles will reportedly be added by the end of 2027, to coincide with the completion of the current state armament program (TASS 2018b). The sites that have already been equipped with Avangard at the 621st Missile Regiment still appear to be upgrading with new and different security perimeters, in addition to new buildings for crew and guards. Two more silos are also being upgraded, presumably for the next two Avangard missiles. Similar to the new silos at Kozelsk, the modified Dombarovsky silos appear to have some form of air defense system.

While the 2018 Nuclear Posture Review anticipated that Russian missile forces will increase over time, the evidence for this still is not clear. The US National Air and Space Intelligence Center predicted in 2017 that "the number of missiles in the Russian ICBM force will continue to decrease because of arms control agreements, aging missiles, and resource constraints" (US Air Force 2017, 26). With the ongoing modernization, the force level will likely level out as the modernization program is completed.

After previous uncertainty about whether Russia's new strategic systems would fit into the counting rules under New START, the deputy director of the Russian Foreign Ministry's nonproliferation and arms control department stated in November 2019 that both Sarmat and Avangard could be "easily included" in the treaty. Regarding Sarmat, he said that it would enter the treaty "as a new type of ICBM, for which there is a special procedure, from the creation of a prototype to its authorization for service." He further noted that Avangard "will enter the treaty very smoothly" because "it is an optional warhead for an ICBM of the corresponding type, to which the treaty applies, too" (TASS 2019h).

Roscosmos director general Dimitry Rogozin suggested in July 2019 that going forward all retired Russian missiles should be "salvaged by launch," meaning that they would be recycled for civilian purposes like space launches or asteroid deflection. This concept has already seen success with the Dnepr space launch vehicle, which was based on the retiring SS-18, but could soon be scaled up to include other types of retiring ICBMs like the SS-19s and SS-25s (Sputnik 2019).

According to the Russian Defense Ministry, between 2012 and 2020 the Strategic Rocket Force conducted ten Yars launches and five Avangard launches (Russian Federation Defense Ministry 2020c, 13). Between 2019 and 2021, the Strategic Rocket Force is expected to conduct nine additional ICBM test launches: two Sarmats, three Yars, and four Topols, although it is possible that the latest scheduled tests will be postponed due to the ongoing Covid-19 pandemic (Pravda 2019). The Strategic Rocket Force often test-launches its missiles to the Sary-Shagan test site in Kazakhstan. However, given that Kazakhstan ratified the Treaty on the Prohibition of Nuclear Weapons in August 2019, it is unclear whether the country will continue to allow Russia to use its test site at Sary-Shagan for its ICBM launches once the treaty enters into force in January 2021. Article 4(2) of the treaty notes that each state party must ensure "the elimination or irreversible conversion of all nuclear-weapons-related facilities." This would necessarily include Sary-Shagan, which is clearly connected to Russia's nuclear weapons complex (United Nations 2017). This means that upon entry into force, Kazakhstan will face a tough decision over whether to fully comply with the treaty and risk souring relations with Russia, or whether to dilute its compliance. This potential compliance issue could be the reason why Russia is building a new proving ground for its Sarmat tests at Severo-Yeniseysky, a decision which was announced in December 2020 (Russian Federation 2020a).

Russia is also developing a nuclear-powered, ground-launched nuclear-armed cruise missile, known as 9M730 Burevestnik (NATO's designation is SSC-X-9 Skyfall). This missile has faced serious setbacks: according to US military intelligence, it has failed nearly a dozen times since its testing period began in June 2016 (Panda 2019a). In November 2017, a failed test resulted in the missile being lost at sea, which required a substantial recovery effort (Macias 2018). A similar recovery effort in August 2019 resulted in an explosion that killed five scientists and two soldiers at Nenoksa; the explosion's connection to Skyfall was confirmed by US State Department officials in October 2019

(DiNanno 2019). Due to these setbacks, it is possible that the Burevestnik program has been put on pause; there were no tests of the system in 2020 and, unlike other elements of Russia's nuclear forces, it was not mentioned in Defense Minister Shoigu's year-end remarks.

According to Defense Minister Sergei Shoigu, over 950 structures and facilities have been built for the strategic missile forces as of December 2020. He further noted that launch facilities in Kozelsk, Yasnoye, Uzhur, Novosibirsk, and Yoshkar-Ola will be prioritized for completion next year (Russian Federation 2020a).

Submarines and submarine-launched ballistic missiles

The Russian Navy operates 11 nuclear-powered nuclear-armed ballistic missile submarines (SSBNs) of three classes: six Delta IV (Project 667BRDM), one Delta III (Project 667BRD), and four Borei (Project 955), one of which is an improved Borei-A (Project 955A).[3] Each submarine can carry 16 SLBMs, and each SLBM can carry several MIRVs, for a combined maximum loading of approximately 816 warheads. Only some of these submarines are operational, and the warhead loading on some of the missiles may have been reduced as part of New START implementation, however, so the total number of warheads carried is lower, possibly around 624.

Until the mid 2020s, the mainstay of Russia's nuclear submarine force will continue to be the six third-generation Delta IVs built between 1985 and 1992, each equipped with 16 SLBMs. All Delta IVs are part of the Northern Fleet and based at Yagelnaya Bay (Gadzhiyevo) on the Kola Peninsula. Russia has upgraded the Delta IVs to carry modified SS-N-23 SLBMs, known as Sinevas, each of which carries up to four warheads. A modified Sineva, known as Layner (or Liner), may carry a modified payload. Normally four to five of the six Delta IVs are operational at any given time, with the other one or two in various stages of maintenance.

Two Delta III nuclear submarines *(K-223 Podolsk* and *K-433 Svyatoy Georgiy Pobedonosets)* were reportedly decommissioned in early 2018, leaving one Delta III – *Ryazan (K-44)* – operational with Russia's Pacific Fleet on the Kamchatka Peninsula (Podvig 2018b). The remaining submarine is still visible in satellite images but doesn't appear to sail much, although one. A missile launch in 2019 was partially aborted (Reuters 2019). The Delta III is equipped with 16 SS-N-18 M1 Stingray (RSM-50) SLBMs with three warheads each.

The Delta IIIs and Delta IVs will eventually be replaced by the new class of Borei (Project 955/A) SSBNs. Each boat is armed with 16 SS-N-32 (Bulava) SLBMs that can carry up to six warheads each. It is possible that the missile payload has been lowered to four warheads each to meet the New START treaty limit on deployed strategic warheads. In May 2018, one of the new boats, *Yuri Dolgoruki (K-535)*, salvo-fired four Bulavas as part of a test launch (Russian Federation Defence Ministry 2018a). In December 2020, another Borei, *Vladimir Monomakh (K-551*), salvo-fired four Bulavas during a test launch from the Sea of Okhotsk—the 35th-38th tests of the Bulava SLBM, and the first Bulava launch from a Pacific Fleet submarine (Russian Federation Defense Ministry 2020d; Podvig 2020b). Four Boreis are currently in service, with another four in various stages of construction, and two more to be purchased, for a total of 10 Borei SSBNs. The first boat, *Yuri Dolgoruki*, is based at Yagelnaya in the Northern Fleet. The second boat, *Alexander Nevsky (K-550)*, arrived at its home base at Rybachiy near Petropavlovsk in September 2015, where it was joined by the third Borei, *Vladimir Monomakh (K-551)*, in September 2016.

The first of the improved Borei-A/II (Project 955A) SSBNs, and the fourth Borei submarine in total, *Knyaz Vladimir (K-549)*, faced delays following its laying down in July 2020, but left dry dock in November 2017 to begin sea trials (Podvig 2018a). Despite previous rumors that the improved Borei class would have 20 missile tubes, satellite images taken of the first unit in 2018 showed only 16 tubes (Kristensen 2018). In October 2019, the *Knyaz Vladimir* successfully completed a long-awaited test-launch of the Bulava SLBM from a submerged position in the White Sea, a significant milestone during its second round of sea trials (Gady 2019). The new boat was scheduled to join the Northern Fleet in December 2019 (TASS 2019b); however, delivery was delayed due to "certain shortcomings" discovered during sea trials (TASS 2019j). On June 12, 2020, the *Knyaz Vladimir* was finally accepted into the Navy (Russian Federation Defense Ministry 2020e).

The fifth Borei – *Knyaz Oleg* – underwent hull pressure tests in November 2016 and was originally scheduled for delivery in 2018 but was delayed for several years before finally being launched in July 2020 (TASS 2020j). The keel of the sixth boat – *Generalissimus Suvorov* – was laid down in December 2014 for possible completion in 2018 but has also been delayed. Despite these delays, Defense Minister Sergei Shoigu declared in December 2020 that the Navy is expected to receive both the *Knyaz Oleg* and the *Generalissimus Suvorov* in 2021, equipped with Bulava SLBMs (Russian Federation 2020a). The keel for the seventh boat – *Emperor Alexander III* – was laid down in December 2015 for

scheduled delivery in 2019 but has also been delayed. The keel for the eighth Borei SSBN – *Knyaz Pozharsky* – was laid in December 2016 for potential delivery between 2021 and 2023 (Russian Federation Defense Ministry 2016). Russia has decided to build two more Borei-As: the first keel was originally scheduled to be laid on May 9, 2020, but has been delayed until 2021 (RIA Novosti 2019b; TASS 2020j). These two SSBNs would likely be delivered in 2026 and 2027, respectively, bringing the total fleet up to ten boats. Eventually, five SSBNs will be assigned to the Northern Fleet, and five will be assigned to the Pacific (TASS 2018c).

In December 2020, Russia conducted its annual nuclear force readiness exercise, during which a Delta-IV SSBN launched a Sineva SLBM from the Barents Sea (Russian Federation Defense Ministry 2020f). This year's exercise appears to have been more successful than the previous year's, during which the Delta-III class *Ryazan* SSBN only fired one of its two planned Sineva SLBMs from a submerged position, due to unexpected information regarding the "technical condition of the missile," according to the Russian Defense Ministry (Interfax 2019). Additionally, launches of 3 M-54 Kalibr cruise missiles during the 2019 exercise reportedly did not proceed as planned, and required the use of backup launch systems in order to fire (Sidorkova and Kanaev 2019).

The Russian Navy is also developing the Status-6 Poseidon mentioned above – a nuclear-powered, very long range, nuclear-armed torpedo. Underwater trials began in December 2018. The weapon is scheduled for delivery in 2027 and will be carried by specially configured Oscar submarines (TASS 2018g). The first of these special submarines – the Project 09852 K-329 Belgorod – was launched in April 2019 and was originally scheduled for delivery to the Navy by the end of 2020; however, it appears that this delivery will be delayed until 2021 (TASS 2020d). The Belgorod will become Russia's largest submarine and reportedly will be capable of carrying up to six Poseidon torpedoes (TASS 2019f). The second special submarine – Project 09851 Khabarovsk – might be launched in the first half of 2021, after its initial June 2020 launch date was postponed. Khabarovsk will reportedly also carry up to six Poseidon torpedoes (TASS 2020e).

Strategic bombers

Russia operates two types of nuclear-capable heavy bombers: the Tu-160 Blackjack and the Tu-95MS Bear H. We estimate that there are 60 to 70 bombers in the inventory, of which perhaps only 50 are counted as deployed under New START. Both bomber types can carry the nuclear AS-15 Kent (Kh-55) air-launched cruise missile and upgraded versions are being equipped to carry the new AS-23B (Kh-102) nuclear cruise missile. Two versions of the Tu-95 are thought to exist: Tu-95H6, which can carry up to six missiles internally, and Tu-95H16, which was built to carry missiles both internally and on wing-mounted pylons for a total of 16 missiles. The Tu-95 modernization program is equipping the Tu-95s to carry eight AS-23B missiles externally for a maximum of 14 missiles per aircraft. The Tu-160s are also being modernized to carry up to 12 AS-23B internally. The new AS-23B being added during bomber modernization will likely replace the AS-15.

It is unclear how many nuclear weapons are assigned to the heavy bombers. Each Tu-160 can carry up to 40,000 kilograms of ordnance, including 12 nuclear AS-15B air-launched cruise missiles. The Tu-95MS can carry six to 16 cruise missiles, depending on configuration. Combined, the bombers could potentially carry over 800 weapons, but we estimate weapons only exist for deployed bombers for a total of approximately 580 bomber weapons. The Tu-160 may also have a secondary mission with nuclear gravity bombs, but it seems unlikely that the old and slow Tu-95 would stand much of a chance against modern air defense systems.[4] According to Defense Minister Sergei Shoigu, Russian strategic bombers performed 50 flights on preset routes in 2020 (Russian Federation 2020a). Most of the nuclear weapons assigned to the bombers are thought to be in central storage, with only a couple hundred deployed at the two bomber bases.[5] Modernization of the nuclear weapons storage bunker at Engels Air Base continues.

The aging Tu-160s and most of the Tu-95MSs have also been undergoing various minor upgrades for several years. The first seven upgraded Tu-160s and Tu-95MSs returned to service in 2014, another nine followed in 2016, and five more were added in 2018. Only a few dozen of the Tu-95MSs – perhaps around 44 – will be modernized, while at least 10 Tu-160s were slated to be modernized by 2019, although there has been some delay. Two additional Tu-160s and five Tu-95MS bombers were reportedly upgraded in 2020 (Russian Federation 2020a).

In addition to these minor upgrades, Russia is conducting a significant modernization campaign for its aging Tu-160 force; however, there is some confusion with regards to the nomenclature of the upgraded planes, with various news outlets using Tu-160, Tu-160M, Tu-160M1, and Tu-160M2 designations interchangeably. It appears that there are two distinct modernization programs for the Tu-160 taking place simultaneously: one program involving a "deep modernization" of existing Tu-160 airframes to incorporate

a next-generation engine, as well as new avionics, navigation, and radar systems, and another program involving the incorporation of similar next-generation systems onto completely new airframes (Krasnaya Zvezda 2020b; Butowski 2016; TASS 2018h).

The first public flight of the Tu-160M (sometimes referred to as Tu-160M1) prototype was conducted in January 2018 at the Gorbunov Aviation Factory in Kazan, during a visit by President Putin. Immediately after the visit, a 160 billion ruble contract (approximately 2.13 USD billion in US dollars) was signed for the modernization of ten "deeply modernized" Tu-160M aircraft using existing airframes by 2027 (Russian Federation 2018b).

This contract appears to be separate from the Tu-160M2 project, which will require serial production of completely new airframes in order to accommodate the 50-aircraft order made by the Russian Aerospace Force (VKS). During Putin's 2018 factory visit in Kazan, he described the requirement for the new aircraft: "The older version of this plane was discontinued in 1993. In 2015, we decided to modernize it and resume production. This, in fact, is a completely different aircraft, including avionics and everything else. [...] It may look the same, but the engine, the flight range and the capacity are different" (Russian Federation 2018b).

Both the Tu-160M and Tu-160M2 aircraft will reportedly include a new engine – the NK-32-02 – that is said to increase the aircraft's range by approximately 1,000 kilometers, or about 621 miles (TASS 2017). The Tu-160M's first flight with its older NK-32 engine was conducted in February 2020, and the aircraft's first flight with its next-generation engine took place in November 2020, although the United Aircraft Corporation declined to show pictures of the November test flight due to classification concerns, instead electing to couple its announcement with pictures of an older version of the plane (United Aircraft Corporation 2020). A second Tu-160M, converted from an older Tu-160 airframe, began ground tests at the Gorbunov factory in December 2020 (TASS 2020h). In January 2019, Defense Minister Sergei Shoigu announced that the first Tu-160M aircraft would be delivered to the VKS in 2021; however, state tests of the modernized aircraft have still not taken place as of December 2020, so this scheduled delivery may be delayed until late 2021 or possibly 2022 (Russian Federation Defense Ministry 2019b; Russian Federation 2020a).

The Tu-160M2 – which is also expected to include a communications suite drawn from the fifth-generation Su-57 fighter – is expected to make its maiden flight in the fourth quarter of 2021 (TASS 2020f, 2020g). It is possible that the eventual target of 50 new Tu-160M2 bombers might be exaggerated, but if it is accurate, it would probably result in the retirement of most, if not all, of the remaining Tu-95MSs, which are expected to be retired no later than 2035.

The Tu-160M2, meanwhile, is only a temporary bridge to the next-generation bomber known as PAK-DA, the development of which has been underway for several years. The Russian government signed a contract with manufacturer Tupolev in 2013 to construct the PAK-DA at the Kazan factory. Research and development work on the PAK-DA has reportedly been completed, and the aircraft is expected to share many systems with the Tu-160M2 (TASS 2019l). Construction of the first aircraft's cockpit reportedly began in the spring of 2020, and final assembly is expected in 2021 in advance of flight trials (TASS 2020i). Preliminary tests of the PAK-DA are scheduled for April 2023 (to be completed by fall 2025), and state tests are scheduled for February 2026. Initial production is expected to begin in 2027, with serial production beginning in 2028 or 2029 (Izvestia 2020; TASS 2019c). However, it is unclear whether the Russian aviation industry has enough capacity to develop and produce two strategic bombers at the same time.

Nonstrategic nuclear weapons

Russia is updating many of its shorter-range, so-called "nonstrategic" nuclear weapons, and introducing new types. This effort is less clear and comprehensive than the strategic forces modernization plan, but also involves phasing out Soviet-era weapons and replacing them with newer but fewer arms. New systems are being added, leading the Trump administration's Nuclear Posture Review to accuse Russia of "increasing the total number of [nonstrategic nuclear] weapons in its arsenal, while significantly improving its delivery capabilities" (US Defense Department 2018, 9). In the longer term, though, the emergence of more advanced conventional weapons could potentially result in reduction or retirement of some existing nonstrategic nuclear weapons.

Nonetheless, the Russian military continues to attribute importance to nonstrategic nuclear weapons for use by naval, tactical air, and air- and missile-defense forces, as well as on short-range ballistic missiles. Part of the rationale is that nonstrategic nuclear weapons are needed to offset the superior conventional forces of NATO and particularly the United States. Russia also appears to be motivated by a desire to counter China's large and increasingly capable conventional forces in the

Far East, and by the fact that having a sizable inventory of nonstrategic nuclear weapons helps Moscow keep overall nuclear parity with the combined nuclear forces of the United States, the United Kingdom, and France.

After the 2018 Nuclear Posture Review was published, inaccurate and exaggerated information was distributed in Washington by defense sources that attributed nuclear capability to several Russian systems that had either been retired or were not, in fact, nuclear. Moreover, although the Nuclear Posture Review claims Russia has increased its nonstrategic nuclear weapons over the past decade, the inventory has in fact declined significantly – by about one-third – during that period (Kristensen 2019).

We estimate that Russia today has approximately 1,910 nonstrategic nuclear warheads assigned for delivery by air, naval, ground, and various defensive forces.[6] This is a slight increase compared with the previous Nuclear Notebook on Russian forces. It is possible that there are more nuclear-capable systems and that this inventory is growing but there is little public information available. This estimate, and the categories of Russian weapons that we have been describing in the Nuclear Notebook for years, were confirmed by the Nuclear Posture Review, which said:

> Russia is modernizing an active stockpile of up to 2,000 nonstrategic nuclear weapons, including those employable by ships, planes, and ground forces. These include air-to-surface missiles, short range ballistic missiles, gravity bombs, and depth charges for medium-range bombers, tactical bombers, and naval aviation, as well as anti-ship, anti-submarine, and anti-aircraft missiles and torpedoes for surface ships and submarines, a nuclear ground-launched cruise missile in violation of the 1987 Intermediate-Range Nuclear Forces Treaty, and Moscow's antiballistic missile system (US Defense Department 2018, 53).

The Nuclear Posture Review also said:

> Russia possesses significant advantages in its nuclear weapons production capacity and in nonstrategic nuclear forces over the US and allies. It is also building a large, diverse, and modern set of nonstrategic systems that are dual-capable (may be armed with nuclear or conventional weapons). These theater- and tactical-range systems are not accountable under the New START Treaty and Russia's nonstrategic nuclear weapons modernization is increasing the total number of such weapons in its arsenal, while significantly improving its delivery capabilities. This includes the production, possession, and flight testing of a ground-launched cruise missile in violation of the Intermediate-Range Nuclear Forces Treaty. Moscow believes these systems may provide useful options for escalation advantage. Finally, despite Moscow's frequent criticism of US missile defense, Russia is also modernizing its long-standing nuclear-armed ballistic missile defense system and designing a new ballistic missile defense interceptor (US Defense Department 2018, 9).

These paragraphs constitute the first substantial official US public statement on the status and composition of the Russian nonstrategic nuclear arsenal in more than two decades, even though the paragraphs also raise questions about assumptions and counting rules. Most of the nonstrategic weapon systems are dual-capable, which means not all platforms may be assigned nuclear missions, and not all operations are nuclear. Moreover, many of the delivery platforms are in various stages of overhaul and would not be able to launch nuclear weapons at this time.

Sea-based nonstrategic nuclear weapons

As far as we can ascertain, the biggest user of nonstrategic nuclear weapons in the Russian military is the navy, which we estimate has roughly 930 warheads for use by land-attack cruise missiles, anti-ship cruise missiles, anti-submarine rockets, anti-aircraft missiles, torpedoes, and depth charges. These weapons may be used by submarines, aircraft carriers, cruisers, destroyers, frigates, corvettes, and naval aircraft.

Major naval modernization programs focus on the next class of nuclear attack submarines, known in Russia as Project 885/M or Yasen/-M. The program is progressing very slowly. The first of these boats, known as *Severodvinsk*, entered service in 2015 and is thought to be equipped with a nuclear version of the Kalibr land-attack sea-launched cruise missile (the SS-N-30A) (Gertz 2015). It can also launch the SS-N-26 (3M-55) anti-ship/land-attack cruise missile, which the US National Air and Space Intelligence Center says is "nuclear possible" (US Air Force 2017, 37). The second boat, and the lead ship of the improved Yasen-M class – known as *Kazan* – was originally scheduled to join the Northern Fleet in late 2019 (TASS 2018d); however, the boat was delayed due to the poor results of its dockside trials, which indicated that "some of the ship's auxiliary sub-assemblies and mechanisms do not meet the requirements of the specifications set by the Defense Ministry" (TASS 2019d). The *Kazan* underwent sea trials in late 2020, successfully hitting a target over 1,000 kilometers away with a Kalibr cruise missile (TASS 2020k). State trials are expected to be completed by the end of 2020, meaning that the *Kazan* will likely become operational in 2021 (Krasnaya Zvezda 2020c). The *Severodvinsk* is reportedly 10 to 12 meters longer than the *Kazan* and can therefore accommodate 40 Kalibr missiles, eight more

than the *Kazan* (Gady 2018). Six more Yasen-M boats are planned – with two boats to be laid down in 2021 for completion by 2027 – although the CEO of the United Shipbuilding Corporation acknowledged that program delays were likely due to unexpected "design flaws" (RIA Novosti 2019a). The Yasen-class submarines will also be able to deliver the SS-N-26 cruise missile, SS-N-16 (Veter) nuclear anti-submarine rockets, as well as nuclear torpedoes.

Other upgrades of naval nonstrategic nuclear platforms include those planned for the Sierra class (Project 945), the Oscar II class (Project 949A), and the Akula class (Project 971). While the conventional version of the Kalibr is being fielded on a wide range of submarines and ships, the nuclear version will likely replace the current SS-N-21 nuclear land-attack cruise missile on select attack submarines. There is also speculation that Russia might consider building a new type of cruise missile submarine based on the Borei SSBN design, which would be called Borei-K. The Borei-Ks could potentially carry nuclear-armed cruise missiles instead of ballistic missiles, and if they were approved then they would be scheduled for delivery after 2027 (TASS 2019e).

Air-based nonstrategic nuclear weapons

The Russian Air Force is the military's second-largest user of nonstrategic nuclear weapons, with roughly 500 such weapons assigned for delivery by Tu-22 M3 (Backfire) intermediate-range bombers, Su-24 M (Fencer-D) fighter-bombers, the new Su-34 (Fullback) fighter bomber, and the MiG-31 K. All types can deliver nuclear gravity bombs. A total of four regiments are now equipped with the new Su-34, which is replacing the Su-24, with a total of 125 aircraft delivered so far. The new Su-57 (PAK-FA) that is in development (called Felon by NATO) was listed as nuclear-capable by the 2018 Nuclear Posture Review (US Defense Department 2018), but it is not yet fully operational. The Tu-22 M3 can also deliver Kh-22 (AS-4 Kitchen) air-launched cruise missiles. An upgraded missile known as Kh-32 is in development to replace the Kh-22. The Tu-22 M3 and Su-24 M are also being upgraded, and the new Tu-22 M3M – which reportedly contains 80 percent entirely new avionics and shares a communications suite with the new Su-57 fighter – conducted its maiden flight in December 2018 (United Aircraft Corporation 2018; TASS 2020g). The second prototype of the upgraded Tu-22M3M conducted its first flight in March 2020, and has since conducted four additional flight tests—one of which tested the plane's resilience at supersonic speeds (TASS 2020l). It is possible the Russian Air Force also has various types of other guided bombs, air-to-surface missiles, and air-to-air missiles with nuclear capability, in which case the air force's inventory of warheads – and thus also Russia's total number of nonstrategic warheads – could be greater.

Russia has also developed a new long-range dual-capable air-launched ballistic missile known as the Kh-47 M2 Kinzhal. The missile, which appears similar to the ground-launched SS-26 short-range ballistic missile used on the Iskander system, allegedly has a range of up to 2,000 kilometers (about 1,243 miles) and is launched from the center-pylon of specially modified MiG-31 K (Foxhound) air interceptors. The Kinzhal could potentially be used against targets on both land and sea and has reportedly been deployed on experimental combat duty in the Southern Military District since December 2017 (TASS 2018e). The Kinzhal was publicly demonstrated for the first time in an airshow in August 2019, although it is unclear if the missile was actually fired during the competition (TASS 2019g).

Additionally, the Russian Aerospace Force reportedly received its first batch of Su-57 (PAK-FA) fighter jets in late 2020 (TASS 2020m). Four more are scheduled for delivery in 2021, and the delivery of 22 aircraft are scheduled by the end of 2024. The full contract is expected to comprise 76 planes for delivery by the end of 2028 (TASS 2020n). The US Defense Department says that the Su-57s are nuclear-capable (US Defense Department 2018). They will reportedly also be equipped with hypersonic "missiles with characteristics similar to that of the Kinzhal" (TASS 2018f)

Nonstrategic nuclear weapons in missile defense

The 2018 Nuclear Posture Review also asserted that Russia continues to use nuclear warheads in its air and missile defense forces. The missile defense forces use the Gazelle interceptor, but the Nuclear Posture Review did not identify which air defense system has dual-capability or how many are assigned nuclear warheads. The US Defense Intelligence Agency said in its March 2018 Worldwide Threat Assessment that, "Russia may also have warheads for surface-to-air and other aerospace defense missile systems" (Ashley 2018). The S-300 is gradually being replaced by the S-400 system with SA-21 interceptors, and US government sources privately indicate that both the S-300 (SA-20) and S-400 (SA-21) are dual-capable. An upgrade of the nuclear-tipped A-135 anti-ballistic missile defense system around Moscow is underway, and it will be known as A-235; however, it remains unclear whether the A-235 system will use either nuclear or conventional

warheads, or perhaps instead rely on kinetic hit-to-kill technology (Red Star 2017).

Russian officials said over a decade ago that about 40 percent of the country's 1991 stockpile of air defense nuclear warheads remained. Alexei Arbatov, then a member of the Russian Federation State Duma defense committee, wrote in 1999 that the 1991 inventory included 3,000 air defense warheads (Arbatov 1999). Many of those were probably from systems that had been retired, and US intelligence officials estimated that the number had declined to around 2,500 by the late 1980s (Cochran et al. 1989), in which case the 1991 inventory might have been closer to 2,000 air defense warheads. In 1992, Russia promised to destroy half of its nuclear air defense warheads, but Russian officials said in 2007 that 60 percent had been destroyed (Pravda 2007).

If those officials were correct, the number of nuclear warheads for Russian air defense forces might have been 800 to 1,000 a decade ago. Assuming that the inventory has shrunk further since 2007 (due to the improving capabilities of conventional air-defense interceptors and continued retirement of excess warheads), we estimate that nearly 290 nuclear warheads remain for air defense forces today, plus an additional roughly 90 for the Moscow A-135 missile defense system and coastal defense units, for a total inventory of about 380 warheads. However, it must be emphasized that this estimate comes with considerable uncertainty.

Ground-based nonstrategic nuclear weapons

Defense Minister Sergei Shoigu announced in December 2019 that the upgrade of all army missile brigades to the SS-26 (Iskander) short-range ballistic missile had been completed (Russian Federation 2019). This includes at least 12 brigades: four in the Western Military District; two in the Southern Military District; two in the Central Military District, and at least four in the Eastern Military District. Each SS-26 launcher can carry up to two missiles with a range of at least 350 km. We estimate there are roughly 70 warheads for short-range ballistic missiles. There are also unconfirmed rumors that the SSC-7 (9M728 or R-500) ground-launched cruise missile may have nuclear capability.

The US government also says Russia has developed and deployed a dual-capable ground-launched cruise missile in violation of the now demised Intermediate-Range Nuclear Forces Treaty. The missile is identified as the 9M729 (SSC-8) (US State Department 2019a). Former National Intelligence Director Dan Coats said Russia initially tested the 9M729 to prohibited ranges from a fixed launcher, then tested it to permitted ranges from a mobile launcher (Office of the Director National Intelligence 2018). The first two battalions were deployed in late 2017 (Gordon 2017), and US intelligence sources have since indicated that Russia has deployed four battalions in the Western, Southern, Central, and Eastern Military Districts with nearly 100 missiles (including spares) (Gordon 2019). Each battalion is thought to include four launchers, each with four missiles, for a total of 64 missiles plus spares across all four battalions. We estimate the four battalions are co-located with the Iskander sites at Elanskiy, Kapustin Yar (possibly moved to a permanent base by now, possibly in the Far East), Mozdok, and Shuya. It is possible, but unknown, if more battalions have been deployed.

Gen. Paul Selva, former vice chairman of the Joint Chiefs of Staff, however, told Congress in 2017 that the 9M729 deployment at that time did not give Russia a military advantage: "Given the location of the specific missiles and deployment, they don't gain any advantage in Europe" (Brissett 2017). After having denied the existence of a 9M729 missile, the Russian military in January 2019 displayed what it said was a launcher, missile canisters, and schematics of a missile named 9M729, but claimed its range was less than 500 kilometers, or about 311 miles (TASS 2019k). However, a US intelligence report on the display subsequently concluded that the event was a hoax: Neither the missile, nor its launch vehicle, nor the schematics shown were what Russia claimed them to be (Panda 2019b). The Trump administration in February 2019 formally announced the United States would withdraw from the Intermediate-Range Nuclear Forces Treaty effective in six months (US State Department 2019b). On August 2, 2019, the Intermediate-Range Nuclear Forces Treaty officially died.

It is unknown if Russia has added 9M729 battalions beyond the four reported in December 2018. There is no public confirmation that it has, but in February 2019, only a few weeks after Russia acknowledged the existence of the 9M729 but claimed its range was legal, the press service of Russia's Western Military District reported it had carried out "electronic launches" of the 9M279 in the Leningrad region (RIA Novosti 2019c). This could indicate the 9M729 has been added to a fifth brigade: the 26th Missile

Brigade outside Luga about 125 km south of St. Petersburg. And in December 2019, Izvestia reported that the Russian military planned to add a fourth battalion to each Iskander brigade (Izvestia 2019). It remains to be seen if this means 9M729 launchers will be added to all of Russia's 12 Iskander brigades; however, in October 2020 Putin declared his willingness to impose a moratorium on future 9M729 deployments in European territory, "but only provided that NATO countries take reciprocal steps that preclude the deployment in Europe of the weapons earlier prohibited under the INF Treaty" (Russian Federation 2020b).

Notes

1. We estimate that Russia stores its nuclear weapons at approximately 40 permanent storage sites across the country, including about 10 national-level central storage sites (Kristensen and Norris 2014, 2–9). Essential references for following Russian strategic nuclear forces include the general New START aggregate data that the US and Russian governments release biannually; BBC Monitoring; Pavel Podvig's website on Russian strategic nuclear forces (Podvig n.d.); and the Russia profile maintained by the James Martin Center for Nonproliferation Studies (2018) on the Nuclear Threat Initiative website.
2. For examples of such analyses, see Sokov (2020); Oliker (2018); Tertrais (2018); Oliker and Baklitskiy (2018); Bruusgaard (2016, 2017).
3. Three Typhoon-class (Project 941) submarines also remain afloat. One has been converted to a missile test platform. None of these submarines carries nuclear weapons.
4. One normally well-informed source says there are no nuclear gravity bombs for the Tu-95MS and Tu-160 aircraft (Podvig 2005).
5. Russia is also adding conventional cruise missiles to its bomber fleet, a capability that was showcased in September 2015 when Tu-160 and Tu-95MS bombers launched several long-range conventional Kh-555 and Kh-101 cruise missiles against targets in Syria. New storage facilities have been added to Russia's bomber bases over the past few years that might be related to the introduction of conventional cruise missiles.
6. A US government telegram stated in September 2009 that Russia had "3,000–5,000 plus" nonstrategic nuclear weapons (Hedgehogs.net 2010), a number that comes close to our estimate at the time (Kristensen 2009). The US deputy undersecretary of defense for policy, James Miller, stated in 2011 that nongovernmental sources estimated Russia might have 2,000 to 4,000 nonstrategic nuclear weapons (Miller 2011). For a more in-depth overview of Russian and US nonstrategic nuclear weapons, see Kristensen (2012). Some analysts estimate that Russia has significantly fewer warheads assigned to nonstrategic forces (Sutyagin et al. 2012).

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