INTERCONTINENTAL BALLISTIC MISSILE

Sarmat Multiple-Warhead Heavy ICBM

The first system announced by Putin in his March 2018 address was a new ICBM called the Sarmat,[6] a replacement for the R-36M2 Voevoda ICBM (called the SS-18 by NATO) deployed currently.[7] Putin announced the Sarmat as more capable than the Voevoda. "Weighing over 200 tons, it has a short boost phase, which makes it more difficult to intercept for missile-defense systems," he said. "The range of the new heavy missile, the number and power of its combat blocs is bigger than Voevoda's. Sarmat will be equipped with a broad range of powerful nuclear warheads, including hypersonic, and the most modern means of evading missile defense…. Voevoda's range is 11,000 km while Sarmat has practically no range restrictions…. It can attack targets both via the North and South poles." The video accompanying his speech showed ICBM tracks from Russia to the United States through both a northern and a southern route.

The RS-28 Sarmat is a liquid-fueled, multiple-warhead ICBM under contract to the Makeyev State Rocket Design Center since 2011[8] and being manufactured at the Krasnoyarsk Machine-Building Plant (Krasmash).[9] NATO refers to the new Sarmat as the SS-30 Satan 2. The Voevoda was designed and manufactured during Soviet times in Ukraine; its service life has been extended, and it is projected to go out of service as early as 2022, with the oldest units needing to be replaced as early as 2022 and all the units needing to to replaced by 2027,[10] imposing a time constraint on the Sarmat development and deployment schedule.

Test footage of the Sarmat strategic missile system

Source: Ministry of Defense, Russia

Technical characteristics

The development of the Sarmat was reported previously in open sources; however, some of the claims in Putin's 2018 address were new. The new capabilities, if realized, would

make the Sarmat ICBM a more advanced capability than the Voevoda, with new military characteristics and advanced evasive technologies.

Below is an assessment of reported information that adds detail to the capabilities referred to in the 2018 speech:

- **Short boost phase:** The short-boost-phase claim is somewhat puzzling, because the Sarmat, like the Voevoda, uses liquid fuel.[11] Liquid fuels tend to produce longer boost phases than solid fuels.[12] It is hard to be definitive about what is behind the short-boost-phase claim, but there is substantial reporting suggesting the new first-stage engine for the Sarmat, the PDU-99,[13] is being designed to lower the signature and/or increase the thrust and boost speed of the Sarmat. Reporting consistently names Energomash as the engine design agency; however, whereas many report the PDU-99 is a variant of the engine used on the current Voevoda,[14] others claim it is a more advanced pulsed-detonation engine.[15] Some reports assert the new engine will hyperaccelerate the Sarmat into orbit, reducing the infrared signature of the launch as well as the time available for early-warning satellites to detect such a launch.[16] Since infrared signature is closely related to engine type, fuel composition, burn time, rocket geometry, chamber parameters, and flight conditions,[17] it is possible that a new engine and/or new fuel could cause the boost phase to be harder to detect and characterize. It is widely reported the PDU-99 was tested in August 2016, although no detail is given about the engine.[18] Later that same month, it was also reported, a full-scale pulse detonation engine was tested by the Russian Advanced Research Foundation[19] supported by Energomash. The Advanced Research Foundation engine was said to employ clean fuel and obtain high thermodynamic efficiency while providing lower cost and increasing the payload weight for space missions. If the pulse-detonation engine test is accurately reported, it represents a scientific breakthrough. However, deploying a pulse-detonation engine on the Sarmat would be quite ambitious and likely would require significantly more testing.
- **Range:** The Sarmat ICBM will be placed into existing SS-18 missile silos with minimum modifications to launch-area infrastructure.[20] The missile is expected to be about 36.3 m (109 ft) long and 3 m (9 ft) in diameter.[21] Whereas Putin claimed "practically no range restrictions" for the Sarmat, most reporting suggests the range will be about 16,000 km (about 9900 mi), to support a South Pole route to the United States. Without getting larger, the Sarmat is said to have increased its range and throw-weight[22] by reducing its missile airframe weight by nearly 50 percent through the use of advanced composite materials.[23] Although there were two range options developed and originally deployed for Voevoda—11,000 km (about 6800 mi) for a North Pole attack and 16,000 km (about 9900 mi) for a South Pole attack—the only currently deployed version of the Voevoda has a range of 11,000 km (about 6800 mi).[24] If the Sarmat range is 16,000 km (9900 mi), it will provide Russia with an ICBM range beyond what is currently deployed but equivalent to formerly deployed ICBM ranges.
- **Number, power, and types of nuclear warheads:** The Voevoda carries up to 10 warheads of about 750 kt each as well as decoys and penetration aids. The number of warheads expected to be carried on the Sarmat is most frequently reported as 10 to 16,[25] but reports can be found referencing as few as three[26] and as many as 24[27] hypersonic Avangard warheads. All reports suggest the Sarmat is being designed to carry a combination of countermeasures and warheads that can target different locations.[28] References to throw-weight and yield include up to 10 750-kt warheads (7.5

Mt), 16 hypersonic glide vehicles yielding 500 kt each (8 Mt), 24 hypersonic glide vehicles each yielding 150 kt (3.6 Mt), or combinations thereof. The total yield the missile can carry has been consistently reported to be about 8 Mt.[29] If the number of warheads is 10, and the total yield is 8 Mt, the Sarmat will be very similar to the Voevoda deployed today.[30] Given what is reported about the size and weight of the Avangard, it is reasonable to assume the Sarmat will not carry 24 warheads without significant re-engineering of the hypersonic system.

- **Modern means to evade missile defense:** The implication in Putin's speech is that the Sarmat has modern evasive measures in addition to a short boost phase. Some of these measures likely include the use of improved decoys, making it hard for radars to adequately track the correct target. (Decoys are already employed on the Voevoda.) The original Voevoda missile is sometimes said to have deployed fractional orbital bombardment re-entry vehicles capable of dynamically maneuvering outside of the ballistic track to make the warhead's flight path and intended target harder to predict.[31] The Sarmat is expected to carry the Avangard hypersonic missile, which will likely have more non-ballistic maneuverability.

The claims of potential capabilities for the Sarmat are extensive, and it is reasonable to assume that trade-offs will be made between realizing the advancements and the cost and schedule associated with deployment. An open-ended development schedule for the Sarmat is not a realistic option, since the Voevoda lifetime is limited.

Deployment schedule

During his 2018 and 2019 addresses, Putin mentioned that the Sarmat was in active testing. There have been two tests (late December 2017 and March 30, 2018) of the ejection mechanism from the silo, and the second may have also validated performance of the initial flight phase. A third ejection test may have been conducted in May 2018,[32] and it is shown along with component manufacturing on a video released on July 28, 2018.[33] Although it was expected, no complete flight testing of the Sarmat was conducted in 2018, and full-scale tests were initially reported to be delayed to 2019.[34] Given that preparation for such tests has not yet been observed, it is reasonable to assume it could be 2020 before a full-scale flight test is conducted. Recent reporting described a fire at the Sarmat production facility in April 2019, and Russian government officials now say the tests will be completed by the end of 2020.[35]

The development of Sarmat is behind the originally announced deployment date of 2016–2018.[36] Current Russian plans indicate serial production in 2020 and operational deployment in 2021.[37] These dates are optimistic relative to expected final testing timelines, which continue to be pushed out. In early 2017, there were 46 Voevoda missiles fielded,[38] and it is generally believed that all will be gradually replaced by the new Sarmat ICBMs. It seems likely that Russia will be able to replace the Voevoda with some version of the Sarmat at or before the end of life of most or all Voevoda missiles, but significant work and expenditure will be required.

Military objective

Historically, Russia has deployed a higher proportion of its strategic nuclear forces on land rather than at sea, in contrast to the United States, which relies more heavily on sea-based weapons. Silo-based ICBMs are viewed as the fastest response leg of a nuclear triad but vulnerable to a first strike. Because of the number and types of warheads and likely decoys intended for the Sarmat, Russia seems to be seeking to increase its ability to overwhelm any U.S. missile defenses and ensure that its strategic-range ICBM-based nuclear missiles can penetrate existing or new missile-defense capabilities.