

# **NUCLEAR- CAPABLE MISSILES**

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## **About the Author**

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## **INTRODUCTION**

Six countries with nuclear weapons and missiles capable of carrying them (hereafter “nuclear missiles”) were examined in this study. It is interesting to note the diversity of the missiles in each country and the history of when they acquired each type. Diversity can be explained by where they are launched from: land, sea (including sub surface) or air, the ranges of the missiles:

short to long range, and the basing mode for land-based missiles: mobile and silo. Many other factors also enter in to these decisions but the major one is the enemy country and its location relative to the possessing state.

Table 1 shows how these countries planned and deployed nuclear missiles.<sup>1</sup> Compared with two decades ago, this table now shows a high level of nuclear-missile activity.

**Table 1: Nuclear-capable missiles in six Indo-Pacific countries <sup>2</sup>**

|                           | USA                                                              | Russia | PRC | India | Pakistan | DPRK |
|---------------------------|------------------------------------------------------------------|--------|-----|-------|----------|------|
| <b>Ballistic Missiles</b> |                                                                  |        |     |       |          |      |
| SRBM                      | X                                                                | X      | X   | X     | X        | X    |
| MRBM                      |                                                                  |        | X   | X     | X        | X    |
| IRBM                      |                                                                  |        | X   | X     | X        | X    |
| ICBM                      | X                                                                | X      | X   | D     |          | D    |
| SLBM                      | X                                                                | X      | X   | X     |          | D    |
| ALBM                      |                                                                  | X      |     |       |          |      |
| <b>Cruise Missiles</b>    |                                                                  |        |     |       |          |      |
| Land Short Range          |                                                                  |        | X   |       | X        |      |
| Land Long Range           |                                                                  | X      | X   | X     |          | D    |
| Air Long Range            | X                                                                | X      | X   |       |          |      |
| Sea Long Range            |                                                                  | X      |     |       |          |      |
| Land Nuclear-Powered      |                                                                  | D      |     |       |          |      |
| Long Range Submarine      |                                                                  |        |     |       |          |      |
| Nuclear-Powered Torpedo   |                                                                  | D      |     |       |          |      |
| <hr/>                     |                                                                  |        |     |       |          |      |
| X =                       | Deployed missiles                                                |        |     |       |          |      |
| D =                       | Missile in Development                                           |        |     |       |          |      |
| Blank =                   | Country not developing this type of missile or unknown if D or X |        |     |       |          |      |
| <b>Missile Ranges</b>     |                                                                  |        |     |       |          |      |
| SRBM                      | 300-1000 km                                                      |        |     |       |          |      |
| MRBM                      | 1000-3000 km                                                     |        |     |       |          |      |
| IRBM                      | 3000-5500 km                                                     |        |     |       |          |      |
| ICBM                      | 5500 km >                                                        |        |     |       |          |      |
| SLBM                      | Sub/Ship all Ranges                                              |        |     |       |          |      |
| ALBM                      | Air all Ranges                                                   |        |     |       |          |      |

<sup>1</sup> If the square is blank it shows the country is not developing this type of missile or its status is unknown.

<sup>2</sup> The United States and USSR/Russian strategic bombers have carried nuclear equipped ALCMs for around 40 years.

## **United States and Russian Nuclear Missiles**

Long-range, nuclear-capable missiles were developed and deployed as an extension of the United States and Soviet post-World War 2 bomber aircraft and German V-missiles. Throughout the Cold War they deployed various nuclear-capable missiles in hardened silos and on mobile vehicles, ballistic missile submarines, and various bomber aircraft. The START treaty (Strategic Arms Reduction Treaty) limited and reduced the numbers of these weapons significantly to what the United States and Russia have today. The New START treaty will continue for five years until February 2026. No other treaty restricts nuclear weapons in the Indo-Pacific region beyond these limits in two of the six states with nuclear missiles.

The timing, situation between countries, geography, and available technology largely determines nuclear weapons development. The United States and former Soviet Union were allies during World War 2 but as they became adversaries, both deployed nuclear weapons in the 1950s. Each developed tactical and strategic platforms that could deliver nuclear warheads. Tactical weapons included short- and medium-range missiles to fight a war in Europe and the western Pacific. Long-range missiles were deployed to destroy homeland targets from afar, either from the own homeland or from at sea on submarines.

Both deployed families of inter-continental ballistic missiles (ICBMs) from the 1950s to the mid-1960s. The ICBM was the weapon of choice as bombers became more vulnerable to improving air defenses. To extend the life of the bomber fleet, standoff cruise missiles that launched outside the adversary's air defense zone were developed. The bombers with these types of missiles are still deployed and each state plans to use them until at least the mid-21st century. Both countries consider their fleet of SSBNs (Submersible Ship Ballistic Missile Nuclear) as the most survivable leg of their respective nuclear triads.

The United States and Russia are in the process of replacing each element of the nuclear triad. Of the two, Russia is further along. The United States is just getting started. Russia has deployed four new Borei SSBNs and plans to add another six. These submarines carry a new SLBM, (submarine-launched ballistic missile), the Bulava. Russia is also replacing its ICBMs with new

missiles and have ordered ten new Tu-160MS bombers and are designing a Tu-PAC stealth bomber.

The United States plans on replacing its 400 silo-based 50-year-old Minuteman 3 ICBMs with the new Ground Based Strategic Deterrent (GBSD) missile and its Ohio Class SSBNs with Columbia class SSBNs that will enter service in 2031. The long-range bombers will also be replaced starting in 2025 by a new stealth bomber, the B-21. One hundred of the B-21 bombers have been ordered along with a new Long Range Stand Off Missile (ALCM).

### **Peoples Republic of China (PRC)**

The PRC tested its first atomic bomb in 1964 and its first ICBM in May 1980. It deployed eighteen of these liquid fuel DF-5 ICBMs that were upgraded in 2015. Over the next 35 years China built out its nuclear triad with mobile ICBMs and currently deploys six SSBNs with at least seventy-two launch tubes. It has begun to test a next generation of SLBMs and construction of a new class of SSBN to carry it. It also finished building about 100 new H-6K intermediate-range bombers and began production of the H-6N bomber capable of carrying a variant of the DF-21 ballistic missile. A new H-20 stealth bomber with an estimated range of 8,500 km is expected to begin testing in late 2021 or 2022.

The biggest surprise in 2021 was the discovery of over 200 missile silos under construction in the western desert for DF-41 solid fuel ICBMs. This discovery and the other additions to the nuclear triad shows that China may double their nuclear weapons arsenal by 2030—as asserted by the US Department of Defense.<sup>3</sup> This development would portend a huge departure from their 30 years of deterrence and possibly also their declaratory doctrine of no-first use.

### **India**

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<sup>3</sup> “Two decades later, the PLA’s objective is to become a “world-class” military by the end of 2049—a goal first announced by General Secretary Xi Jinping in 2017. Although the CCP has not defined what a “world-class” military means, within the context of the PRC’s national strategy it is likely that Beijing will seek to develop a military by mid-century that is equal to—or in some cases superior to—the U.S. military, or that of any other great power that the PRC views as a threat.” US Department of Defense, *Military and Security Developments Involving the People’s Republic of China*, 2020, Office of the Secretary of Defense, Annual Report to Congress, at: <https://media.defense.gov/2020/Sep/01/2002488689/-1/-1/1/2020-DOD-CHINA-MILITARY-POWER-REPORT-FINAL.PDF>

India has joined the nuclear triad club late and is now adding modern delivery systems. The strongest part of their triad is ground-launched ballistic missiles. The nuclear-capable Prithvi 1 and 2 and Agni 1 to 5 missiles are mobile and include short- and intermediate-range weapons with an ICBM under development. India's naval SSBN force currently consists of two operational submarines with two more under construction. The two existing SSBNs have a total of thirty-six short-range missiles, but some or all of these will be replaced with twelve intermediate-range missiles in the near future. The aircraft triad piece consists four types of short-range fighter-bombers. They mainly carry unguided free fall bombs. However, forty Su-30MKI fighters have been modified to carry the BrahMos supersonic nuclear capable cruise missile. BrahMos missiles are also launched from ground Transporter, Erector, Launchers (TEL), surface ship, and submarines. A hypersonic version of this missile is under development. India's large number of short to medium range missiles reflects their primary historical nuclear adversary was Pakistan. Over the last 20 years, however, China has become a major problem for India as the two countries have had several skirmishes along India's northern border with China. These actions and the fact the China has become Pakistan's primary arms supplier has probably driven India to deploy IRBMs and to develop their ICBM.

### **Pakistan**

Since the Partition, Pakistan has viewed India to be its mortal enemy. All Pakistani deployed missiles were developed with India as their target. Pakistan is also close to developing a nuclear triad. The ground-launched ballistic and cruise missiles are the largest portion of this triad. The Mirage 3 fighter-bombers can deliver nuclear bombs and some were probably modified to carry the Ra'ad-1 nuclear-capable cruise missile. The Ra'ad-2 longer-range version is planned to replace the older version beginning in 2021. The Babur-3 nuclear-capable cruise missile is the submarine version of missile and was tested at sea in 2017 and 2018. It is possible it will be deployed on the three current Agosta class submarines and the eight Hangor class submarines ordered from China.

### **Democratic Peoples' Republic of Korea (DPRK)**

The DPRK's nuclear-capable missiles today are land-based and mobile. They are short- to intermediate-range operational missiles, with at least three intercontinental range missiles under

development. September 2021 was a very busy month for testing new missiles. The first of these were two long-range ground launched cruise missiles. The DPRK reported these were successful. Next were three short-range ballistic missiles that were successfully launched from a rail train car. These were quickly followed by a ground launch what they called the HS-8 hypersonic missile. Its booster appears to be a one third shorter version of the HS-12 IRBM. Then on 19 October 2021 they launched a short-range missile probably from the submerged Gore submarine and claimed it was successful.

The DPRK is testing an intermediate-range submarine ballistic missile and modifying a conventionally powered submarine with three launch tubes for these missiles. This submarine is expected to be in the water in 2021/2022. They may also be building a nuclear powered submarine with six launch tubes although there is no hard evidence of this intention. The DPRK's air force also has at least two types of aircraft that are capable of carrying gravity nuclear bombs. There is no publicly available data, however, to indicate any of them have been modified to carry these bombs or any nuclear-armed missiles.

DPRK has a very diverse arsenal of missiles. How this came to be is not typical. The DPRK first acquired Soviet Scud missiles from Egypt, copied them and deployed them against the ROK and US forces in the ROK. They soon determined there was a market for these missiles in the Mideast and Pakistan and sold not only the missiles but also the factories to make them. They scaled up the technology and produced a longer-range missile that also sold. With time, they established a strong relationship with Iran and continue to work with them on the latter's space program.

The DPRK were assisted by Russia or Ukraine to obtain high energy fuel engines. They were also assisted by China on solid fuel motors and commercial trucks, which they modified into TELs. The DPRK continues to surprise most experts on what they will do next. But it is self-evident that the DPRK's highest priority is to develop an ICBM that threatens the US mainland.

## **MISSILES IN DETAIL**

The nuclear-capable missiles discussed in this chapter are all offensive weapons launched from silos, vehicles, surface ships, submarines, and aircraft. They are classified as ballistic missiles, cruise missiles, and a few are hybrid missiles, mainly the new hypersonic glide vehicles. The

ballistic missiles can have one to four stages, where cruise missiles usually have a booster and a sustainer stage. Missiles can have solid fuel motors, liquid fuel engines, or a combination of both to power them, and Russia is now developing a nuclear engine.

In this chapter, missiles are grouped together by maximum range: Close 50 to 300km, Short 300 to 1,000km, Medium 1,000 to 3,000km, Intermediate 3,000 to 5,500km, and Intercontinental 5,500 to 15,000+km. Submarine and air launched missiles are listed as SLGMs (submarine-launched guided missiles) and SLBMs and ALCMs (air-launched cruise missiles) followed by their ranges.

The typical ways these ranges are shown are by range rings radiating out from the country or launch site. Maps in most media presentations show these rings to compare the various missiles a country has deployed and the areas they cover. If not updated, these graphics can show bogus information. For example some DPRK rings maps include the Hwasong-10 (Musudan) IRBM and Hwasong-13 (KN-08) ICBM as deployed when they are terminated programs and the Unha 2/3 (Taepo Dong-2) as an ICBM when it is a space launch vehicle. Shorter-range missiles usually carry lower yield nuclear warheads where throw weight is restricted. Longer-range missiles can carry one large warhead or multiple warheads, some with a post boost vehicle so they can be independently targeted.

This essay divides missile states into three groups. Group one includes United States, Russia, People's Republic of China, and India. These countries all have operational nuclear triads that consist of land-based missiles, either in silos and mobile vehicles or both, sea based ballistic or cruise missiles in nuclear submarines, and airborne cruise missiles or bombs. Group two consists of countries that have nuclear weapons that are mainly deployed on ground vehicles. These countries include Pakistan and the DPRK. Group three comprises countries that do not currently have nuclear weapons but have the capability to produce the warheads and the missiles to carry them. These countries include Japan, the ROK, and Taiwan. A fourth country, Indonesia, was not included because it currently has limited capability to develop nuclear weapons and the missiles to deliver them. Group one and two countries are discussed in this essay.

If one sorts these countries according to those that are currently missile or missile component proliferators, one finds that this the list includes China, Russia, and the DPRK. A few of the

countries that received missile-related material are in Group two—Pakistan, India, and the DPRK. In the 1970s and 1980s, for example, Pakistan received liquid fuel missile technology from the DPRK and solid fuel technology from China. The DPRK reverse engineered Soviet liquid fuel Scud missiles received from Egypt and sold the missiles they made to several Mid-Eastern countries and Pakistan.

Most of the countries with the exception of Pakistan have space launch vehicle (SLV) programs. The majority started using rockets derived from earlier missile programs; these include the United States, Russia, China, and India. Japan received early help from the United States. The ROK received the Atlas design and manufacturing plant from the United States in 1974, and Russia provided the first stage for the ROK's first KSLVs.

All missile and space-launch rocket countries have developed satellites and satellite components. The most advanced are the Group one countries plus Japan. These are followed by the ROK and Taiwan. With Chinese help, Pakistan has a modest capability and the go-it-alone DPRK has the most primitive program having launched and orbited two satellites, neither of which became operational.

In the last few years two new classes of hypersonic weapons have matured and begun deployments. These are hypersonic glide vehicles (HGV) launched by a rocket before gliding to a target and hypersonic cruise missiles powered by high-speed air-breathing engines or scramjets. Russia has stated they deployed an HGV in December 2019 identified as Avangard aboard two SS-19 ICBMs and armed them with a nuclear warhead. China also has the DF-17 medium-range ballistic missile (MRBM) that reached initial operating capability (IOC) in 2019 and is a DF-ZF HGVs mounted on a DF-16 ballistic missile. They have reportedly not decided if these weapons, once they are deployed, will be nuclear- or conventional-armed or dual-capable. The United States has in development at least four hypersonic missiles but has not decided to deploy any of them yet. As of mid-2010 they have made decisions these hypersonic weapons would only be conventionally armed. India also has a hypersonic cruise missile under development with help from Russia. The DPRK had their first launch of a hypersonic missile in September 2021.

## UNITED STATES

In the 1950s, the United States deployed both strategic and tactical nuclear weapons systems consisting of surface-to-surface missiles, submarine-launched missiles and air-launched missiles from bomber aircraft. In the 1960s and 70s the US nuclear triad consisted of 1000 Minuteman 1 intercontinental ballistic missiles (ICBMs), forty-one George Washington class submarines each carrying 16 Polaris SLBMs with single warheads, and B-52 heavy bombers.

Due to the various Strategic Arms Treaties with the USSR/Russia, the United States reduced its nuclear capable weapons today to 400 silo-based Minuteman 3 ICBMs with one warhead,<sup>4</sup> fourteen Ohio class submarines each armed with 20 Trident 2 D5 missiles<sup>5</sup> with up to ten warheads but normally these missiles carry only four today; and 20 B-B-2A and 46 B-52H<sup>6</sup> nuclear-capable bombers. The B-2As are only authorized to carry nuclear gravity bombs whereas each B-52H may be loaded with up to twenty nuclear-capable ALCMs (AGM-86B cruise missiles). The B-52s are no longer are authorized to carry nuclear gravity bombs. The 62 B-1 heavy bombers in service today have not been nuclear capable since 2007 when their nuclear capability was disabled for START treaty compliance.

The New START Treaty went into force in 2011 and was set to expire 5 February 2021. On that date the United States and Russia agreed to extend this treaty until 5 February 2026. On February 5, 2018, both the United States and Russia announced they had met the New START limitations, which limits the number of nuclear warheads and launch systems for long-range nuclear capable weapons as of March 2019 to the following:

- number of nuclear warheads - 1,550, United States 1,365, Russia 1,461
- deployed long-range delivery vehicles-700, United States 656, Russia 524

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<sup>4</sup> Fifty Minuteman silos are reportedly unmanned and on warm standby—that is, can be quickly made operational.

<sup>5</sup> Four of the 18 Ohio Class SSBNs were converted between 2002 and 2006 to SSGNs and no longer are nuclear capable. Each can carry up to 154 Tomahawk cruise missiles. In addition four of the missile tubes on the remaining fourteen Ohio class SSBNs were deactivated in 2011 in anticipation of the New START treaty for a total of fifty-six launch tubes no longer nuclear capable.

<sup>6</sup> Eighteen B-52H are in reserve and 12 more are in long-term storage. The B52H bombers are starting a big upgrade by getting new engines and electronics that will keep them in service into the 2050s. See "Rapid Fire, Ageless Bomber," *The American Legion Magazine*, November 2021, p 56.

- deployed and non-deployed launchers and delivery vehicles: United States 800, Russia 760

With the exception of the nuclear gravity bombs carried on the 20 B-2 bombers all the other US warheads are carried by missile systems.

### **Inter-Continental Ballistic Missiles, Land Based**

The only operational ICBMs today are the 400 Minuteman 3 missiles deployed at Malmstrom Air Force Base (AFB), Montana, Minot AFB, North Dakota, and F.E. Warren AFB, Wyoming. The three-stage solid fuel missile is 18m in length and 1.67m in diameter and has a range of 9700 kilometers plus. The first of these missiles was loaded in an operational silo in April 1970 and had three re-entry vehicles (RV). With the START 2 treaty these missiles were De-MIRVed to one RV starting in 1996. Today the 400 deployed Minuteman 3 missiles continue to have only a single warhead. Currently four to five Minuteman 3 missiles are tested from Vandenberg AFB each year to a mid-Pacific impact area located at Kwajalein. For the remaining about ten plus years that Minuteman 3 will be operational, the yearly launch rate will fall to two to three per year because of a dwindling supply of these missiles.

The United States Air Force is in the early phase of replacing the 400 Minuteman 3 ICBMs. The program is identified as the Ground Based Strategic Deterrent (GBSD). It includes a new missile and much of the ground-based infrastructure at the three existing Minuteman missile bases. The Minuteman 3 system will be well over 60 years old in 2027-29 when the GBSD begins deployment.

The GBSD missile is in development and will consist of three solid fuel stages and is planned to carry a single RV with a W87 Mod 0 nuclear warhead. The current plan is to produce 642 missiles to replace the 400 deployed Minuteman 3 missiles. The other 242 missiles are for flight tests and spares to be used over the 50-year lifetime of the GBSD. Due to the change of administrations in 2021 these dates and numbers may change.<sup>7</sup>

### **SLBMs**

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<sup>7</sup> John A. Tirpak, "New GBSD To Fly in 2023; No Margin Left for Minuteman - Air Force Magazine," *Air Force Magazine*, June 14, 2021, <https://www.airforcemag.com/new-gbsd-will-fly-in-2023-no-margin-left-for-minuteman/>

To be compliant with the New START Treaty the Navy reduced the number of Trident 2 D5LE<sup>8</sup> (UGM-133) missiles carried by each of the fourteen Ohio Class SSBNs from twenty-four to twenty. Currently there are total of 280 Trident 2 D5LE missiles operational in the United States Navy and sixty-four in the United Kingdom's Royal Navy. Each US missile now has a single nuclear warhead, but when first deployed they had three MIRV warheads. This Trident 2 D5 missile was first tested in January 1987 from a flat pad at the Cape Canaveral Air Force Station and first launched from a submarine in March 1989. Its first deployment took place in 1990. The missile is 13.58m long and 2.11m in diameter. Its stated range is 12,000km (7,500mi), but its exact range is classified.

Currently eight Ohio Class SSBNs are based at Naval Base Kitsap, Washington State, and six are bases at Naval Submarine Base Kings Bay, Georgia. Two of the converted Ohio-Class SSGNs are based at both of these bases. These SSGNs are each loaded with 154 Tomahawk BGM-109 cruise missiles that are not nuclear-capable.

The Columbia-Class SSBN program, the replacement for the Ohio-Class SSBN, is under way. The first will enter service in 2031. The current plan is to deliver one of these submarines per year with all twelve to be completed by 2042 and remain in service until 2085.

The new submarines contain sixteen missile tubes for a total of 192 Trident 2 D5LE (Life Extension) missiles with each planned to carry a single warhead. This is the same missile carried by the Ohio class SSBNs today. The first of these missiles went into service in 1990 on the Ohio class submarines. Life extensions are planned to remain in service on the Columbia Class until 2042. The missiles will have about a 50-year lifetime. There is no information on a replacement missile system at this time.<sup>9</sup>

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<sup>9</sup> Ronald O'Rourke, "Navy Columbia (SSBN-826) Class Ballistic Missile Submarine Program: Background and Issues for Congress" (Washington DC: Congressional Research Service, 30 June 2021); "Columbia-Class Submarine," Wikipedia, accessed September 6, 2021, [https://en.wikipedia.org/w/index.php?title=Columbia-class\\_submarine&oldid=1042774524](https://en.wikipedia.org/w/index.php?title=Columbia-class_submarine&oldid=1042774524); Huntington Ingalls Industries, "Huntington Ingalls Industries Awarded Contract for Construction of First Two Columbia-Class Submarine Modules," *Huntington Ingalls Newsroom*, November 23, 2020, <https://newsroom.huntingtoningalls.com/releases/huntington-ingalls-industries-awarded-contract-for-construction-of-first-two-columbia-class-submarine-modules>; "Columbia Class," General Dynamics Electric Boat, accessed September 7, 2021, <http://www.gdeb.com/about/oursubmarines/columbia/>

## **ALCMs carried by Long-Range Bombers**

The United States currently operates two types of nuclear-capable strategic bombers. These are the 70 year old B-52H Stratofortress models and the newer 30 year old stealth B-2 Spirits. The 20 B-2 bombers are now only authorized to carry nuclear gravity bombs. The United States also operates a third long-range bomber, the B-1 Lancer, that since 2007 is no longer nuclear-capable. Sixty two of these bombers are currently in service.

There are fifty-eight B-52H bombers in service with eighteen in reserve and twelve more in long-term storage. The B-52H bombers are equipped to carry up to twenty nuclear capable AGM-86B Air Launched Cruise Missiles (ALCM). The aircraft are no longer authorized to carry nuclear gravity bombs. The AGM-86B has been in the inventory since 1982 and 1715 were produced. The missile is 6.3m in length and 620mm in diameter. It is subsonic at 890km/h and has a nominal range of 1,100km (680mi).<sup>10</sup>

The US Air Force (USAF) plans to replace the AGM-86B with a new cruise missile, the Long Range Stand off (LRSO) AGM-181. This missile will be capable of being armed with either nuclear or conventional warheads. The USAF awarded a contract on 1 July 2021 for engineering and manufacturing development that, with options, could be valued at about \$2 billion. The AGM181 would be deployed on B-52H, B-2, and the new B21 bombers late in the decade. The B-21s will be based at three existing bomber bases: Ellsworth AFB, South Dakota; Whiteman AFB, Missouri; and Dyess AFB, Texas.<sup>11</sup>

The B-21 Raider is the new intercontinental stealth bomber that will enter service in 2025 and will replace some or all of the B-52H, B-1, and B-2 bombers. The initial order is for 100 B-21s, with possible future orders. The aircraft will be able to deliver conventional and nuclear weapons. It is also possible that the AGM-183A Hypersonic Glide Vehicle would also be carried on the B-21 bombers. The first B-52H is currently going through integration for the AGM-183A missile. The B-21s will be based at three existing bomber bases, listed above. Like the Minuteman replacement

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<sup>10</sup> Missile Defense Project, "AGM-86 Air-Launched Cruise Missile (ALCM)," Center for Strategic and International Studies, last modified July 31, 2021, <https://missilethreat.csis.org/missile/alcm/>

<sup>11</sup> O. Pawlyk, "The Air Force is discussing plans to house its new B-21 stealth bombers," *Military.com*, January 15 2021, at: <https://www.businessinsider.com/air-force-discusses-building-hangar-for-future-b21-stealth-bomber-2021-1?r=AU&IR=T>

program, the numbers of the LRSO/AGM-181 and AGM-183A missiles and B-21 bombers may be cut back by the 2021 administration.<sup>12</sup>

### **Hypersonic Glide Vehicles**

The US Department of Defense (DOD) has at least three Hypersonic Glide Vehicles currently under development. These are Air Force, AGM-183A Air-Launched Rapid Response weapon; Army, Long Range Hypersonic Weapon (RHW); and Navy, Intermediate Range Conventional Prompt Strike (IRCPS). In addition DARPA is doing research on the Hypersonic Technology Vehicle-2.<sup>13</sup>

All are designed to carry conventional warheads to ranges of 1,500-3,000 nautical miles (nm). According to official DOD statements none are planned to fly greater than 3,000nm or be armed with nuclear weapons. The Army and Navy have combined their programs. The Army plans to deploy its first battery in FY2023. The Navy's program will come online two years later. The B-52 and the future B-21 bombers would probably carry the AGM-183A if it were deployed. Flight-testing has begun and an early operational capability is now planned for late FY 2022.<sup>14</sup>

### **RUSSIAN FEDERATION (RUSSIA)**

The former Soviet Union (USSR) deployed its nuclear triad in the 1950/60s on a pace with the United States. By the end of the Cold War, all elements of the now Russian triad had been upgraded with new launchers, missiles, and support equipment. After signing the various arms control agreements with the United States, one class of missiles were eliminated (IRBMs) and limits on strategic weapons (ICBMs), SLBMs, and long-range bombers were put into place. As the Cold War ended and Soviet Union broke apart, US-Soviet era arms control treaties were continued with Russia. The strategic weapons Russia inherited from the USSR became the treaty-counted weapons. Many of these are still deployed and operational today.

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<sup>12</sup> "B-21 Raider," U.S. Air Force, July 6, 2021, <https://www.af.mil/About-Us/Fact-Sheets/Display/Article/2682973/b-21-raider/>

<sup>13</sup> Steve Trimble, "ARRW Revealed," *Aviation Week and Space Technology*, July 26, 2021.

<sup>14</sup> "U.S. Hypersonic Missile Upgrade Concepts Are Now Advancing," *Aviation Week Network*, July 16, 2021, <https://aviationweek.com/defense-space/missile-defense-weapons/us-hypersonic-missile-upgrade-concepts-are-now-advancing>

## ICBMs

Russia is upgrading and replacing much of the older Soviet nuclear weapon systems and developing unique new weapons. New START is the last remaining nuclear treaty between the two countries, and Russia and the United States agreed to extend it for five years until 5 February 2026.

The USSR deployed its first ICBM in 1957 and development of these missiles continues with Russia.

**Table 2: Russia's ICBMs Currently Deployed**

| Missile <sup>15</sup> | Status                                        |
|-----------------------|-----------------------------------------------|
| SS-18/Satan           | 46 Heavy ICBM operational in silos            |
| SS-19/Stiletto        | 2 operational silos with the Avangard WH      |
| SS-25/Topol           | 36 operational, mobile being phased out       |
| SS-27/Topol-M1        | 78 operational mobile,                        |
| SS-29/Sarmat          | Heavy ICBM being deployed, replaces the SS-18 |

The Soviets/Russians developed and tested sixteen ICBM missile systems since 1957 and deployed thirteen of them. Of the deployed systems, four are in service in 2020 and one is being installed. This number does not include the many variants of most of the deployed systems

### ***SS-18 Mod-6***

The liquid fuel SS-18 Satan, considered a heavy ICBM, replaced the SS-9. It was deployed in SS-9 silos in 1974 and it has appeared in six variants with only the single warhead Mod 6 deployed today. The initial operational capability was in 1975. As of 2020, Russia has forty-six SS-18 Mod-6 missiles operational and the SS-29 Sarmat is replacing them at the Dombarovsky Air Base and the Guards Rocket Army at Uzhur

### ***SS-19M4 with the Avangard HGVs***

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<sup>15</sup> These missile names and designated numbers are those given by Western intelligence agencies and are not those used by the Soviet military.

Of the nearly 400 SS-19 missiles that were deployed in the 1980s, twenty remained in service in 2016 and two SS-19M4s were in service in 2020. These two were located at the Dombrovsky ICBM site with Avangard Hypersonic Glide Vehicles (HGV) warheads. It was reported that twelve Avangard would be deployed using the SS-19M4 booster until the Sarmat heavy ICBMs are deployed. The Avangard HGV was one of the new weapons released by President Putin in his February 2018 speech.<sup>16</sup>

### ***SS-25 Topol, RS-12M***

This missile is identified as Sickle by the United States and has a Russian program name RT-2P. The SS-25 Topol is a three-stage solid fuel mobile ICBM with a single warhead. At its high point, 400 of the SS-25 missiles were deployed. About thirty-six of the SS-25 missiles were reportedly deployed in early 2020 and will be phased out in two to three years. Currently the SS-27M1 and SS-29M2 missiles are replacing them.

### ***SS-27 Topol-M, RS-12M1 mobile and RS-12M1 silo***

This missile has been named Sickle B by the United States and has a Russian program name RT-2PM2. The SS-27 appears to be an improved SS-25 and was deployed in a mobile version as Mod 1 and Mod 2 silo version. Only eighteen Mod 1s were deployed at the Teykovo ICBM Base and sixty mod 2s at the Tatishchevo missile site. The Russians announced in 2009 that production of the SS-27 missiles was complete. It is probable that no more will be deployed. This limited deployment may have been in response to the launcher limits of the New START treaty.<sup>17</sup>

### ***SS-27 Mod 2, RS-24 (Yars) mobile and silo versions***

The Yars RS-24 was identified by the USAF National Air and Space Intelligence Center (NASIC) as similar to the SS-27 Mod-1 and not a new missile as claimed by Russia. The United States identifies it as the SS-27 Mod2. However, Russia has said it is a new missile and should be identified as such. In addition, a rail-transported version of the missile identified as RS 24 BZhRK

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<sup>16</sup> Missile Defense Project, "Avangard," Center for Strategic and International Studies, last modified July 31, 2021, <https://missilethreat.csis.org/missile/avangard/>

<sup>17</sup> Missile Defense Project, "RT-2PM2 Topol-M (SS-27 Mod 1 "Sickle B")," Center for Strategic and International Studies, last modified August 2, 2021, <https://missilethreat.csis.org/missile/ss-27/>

Barguzin, designated the SS-X-32, was under development. Because of lack of funds, however, Barguzin development was frozen in December 2027.<sup>18</sup>

### ***SS-X-31 Frontier, RS-26 Rubezh, (Avangard booster)***

The RS-26 is a two-stage missile with upgraded Yars first and second stages. The United States claims that it replaces the SS-20 IRBM eliminated by the INF treaty and can only fly to the minimum ICBM range with a light or no warhead. Its first test from Pletesk on 27 September 2011 failed. But on its second test on 23 May 2012, it flew 5,800 km to the Kura impact site on Kamchatka. Three additional tests on 24 October 2012, 6 June 2013, and 18 March 2015 flew 200km from Kapustin Yar to the Sary Shagan impact area.

The SS-X-31 missile is estimated to be 12m long and 1.8m in diameter. On 22 March 2018 Tass reported all work on Rubezh had been put on hold until the end of 2027. Work on the Avangard HGV would continue for deployment on other booster rockets.<sup>19</sup>

### ***SS-29 (Satan 2), RS-28 (Sarmat) Heavy ICBM***

The SS-29 is the replacement for the more than 30 year old SS-18 Satan heavy ICBM. Russian officials state that the missile will begin serial production in 2020 and enter service in 2021, a delay of five or six years from the initial first service 2016 date. The missiles will be deployed at the two remaining SS-18 sites, the Dombarovsky Air Base and the Guards Rocket Army at Uzhur, and will be deployed in modified SS-18 silos. The SS-29 is a two-stage rocket, 35.5m long and 3m in diameter. The maximum range is 18,000km with ten MIRVs. Avangard HGVs are also planned to be warheads for SS-29 booster rockets. Russia also has more than 120 SS-18 and SS-19 non-deployed missile silos that are preserved for future potential new ICBMs.<sup>20</sup>

## **Russian SLBMs**

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<sup>18</sup> Missile Defense Project, "RS-24 Yars (SS-27 Mod 2)," Center for Strategic and International Studies, last modified August 12, 2021, <https://missilethreat.csis.org/missile/rs-24/>

<sup>19</sup> Missile Defense Project, "RS-26 Rubezh," Center for Strategic and International Studies, last modified July 31, 2021, <https://missilethreat.csis.org/missile/ss-x-31-rs-26-rubezh/>

<sup>20</sup> Missile Defense Project, "RS-28 Sarmat," Center for Strategic and International Studies, May 17, 2017, last modified July 31, 2021, <https://missilethreat.csis.org/missile/rs-28-sarmat/>

At the end of the Cold War in 1991, Russia inherited sixty-two SSBNs with 940 launch tubes compared to the United States with thirty-four SSBNs and 632 missiles, as a result of the START and then New START treaties. As of late 2020 Russia has eleven operational SSBNs with 180 missiles. They also have four project 955A Borei-2 submarines deployed and plans for at least two more. These will replace the remaining Delta-3 and 4 submarines. They have also retained one Typhoon Program 941UM SSBN as a Bulava SLBM test submarine.

There are three types of SLBMs currently operational in the Russian Navy. The oldest is the liquid fuel SS-N-18 Stingray on one Delta-3 submarine in the Pacific Fleet. The SS-N-18 missile will be replaced in one or two years by the solid fuel Bulava SS-N-30 when the next Borei SSBN arrives in the Pacific. There are 6 Delta-4 SSBNs operational on the North Fleet and each carries sixteen liquid fueled Skif SS-N-23 SLBMs for a total of ninety-six launch tubes. The North and Pacific Fleets currently each have two Borei class SSBNs. The North Fleet has one Borei with sixteen launch tubes and a Borei-2 with twenty tubes. It is probable that the Northern Fleet will get at least four more Borei-2 submarines and the Pacific Fleet at least two more.

### ***SS-N-32 RSM-56 Bulava SLBM***

The RSM-52 Bulava SS-N-32 missile is the third solid propellant SLBM deployed by the Russian Navy and it appears to be a distant relative of the Topal M SS-27. The one remaining Typhoon, Dmitriy Donskoy, was modified from 1990 to June 2002 to be the test submarine for the Bulava SS-N-32 missile. It had twenty launch tubes, one of which was fitted with a Bulava launcher for the new missile.

The Bulava missile is a three-stage missile with stages one and two solid fuel and stage three liquid. It is 12.1m long and 2m in diameter. It carries six to ten warheads and has a range of 8,000 to 10,000km. First stage tests were completed in late 2004, and tests from the Dmitriy Donskoy began in 2005. These tests into 2009 had six failures in thirteen flights. Tests were then put on hold until October 2010. In June 2011 the first test from a Borei submarine took place. Because of

failures more testing took place. The Russian Navy finally accepted the missile into service in June 2019. Its range is greater than 9,000km.<sup>21</sup>

### ***Kanyon weapons systems, Poseidon/Status-6/ Skif seabed-launched variant***

Kanyon has been referred to as a “new intercontinental, nuclear-armed, nuclear-powered undersea autonomous torpedo.” Not a true missile, it is not covered by the New START Treaty. The first mention of this weapon was on Russian television in 2015, and President Putin highlighted it in his February 2018 national address. The weapon was estimated to be capable of traveling thousands of nautical miles at about 70-100 knots at depths of 1,000m. It has been designed to be a strategic weapon to destroy naval bases, ports, and coastal cities with a two-megaton nuclear warhead detonated under water. Estimates are Kanyon will become operational in the late 2020s.

The torpedo is 24m in length and 1.6m in diameter. Underwater testing was reported to have begun in December 2018, but systems tests could have started in 2016. The massive torpedo will be capable of being launched from the Sarov test submarine, the Khabarovsk class of operational submarines, the Belgorod special mission submarine (crewed but not controlled by the Russian Navy), and possibly from launchers emplaced on the seabed.<sup>22</sup>

### ***Sarov B-90 Test Submarine***

Construction of the test submarine Sarov B-90 began in Nyhny Novgorod in 1988 as a Kilo class conventional powered attack submarine but was stopped because of funding in 1998 when it was 40 percent complete. It was moved via the inland waterway to the Sermash shipyard in Severodvinsk sometime around 2003 and construction resumed. It was renamed Sarov B090. It was heavily modified with a nuclear electric power plant and a single large torpedo tube about

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<sup>21</sup> Missile Defense Project, “RSM-56 Bulava (SS-N-32),” Center for Strategic and International Studies, August 10, 2016, last modified August 2, 2021, <https://missilethreat.csis.org/missile/ss-n-32-bulava/>

<sup>22</sup> Charlie Gao, “Russia’s Deadly Status-6 Nuclear Torpedo: 1 Fact You May Not Know,” *The National Interest*, March 2, 2019, <https://nationalinterest.org/blog/buzz/russia%E2%80%99s-deadly-status-6-nuclear-torpedo-1-fact-you-may-not-know-46002>; H.I. Sutton, “Analysis - Russian Status-6 Aka KANYON Nuclear Deterrence and Pr 09851 Submarine,” *Covert Shores*, December 19, 2016, <http://www.hisutton.com/Analysis%20-%20Russian%20Status-6%20aka%20KANYON%20nuclear%20deterrence%20and%20Pr%2009851%20submarine.html>

25m long 2m in diameter in the bow. It was accepted into Navy service in August 2008. Tests of the Status 6 torpedo started at least by September 2009 in the White Sea.<sup>23</sup>

### ***Belgorod SSN***

The second unit that carries the Status 6/Skif nuclear torpedo is the afore-mentioned Belgorod Project 09852 Special Mission Submarine. The Belgorod was an unfinished Oscar-2 SSGN that has been extensively modified starting in 2012 and finally launched in April 2019 from the Sermash shipyard. The Belgorod is manned by the Navy but operated under the Main Directorate Deep Sea Research (GUGI). GUGI's main missions are underwater intelligence and placement of weapons and sensors on the sea floor. The Belgorod is reported to be the longest submarine the world. It entered the White Sea in June 2021 to start sea trials and could be delivered to the GUGI/Navy probably in 2022.<sup>24</sup>

### ***Khabarovsk SSNs***

The first of a new Khabarovsk Class, Project 09851, SSNs is planned to be launched in the fall of 2021 from the Sermash shipyard.<sup>25</sup> Work started on this submarine in 2014 and three more are reportedly to be built. The second of these is reported to be under construction. These submarines are based on the design of the Borei class SSBNs minus the section that carries the ballistic missiles. Like the Belgorod it will carry six of the Status 6 nuclear torpedoes mounted in the bow. If all four of these submarines are built, then two will likely be delivered to both the Northern and Pacific fleets.

### ***Seabed based Status 6/Skif launched variant***

A question that needs to be answered is why was the Belgorod modified to carry the Status 6 nuclear inter-continental torpedoes? Russia already had the Sarov test submarine and the first of

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<sup>23</sup> "Russian Submarine Sarov (B-90)," Wikipedia, last modified May 29, 2021,

[https://en.wikipedia.org/w/index.php?title=Russian\\_submarine\\_Sarov\\_\(B-90\)&oldid=1025823327](https://en.wikipedia.org/w/index.php?title=Russian_submarine_Sarov_(B-90)&oldid=1025823327)

<sup>24</sup> H.I. Sutton, "New Details of Russian Belgorod "Doomsday" Submarine Revealed," *USNI News*, February 25, 2021, <https://news.usni.org/2021/02/25/new-details-of-russian-belgorod-doomsday-submarine-revealed>

<sup>25</sup> Xavier Vavasseur, "Russia's Khabarovsk Submarine to Be Launched in Fall 2021," *Naval News* (blog), April 19, 2021, <https://www.navalnews.com/naval-news/2021/04/russias-khabarovsk-submarine-to-be-launched-in-fall-2021/>

operational Khabarovsk Class submarines that will carry six of the Status 6 torpedoes will be launched in the fall of 2021.

Where does the very expensive Belgorod that does not report to the Navy and has several other missions fit? One of the possibilities is a test sub for the procedures to handle and load the six torpedoes for crews that will man the Khabarovsk subs. A second possibility is the Belgorod had space for these weapons and made it available to the Navy so there would be six more weapons in the Northern fleet. Although possible, neither of these possibilities is realistic because the Navy does not operate the Belgorod and the submarine will have other very sensitive missions, such as cable tapping, installing underwater sensors, and sonar imaging foreign targets.

### *Skif version of Status-6 launcher on the seabed*

A few reports mentioned a seabed-based Skif version of the Status 6 torpedo, but it is not known if this variant exists. If it does, that would explain perhaps that the Belgorod and GUGI would be involved. Belgorod could be the delivery means to place the Skif torpedoes in their protective enclosures undetected on the seabed and probably under the ice during winter. The Skif system would need reliable, secure, and redundant communication links to send status and local surveillance data back to the onshore command authorities. That authority would require return links to update targeting data and issue launch orders.

A ready-made communication system that will exist in the Arctic is the Russian project Harmony underwater listening system. To power the Harmony sensors, GUGI has developed small nuclear-powered electrical generators that also sit on the seafloor. These generators could also power the Skif launchers. Harmony already has all the facilities needed to support the Skif system including providing surveillance of the specific Skif deployment area and the surrounding sea.<sup>26</sup>

## **ALCMs carried by Russian Long-Range Bombers**

### *Tu-160MS Blackhawk Bombers*

Russia has two long-range bombers, the 40 year old Tu-95MS Bear H and the 30 plus year old Tu-160MS Blackhawk (Russian name White Swan). Production of the Tu-160MS began in 1981 and

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<sup>26</sup> Garmoniya/Harmony - RUSOSUS, GlobalSecurity.org, <https://www.globalsecurity.org/intell/world/russia/harmony.htm>

thirty-six bombers were produced through 1987. At the fall of the USSR, Russia had seventeen and the Ukraine had nineteen of the bombers. They returned eight to Russia and eleven were scrapped. A new Tu-160MS was assembled from leftover parts and delivered to the Air Force in 2017, and there was a further order for 10 aircraft that are under construction. Of the remaining Tu-160MS, as of March 2020, sixteen were included in the bomber count for the New START treaty.<sup>27</sup>

### ***Tu-95MS Bear H Bombers***

The Tu-95MS was based on the design of the 1950s Tu-95A/B and modified with new engines and electronics. Construction began in 1981 and it entered service in 1987. A production run of sixty-five to seventy of these bombers ended in the late 1980s. Sixty-three were counted in 2010 for the New START Treaty and fifty-five are in service as of 2020. Modernization of these airplanes has continued. The Tu-95MS are planned to remain in service until 2050s as an engine replacement program and new electronics installation are underway.

### ***Stealth Bomber Tu-PAC DA nearing testing***

Russia also has under construction a Tupolev PAC DA stealth strategic bomber prototype. Planning for the aircraft began in 2009, and building of the prototype began early 2020 to be completed in 2021. If successful this aircraft would be built in small numbers and not enter service until the late 2020s.<sup>28</sup>

### ***Kh-101/102 Raduga stealth cruise missile***

The Tu-95MS and Tu-160MS bombers are being configured to carry the Kh-101 (conventional warhead)/102 (nuclear warhead) ALCMs. The Tu-95MS can carry eight missiles on under wing pylons and the Tu-160 can carry twelve missiles internally. These missiles are replacing the Kh-15SM Granet/AS-15 Kent that has been in service since 1984 are still carried on the bombers that have not yet been upgraded.

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<sup>27</sup> "Tupolev Tu-160," Wikipedia, accessed August 23, 2021, [https://en.wikipedia.org/w/index.php?title=Tupolev\\_Tu-160&oldid=1040318700](https://en.wikipedia.org/w/index.php?title=Tupolev_Tu-160&oldid=1040318700)

<sup>28</sup> Kris Osborn, "PAK DA: Russia's Mysterious Stealth Bomber Is Coming," *The National Interest*, July 20, 2021, <https://nationalinterest.org/blog/buzz/pak-da-russias-mysterious-stealth-bomber-coming-190021>

The Kh-101/102 has a range of 4,500-5,500km and a speed of 900km/h. These missiles are subsonic, fly a low altitude profile (30-70m off the ground), and can receive updated target information while on-route. The Kh-102 is a standoff nuclear missile for the Russian strategic bombers. The Kh-101/102 entered service in 2012.

An improved version of the Kh-101/102 identified as the Kh-BD is set to enter service on the Tu-160MS bombers in 2020. Its range has been extended out to 6,000 to 7,000 km.<sup>29</sup>

### ***Kh-47M2 Kinzhal air-launched ballistic missile (ALBM)***

One of the new weapons President Putin called a strategic missile in his 1 March 2018 state of the nation address was the nuclear-capable Kinzhal ALBM. The Kinzhal, one of the new hypersonic glide vehicles (HGV), is 8m long and 1m in diameter. It is based on the Iskander short-range ground launched missile. The Kinzhal entered service in December 2017 and has been launched by Mig-31K long-range fighter aircraft and Tu-22M3M medium range bombers. These aircraft are flown by the Russian Aerospace Force (VKS). In 2016 the VKS planned to upgrade 30 their 60 operational Tu-22M3 bombers to the M3M variant to carry 4 Kinzhal missiles.

The Tu-22M3M has a range of 7,000km and the Kinzhal, when launched from that aircraft, has a stated range of 3,000km. The New START Treaty does not cover the Tu-22 M3M and the Kinzhal Kh-47M2 missile, yet they could hit nearly all US targets and have become a major concern to the United States. As of mid 2020 there is no evidence the Russians plan to put these missiles on their inter-continental Tu-160MS or Tu-95MS bombers any time soon.<sup>30</sup>

### **New ground/surface ship-launched missiles**

#### ***9M730 Burevestnik/SSC-X-9 SkyFall nuclear powered nuclear armed cruise missile***

The Burevestnik missile is 12m in length including its 3m-booster solid rocket, needed for launch. The booster is dropped after it is expended and the missile continues using its nuclear power plant. For testing it is launched from a permanent rail, hydraulically elevated at about 45 degrees. The

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<sup>29</sup> Douglas Barrie, "Kh-101 Missile Test Highlights Russian Bomber Firepower," *IJSS* (blog), February 8, 2019, <https://www.ijss.org/blogs/military-balance/2019/02/russian-bomber-firepower>

<sup>30</sup> Missile Defense Project, "Kinzhal," Center for Strategic and International Studies, March 27, 2018, last modified July 31, 2021, <https://missilethreat.csis.org/missile/kinzhal/>

missile is probably subsonic, flies at low altitude on an unpredictable track, and has an unlimited range.

The testing history of this missile is not well known. The US initially identified this missile as the KY-30. The KY identifies some phase of the program was tested at Kapustin Yar. This may have been airframe and launcher testing without the small nuclear power reactor. The 9M730 Burevestnik program, starting in 2014, built a major test complex at Kapustin Yar that was operational by mid 2016. Consisting of a launch pad with a permanent rail launcher, a pad support area that normally has ten green painted van trailers and a 36m X 16m bunker. Four hundred and twenty-five meters directly in front of the launch pad is a large triangular bermed impact area for testing the booster rockets used at launch. The movable shelter that encloses the launch rail and missile was in place by July 2017 indicating full missile tests could take place. The only evidence tests may have taken place at this time is the activity inside the bermed impact area.

Testing then appears to have moved to the Arctic on Novaya Zemlya at a small isolated site identified as Pan’Koro. This launch site was built in a remote area from 2013 to 2016. The tests were conducted from a concrete pad with an environmental shelter that moved on tracks forward before the test. Four tests were reported between November 2017 and February 2018, all of which failed after take off. The November 2017 test flew for two minutes and went 22 miles (35.4km) before it failed, but it was assessed as a partial success.

On his 1 March 2018 state of the nation speech President Putin included the 9M730 Burevestnik missile. Sometime in 2018 or early 2019 testing shifted to a launch pad at the Nyonoska/Nenoska Missile Test Range on the shore of the White Sea. The pad had been used to test naval ballistic missiles and the launch tube was removed by 2016. The new launch pad was probably complete in late 2017 and was similar to pads at Kapustin Yar and Pan’Koro. The launch azimuth is 90 degrees over the White Sea. The first test from this pad may have been in mid 2018 and it was a launch failure. An explosion of a Burevestnik missile on 8 August 2019 occurred during an underwater recovery operation that killed seven people. Reports on the explosion stated the missile had been under water for about one year. That was probably the missile from the launch failure in mid 2018. No further tests from Nenoska have been reported.

On 29 January 2019 it was reported a Burevestnik missile was launched from Kapustin Yar and it was considered a partial success. Also noted was this was the first launch in nearly a year. There have been thirteen reported launches of the Burevestnik missile. Two were considered to be partial successes. If tests continue and the results improve, a decision could be made to deploy the Burevestnik missile. Recent 2020 activity at the Pan'Koro test area indicates the program may be ready for more testing. Any deployment probably would not occur until the late in this decade.<sup>31</sup>

### ***3M22 Tsirkon (Zircon)/SS-N-33 ship/submarine-launched hypersonic cruise missile***

The Tsirkon hypersonic missile is in the late stage of its development and is expected to become operational in 2023. Tsirkon was developed as an anti-ship missile and is launched from the 3S-14 vertical launch systems from several classes of Russian Navy ships and can also be launched from the new Yasen-class submarines. Tsirkon also has the capability to attack ground targets. On 24 December 2019 President Putin said a land-based version of this missile was being developed, probably to replace the old anti-ship missiles that are deployed. There is a report that the Tsirkon is nuclear capable.

Testing may have begun from a Tu-22M3 supersonic bomber in 2012/13. This may have been to test the scramjet. In 2015 testing from a ground platform took place—probably to integrate the missile with its booster. Its first success was reported in 2016. Testing continued with a launch in April 2017 when it attained the speed of Mach 8. Further tests took place in June 2017 and December 2018. The first tests that used a naval ship were successfully launched from the Admiral Gorshkov in early January 2020 while in the Barents Sea, to a target in the Northern Urals at a distance of 500km. The Gorshkov was again used for a test on 7 October 2020 from the White Sea when, for the first time, it destroyed a naval target in the Barents Sea at a 450km range. The latest test was also from the Admiral Gorshkov in the White Sea to a target in the Barents Sea 350km away. It took place on 19 July 2021 and was successful.

The Tsirkon missile is 10-12m in length. It uses a solid fuel booster rocket to get it supersonic so the liquid fuel scramjet engine can start. The missile's range is 1000km, and it flies at an altitude

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<sup>31</sup> Thomas Newdick, "It Looks Like Russia's Nuclear-Powered Cruise Missile Test Program Is Back In Business," *The Drive* (blog), October 21, 2020, <https://www.thedrive.com/the-war-zone/37191/it-looks-like-russias-nuclear-powered-cruise-missile-test-program-is-back-in-business>

of 28-29km and at speeds on Mach 8-9. Its warhead weight is 300-400kg. It is noteworthy that India announced they would use the same scramjet Zircon technology for their joint hypersonic missile, BrahMos- 2.<sup>32</sup>

## **PEOPLE'S REPUBLIC OF CHINA (PRC)**

The PRC is not party to arms control treaties and therefore is not treaty-limited to the numbers of warheads or types of launchers they can build and deploy. Thus, the PRC was free to announce that it plans to double its strategic nuclear arsenal by 2030. In mid 2021 two new bases for silo launched DF-41 ICBMs were identified under construction in the western desert. The first located near Yumen with 120 silos and the second 380km northeast of Yumen at Hami with 110 silos, in addition fourteen training silos were reported at the Jilastal training area.

The PRC already reached a goal of achieving its triad with the deployment of the Type-094 type SSBN that carries the JL-2 ICBM. Currently six of these submarines are operational with two entering service in 2020. The land-based component of the triad currently consists of the following ICBMs: twenty 1970 vintage DF-5 silo based missiles, about twenty-five DF-31 mobile missiles, and thirty to forty DF-41 road mobile missiles. The strategic bomber fleet consists of about 160 H-6s, a greatly upgraded variant of the 1950s Soviet Tu-16. Under development is the PRC's first dedicated strategic bomber, the stealth H-20. Although some reports indicated that it was to be displayed to the media in November 2020, in fact it was not. It is unlikely to enter service until the late 2020s.<sup>33</sup>

### **Chinese SLBMs**

#### ***JL-1 SLBM/CSS-N-3***

The PRC's first attempt at a Chinese SSBN was one Type-092 SSBN Xia Class carrying twelve JL-1 ballistic missiles. The submarine was commissioned in 1987 but had numerous problems and

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<sup>32</sup> Mark Episkopos, "Russia's Tsirkon Hypersonic Missile Keeps Inching Closer to Reality," *The National Interest* (blog), February 2, 2021, <https://nationalinterest.org/blog/buzz/russia%E2%80%99s-tsirkon-hypersonic-missile-keeps-inching-closer-reality-177512>

<sup>33</sup> Kris Osborn, "China's New H-20 Stealth Bomber to Arrive This Year," *The National Interest* (blog), July 21, 2021, <https://nationalinterest.org/blog/buzz/chinas-new-h-20-stealth-bomber-arrive-year-190085>

conducted one patrol inside Chinese regional waters. The submarine is probably no longer operational. The JL-1/CSS-N-3 is a two-stage solid fuel missile with a range of 1,700km. It is a close relative to the DS-21 MRBM.

### ***JL-2 SLBM /CSS-N-14***

Six Type-94 Jin-Class SSBN each carrying twelve JL-2 ICBM range missiles are operational. The first submarine was commissioned in 2010 and the sixth in 2020. The six Type-94 SSBNs are all based at the Sanya Submarine base on the southern tip of Hainan Island.

The JL-2/CSS-N-14 is a two-stage solid fuel missile with a range of 8,000-9,000km. It is a close relative to the DF-31 ICBM. Its test program is similar the CSS-N-3, probably with shore launches in the mid 1980s and the first test from the Golf SSB in 2001/02. The first successful launch from a Type-94 SSBN was in 2009. The missile is 13m in length, 2m in diameter and can carry a 1 megaton RV or 3-8 MIRVs.<sup>34</sup>

### ***JL-3 SLBM/CSS-N-?***

The JL-3 missile testing began before the first Tang-Class Type-96 SSBN that will carry it commenced. Reportedly, construction of the first of six Type-96 submarines, each with sixteen launch tubes began in 2020.

The JL-3 missile appears to have been first tested in August 2017 probably from the shore site and then from a new test submarine with two launch tubes, identified as a Qing-Class Type-32 test submarine. Tests have continued in 2018 and 2019 with launches from the Bohai Sea to the Gobi Desert impact area. The JL-3 is considered an ICBM with a range of up to 12,000km. It is a close relative to the road mobile DF-41 ICBM. It may take until 2025 to integrate it with the new Type-96 SSBN.<sup>35</sup>

## **Chinese Land-Based Ballistic Missiles**

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<sup>34</sup> "JL-2 Submarine-Launched Ballistic Missile," *Military Today*, accessed September 8, 2021, <http://www.military-today.com/missiles/jl2.htm>

<sup>35</sup> "JL-3 Submarine-Launched Ballistic Missile," *Military Today*, accessed September 8, 2021, <http://www.military-today.com/missiles/jl3.htm>

China's land-based missiles range from greatly upgraded 1970s silo based DF-5 (CSS-4) liquid propellant ICBMs to late 1990 DF-31 and 2010 DF-41 road-mobile ICBMs. The PRC also has several MRBMs and long-range cruise missiles with nuclear warheads. These missiles are operated by the PLA rocket force, formally the Second Artillery Corps. The construction of two new silo based DF-41 launch complexes will add at least 200 plus ICBMs when completed, probably in 2023.<sup>36</sup>

### ***DF-5 Mods 1 and 2, CSS-4 B and C ICBM***

The DF-5 is a two-stage liquid fuel missile 32.6m long with a diameter of 3.35m. Its range is 12,000 to 15,000km. The DF-5 missile was first tested in the 1971 and entered service in 1981. It is deployed in three brigades each with six silos. The latest versions of this ICBM are the DF-5B and 5C that entered service in 2015. There are ten DF-5B launchers, each having three warheads for a total of thirty. There are eight DF-5C launchers, each with ten MIRVs for a total of eighty warheads. The DF-5 missile is the base for the Chang Zheng (CZ- 2,3, and 4) satellite launch vehicles with over 230 launched since 1975 and still in use today.

### ***DF-31, 31A, 31AG / CSS-10 ICBM***

The DF-31 missile is a three-stage solid fuel missile. It's road-mobile and is the land-based variant of the submarine launched JL-2 ICBM. The first successful flight was in August 1999. It was accepted into service in 2006. The DF-31 has a range of 7,200-8,000km. An improved version identified as DF-31A with a range of 11,200km entered service in 2007. To get the extended range the third stage was lengthened. A third version identified as DF-31AG/DF-31B is the DF-31A missile on a new TEL.

The DF-31A is reported to be 18.4m in length with the first and second stages 2m in diameter and the third stage, 1.5m. It is cold-launched after being vertically erected by the TEL. Reports vary on the number of DF-31A missiles deployed, but between twenty-five to thirty is a likely number. It

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<sup>36</sup> Chun Han Wong, "China Appears to Be Building New Silos for Nuclear Missiles, Researchers Say," *Wall Street Journal*, July 27, 2021, <https://www.wsj.com/articles/china-appears-to-be-building-new-silos-for-nuclear-missiles-researchers-say-11627401364>

carries a single 1 megaton thermonuclear weapon. The KT-2 satellite launch vehicle is based on the DF-31.<sup>37</sup>

### ***DF-41, CSS-20 ICBM***

The DF-41 is the newest and largest of the PRC's solid fuel ICBMs. It was first tested in July 2012 and accepted into service in 2017. The missile is cold-launched and has been deployed in a canister on an eight axle TEL. Reports have mentioned silo- and rail-based modes. A probable DF-41 training silo was identified at the PLARF nuclear missile training area near Jilanti in the Gobi desert. In 2021 fourteen more silos were seen under construction at Jilanti. About 230 probable operational silos were reported under construction for the DF-41 missiles in the western desert. A test from a rail car was reported in December 2015, but there is no evidence it has been deployed.

The missile has three stages and is 21m in length and 2.25m in diameter, with a range of 14,000 to 15,000km. Since 2012 there have been at least eleven DF-41 launches. Reportedly, there are up to twenty-four to thirty of these road mobile missiles deployed and probably none yet of the silo or rail-based missiles.<sup>38</sup>

### **Nuclear-Capable MRBMs and IRBMs**

The PRC has several missiles that are nuclear-capable with shorter ranges. The most prominent are the DF-21/CSS-5 range MRBM. These missiles are dual mode and can carry nuclear and conventional warheads. The range of these missiles is around 2,500km. A version of the DF-21 was used to launch the Chinese anti-satellite interceptor in January 2007 and is the basis for the KT-1 & 1A satellite launch vehicles.

The DF-26 IRBM is a two stage solid fuel IRBM with a range of 3,000 to 4,000km. The missile entered service in 2016 and it is estimated 80 missiles are deployed with another 80 reloads. These

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<sup>37</sup> "DF-31," Wikipedia, accessed July 15, 2021, <https://en.wikipedia.org/w/index.php?title=DF-31&oldid=1033682099>

<sup>38</sup> "New Missile Silo And DF-41 Launchers Seen In Chinese Nuclear Missile Training Area," *Federation of American Scientists* (blog), September 3, 2019, <https://fas.org/blogs/security/2019/09/china-silo-df41/>; Missile Defense Project, "DF-41 (Dong Feng-41 / CSS-X-20)," Center for Strategic and International Studies, August 12, 2016, last modified July 31, 2021, <https://missilethreat.csis.org/missile/df-41/>

missiles are dual mode and can carry nuclear and conventional warheads. An anti-ship version may be under development.

### ***DF-17 HGV***

The DF-17 is classified as an MRBM but its real claim to fame is that it is probably the first deployed hypersonic glide vehicle (HGV). The DF-17 is boosted by a DF-16B short-range missile and carried by a modified DF-16 TEL. The HGV is identified as DF-ZF. It was tested at least nine times between January 2014 and November 2017, was displayed in a parade in October 2018, and reached IOC in 2019.

The DF-17 is about 11m in length and 1.2m in diameter. The DF-16 booster accelerates to Mach 5 (6125km/h) before the DF-ZF HGV is released. The range of the DF-17 is 1800 to 2500km. Deployment of at least one brigade at a missile site across from Taiwan has taken place.<sup>39</sup>

### ***PLAAF Long Range Bombers, H-6K and H-6N***

Two versions of the H-6 aircraft, the K and N models, make up China's current strategic bomber force. The K model was tested in 2007 and as of 2020 about 100 of these bombers are in service. The N model went into service in 2019 and at least 4 of these bombers have been seen. It has been reported that the yearly production rate for the N model is about six per year. The N models have several improvements over the K models. They have a fueling probe for air-to-air refueling to greatly extend their range and in place of the bomb bay the capability in the centerline to carry a single variant of the DF-21 ballistic missile, a DF-17 missile with a DF-ZF hypersonic glide vehicle (HGV) or a supersonic DF-100 cruise missile. In addition, the H-6N bomber can also carry the WZ-8/DR-8 hi-speed short-range reconnaissance drone.<sup>40</sup>

### ***CJ-10A (called DF-10 until 2011)***

The K models of the H-6 bomber can carry the CJ-10A cruise missile. The latter is a subsonic missile with a range of 1,500km powered by a single turbofan engine. It appears to have been

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<sup>39</sup> Ankit Panda, "Introducing the DF-17: China's Newly Tested Ballistic Missile Armed With a Hypersonic Glide Vehicle," December 28, 2017, <https://thediplomat.com/2017/12/introducing-the-df-17-chinas-newly-tested-ballistic-missile-armed-with-a-hypersonic-glide-vehicle/>

<sup>40</sup> Greg Waldron, "H-6 Evolves from Cold War Relic to Beijing's Hammer," *Flight Global* (blog), September 4, 2020, <https://www.flightglobal.com/fix-wing/h-6-evolves-from-cold-war-relic-to-beijings-hammer/140043.article>

derived from the Soviet Kh-55 cruise missile. Six missiles can be carried under-wing mounts. The missiles can have a nuclear or conventional warhead. Other variants of this missile are ground- and ship-launched. Currently this missile is the PLAAF's only stand-off weapon for the strategic bomber fleet.

### **CH-AS-X-13**

The CH-X-13 is an air-launched variant of the DF-21 MRBM. It currently can be launched only from the new H-6N bomber, modified with launch position along the aircraft centerline. The missile has two stages and a range of 3,000km. The missile has been tested at least five times between December 2016 and January 2018 and probably more since then. This missile may be deployed by 2025.<sup>41</sup>

### **DF-17 carrying a DF-ZF HGV**

The DF-17 missile seen being carried on a H-6N bomber appears similar to the ground-launched missile discussed in the previous section. It is mounted semi-recessed into the fuselage along the centerline position of the aircraft underside. See the previous discussion of this new missile.<sup>42</sup>

### **CJ-100 /DF-100**

The CJ-100 is a high supersonic (Mach 4.5K) cruise missile powered by a ramjet engine. The two canisters carrying the ground-launched version were seen in the October 1, 2019, parade painted DF-100. A video shows the missile as it exits one of the canisters. The propulsion needed to start the ramjet is provided by two or three segments of a DF-11 or 15 SRBM solid fuel motor. The airborne missile has an estimated range of 2,000km and increases the H-6N bombers unrefueled strike range out to 6,000km.<sup>43</sup>

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<sup>41</sup> H. I. Sutton, "China's New Aircraft Carrier Killer Is World's Largest Air-Launched Missile," *Naval News* (blog), November 1, 2020, <https://www.navalnews.com/naval-news/2020/11/chinas-new-aircraft-carrier-killer-is-worlds-largest-air-launched-missile/>

<sup>42</sup> Greg Waldron, "Chinese H-6N appears with mysterious ballistic missile," *FlightGlobal*, October 19, 2020, <https://www.flightglobal.com/defence/chinese-h-6n-appears-with-mysterious-ballistic-missile/140671.article>

<sup>43</sup> Orion\_INT, "Demystifying The DF-100: A Deeper Look At China's Mysterious Cruise Missile," *Overt Defense* (blog), August 2, 2021, <https://www.overtdefense.com/2021/08/02/demystifying-the-df-100-a-deeper-look-at-chinas-mysterious-cruise-missile/>

## **H-20 Stealth Bomber under development**

The H-20 has been under development since the early 2000s and is the first dedicated bomber developed by the PRC. Reports indicate it will be a long-range subsonic flying wing stealth aircraft to complement the H-6 aircraft and eventually will replace some of them. The aircraft has not yet flown, but tests are expected in the early 2020s. If the tests are successful construction could begin in 2025 and it could enter service by the late 2020s. The bomber will be capable of carrying nuclear and conventional weapons with a range estimated to be greater than 8,500km without aerial refueling. The H-20 will probably be capable of carrying some of the new missiles being developed for the H-6N.<sup>44</sup>

## **REPUBLIC OF INDIA**

India has joined the nuclear triad club late and is now adding modern delivery systems. The strongest part on their triad is ground-launched ballistic missiles. The nuclear-capable Prithivi 1 and 2 and Agni 1 to 5 missiles are mobile and include short-to intermediate-range weapons with an ICBM under development. The naval SSBN force currently consists of two operational submarines with two more being built. The two units have a total of thirty-six short-range K-15 ballistic missiles, but some or all of these will be replaced with twelve intermediate-range K-4 missiles in the near future. The aircraft triad piece consists of four types of short-range fighter-bombers. They mainly carry unguided free fall nuclear bombs. Forty Su-30MKI fighters have been modified to carry the BrahMos supersonic nuclear capable cruise missile. BrahMos missiles are also launched from ground TELs, surface ships, and submarines. A hypersonic version of this missile is under development.

### **India's land-based missiles**

India has developed and deployed both long-range ballistic and cruise missiles and has a very active space launch program. Most of the long-range missiles have been tested from the facilities

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<sup>44</sup> Peter Suci, "Xian H-20 Stealth Bomber: Is This What It Will Look Like?," *19FortyFive* (blog), January 28, 2021, <https://www.19fortyfive.com/2021/01/xian-h-20-stealth-bomber-is-this-what-it-will-look-like/>

on Abdul Kalam Island. The old name for this facility was Wheeler Island and it is also called the Integrated Test Range (ITR).<sup>45</sup>

## **Ballistic missiles**

India has two lines of land-based missiles, Prithvi and Agni. The Prithvi 1 and 2 are single stage liquid fuel missiles and Prithvi 3 uses solid fuel. The first two have been deployed, are probably operational, and are operated by the Strategic Forces Command (SFC). Prithvi 3 is an anti-ballistic missile, the development of which is complete. Deployment is planned in three to four years to protect the capital city.

### ***Prithvi surface-to-surface missiles***

Prithvi-1 was first tested in 1988 and came into service in 1994. The range of the missile is 150km and it is 8.5m in length and 1.1m in diameter. The upgraded Prithvi-2 was first tested in 1996 and entered service in 2003. The propellant tanks were extended to increase its range to 250km. The measurements are length 9.4m and diameter at 1.1m. The Indian Navy's version of this missile is identified as Dhanush, and it had been deployed on at least two surface ships. The Dhanush has been used as a target for the ABM program. These missiles are dual capable with nuclear and conventional warheads.

The Prithvi- 3 is the booster for India's Anti Ballistic Missile (ABM) and Anti Satellite Missile (ASAT). The ABM is a hit-to-kill vehicle and has been tested a reported nineteen times. The program has completed testing and is waiting for a decision to deploy it first around the capital. It is non-nuclear.<sup>46</sup>

### ***Agni family of ballistic missiles***

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<sup>45</sup> The launch site for most if not all the Agni missiles is Abdul Kalam Island (formerly Wheeler Island). During the testing the missiles are moved from a retractable shelter to the launch point by a rail TEL on Pad 1. When the tests are shown on video this rail TEL usually can be seen. This rail TEL is part of the test equipment and not an operational deployed TEL. It could be that seeing the test rail TEL has caused the identification that some of these missiles are actually operationally launched from rail TELs.

<sup>46</sup> Malcolm Claus, Brian Cloughley, and Nick Hansen, "Kill Vehicle, Examining India's ASAT Missile (Standing Tall)", *Janes Intelligence Review*, June 2019

There are two sub-families Agni missiles. The Agni 1, 2, and 4 make up one and the Agni 3 and 5 is the other. Available information on the Agni is at best confusing and at worst wrong. All Agni missiles are solid fuel and are nuclear-capable.

India developed much of its solid fuel technology in the 1980s and early 1990s for their space launch programs with the help of the Soviet Union.

Agni-1 is a short/medium-range single stage solid fuel missile with a 700 to 1,200km range. Flight testing began in 1989.<sup>47</sup> It mounts a single warhead and is carried on a truck TEL. Agni-1 entered service with the 334th Missile Group and became operational in 2007. It was estimated that nearly twenty of the launchers for this missile were deployed. The missile is 14.8m long and 1m in diameter.

The Agni-2 is a medium-range 2-stage solid fuel missile, with an 820 to 2,000km range. It mounts a single warhead and appears to be rail mobile with the 335<sup>th</sup> Missile Group. It entered service in 2008 and became operational in 2011. It is estimated only about ten of these missiles were deployed. The missile is 21m long and 1m in diameter

The Agni-4 was initially called the Agni-2 Prime. This two-stage missile has an intermediate range of 3,500km and mounts a single warhead. The truck mobile missile was deployed and became operational in 2019. About ten of these missiles have been deployed. This missile is about 20m long and 1m in diameter.

The Agni-3 is the first of the 2m diameter solid fuel missiles. It is a two-stage missile, 16.3m in length, and is classified as an intermediate-range missile with a range of 3,200km+. The first test of the Agni-3 was in July 2006, and it went into service in 2011. This missile has been reported as rail mobile but that is questionable. A NASIC 2017 report showed India had deployed fewer than ten of these missiles. By late 2020 that number had certainly increased. The latest test on 30 November 2020 failed.

The newest member of India's ballistic missile family is the Agni-5. Some consider it to be an ICBM and others an IRBM. Its range is over 5,000km but some assert a strike range of 6,000km. The missile has 3 stages, is road mobile, and is enclosed by a canister for environmental

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<sup>47</sup> AGNI-1, Missiles of the World, CSIS Missile Defense Project, <https://missilethreat.csis.org/missile/agni-1/>

protection. The missile is cold-launched from the canister. The first test took place in April 2012 and it entered service in 2019. This missile uses the first and second stages of the Agni-3 with a new third stage. The Agni-5 is 17.5m long and 2m in diameter. The number of missiles deployed is unknown—probably less than ten. The Agni-5 was last launched on 27 October 2021.

Is there an Agni-6 under development? India has not mentioned an Agni-6, but there is speculation that one is being developed.<sup>48</sup>

### **Long-range cruise missiles**

The Nirbhay long-range cruise missile can carry conventional and small nuclear warheads. The missile is subsonic and powered by a turbojet engine with a range of 800 to 1,000km. It measures 6m long and 0.5m in diameter and is launched from a wheeled TEL. The first test in 2013 failed, but subsequent tests starting in 2015 were successful. It was developed by India and has a limited deployment. These Nirbhay and the BrahMos-1 missiles were deployed in 2020 by India to support the continuing border conflict with China.

### ***Hypersonic Technology Demonstrator Vehicle (HSTDV)***

An Agni-1 rocket was used as the booster for two tests of India's indigenous hypersonic cruise missile. The first test in June 2019 failed after launch. The second test on 7 September 2020 was successful. The booster lofted the missile up to 30km to start the scramjet that achieved a Mach 6 speed. There are three more tests planned, making it a weapon capable of carrying conventional and nuclear warheads.<sup>49</sup>

### ***BrahMos 2 Hypersonic Cruise Missile***

The BrahMos 2 missile is under joint development by India and Russia. Initial flight-testing was in Russia and will soon begin in India. Like the BrahMos-1, when deployed, this missile will launch from ships, submarines, aircraft, and land mobile vehicles. The Indian development plan is to achieve Mach 4.5 by 2015 and Mach 6/7 by 2026/27 with deployment by 2028. The Russian-

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<sup>48</sup> Hans M. Kristensen and Matt Korda, "Indian Nuclear Forces, 2020," *Bulletin of the Atomic Scientists* 76, no. 4 (3 July 2020): 217–25, <https://doi.org/10.1080/00963402.2020.1778378>

<sup>49</sup> "Hypersonic Technology Demonstrator Vehicle," Wikipedia, accessed August 21, 2021, [https://en.wikipedia.org/w/index.php?title=Hypersonic\\_Technology\\_Demonstrator\\_Vehicle&oldid=1039857461](https://en.wikipedia.org/w/index.php?title=Hypersonic_Technology_Demonstrator_Vehicle&oldid=1039857461)

developed scramjet engine from the Zircon missile will power the missile. The range of the missile is 450-600km at speeds of Mach 7 (8,500km/h).<sup>50</sup>

## **Indian SLBMs**

The third leg of India's triad is just now coming into being. It consists of the INS Arihant nuclear submarine that has four missile tubes and currently carries twelve K-15 missiles, three in each tube. The INS Arihant is currently completing sea trails, while the long-range K-4 missile is completing testing. Also part of the SSBN project is a large new submarine base, INS Varsha, nearing completion on the east coast south of Visakhapatnam. In addition, two new VLF antennas and bunkered transmitter and C3 building were added to the existing VLF station at INS Kattabomman. These new communications systems will allow the national command authority positive control of the deployed SSBN force—that is, assurance that nuclear weapons are available for immediate use at all times.

The SSBN INS Arihant has four missile tubes and can carry twelve K-15 missiles or four K-4 missiles. The second SSBN INS Arighat has eight missile tubes and can be loaded with twenty-four K-15 or eight K-4 missiles or a combination of each. It is expected the two SSBNs being built will have the same configuration as the INS Arighat.

The K-15 missile is an underwater-launched two stage solid fuel short-range SLBM. Its range is 750m and has a single warhead. Development began in the late 1990s leading to land-based tests from Abdul Kalam Island. In February 2008, the tests moved to a submersible pontoon barge. After a successful barge test series, testing from HIS Arihant began November 2015 with a final test series of three missiles launched on 11 and 12 August 2018. It was declared operational later in August. The K-15 missile is 10m long and 0.74m in diameter.<sup>51</sup>

The K-4 is classified as medium-range missile with a range of 3,500km. It is a two-stage solid fuel nuclear capable missile that is underwater-launched and carries a single warhead. It was probably developed as a variant of the Agni-3. An ejection test was conducted from a submerged barge in

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<sup>50</sup> "BrahMos-II," Wikipedia, accessed August 9, 2021, <https://en.wikipedia.org/w/index.php?title=BrahMos-II&oldid=1037838310>

<sup>51</sup> "Sagarika (Missile)," Wikipedia, accessed August 13, 2021, [https://en.wikipedia.org/w/index.php?title=Sagarika\\_\(missile\)&oldid=1038587463](https://en.wikipedia.org/w/index.php?title=Sagarika_(missile)&oldid=1038587463)

November 2010. Also from the barge, a powered flight took place on 24 March 2014, as did a test on 7 March 2016, both successful. The next barge tests took place on 19 and 24 January 2020 and were the final developmental tests before the missile would go into production. There have been no launches to date of the K-4 missile from either of the SSBNs that are capable of launching it. The K-4 missile is 12m long and 1.3m in diameter.<sup>52</sup>

India has a 5,000km K-5 missile under development that could be ready for testing in 2022. This missile could be launched from the INS Arighat class SSBNs. India is also looking into a K-6 missile that would have a range of 6,000 to 8,000km and require a new S-5 Class submarine. The missile would be significantly larger, that is, greater than 12m in length and 2m in diameter.<sup>53</sup>

### **Anti-satellite (ASAT) program**

India has attempted two anti-satellite tests from the Abdul Kalam Island. The first on 12 February 2019 was a launch failure and the second on 27 March 2019 was a success. It used a kinetic hit-to-kill vehicle and destroyed a dedicated target satellite launched on 24 January 2019. The ASAT kill vehicle was boosted to match the target's orbit by a 2-stage solid fuel rocket before the kill vehicle was separated from it. This booster was reported to be a modified Prithvi-3 missile designated the PDF Mark 2/XSV-1. The latter is the same basic missile used for the ABM system and does not carry a nuclear warhead. The TEL carried ASAT is 13.2m long and 1.4m in diameter.<sup>54</sup>

### **Aircraft launched nuclear capability**

India has two aircraft, sixteen Mirage 2,000H, and thirty-two Jaguars configured to carry nuclear freefall gravity bombs as a secondary mission. They have also modified forty of their SuMKI fighters to carry the BhraMos non-nuclear cruise missiles. The only nuclear-capable missile in their inventory is the Nirbhay cruise missile. The air-launched version of the missile is still under development and was photographed under the centerline of a SuMKI fighter.

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<sup>52</sup> "K-4 (Missile)," Wikipedia, accessed July 24, 2021, [https://en.wikipedia.org/w/index.php?title=K-4\\_\(missile\)&oldid=1035239009](https://en.wikipedia.org/w/index.php?title=K-4_(missile)&oldid=1035239009)

<sup>53</sup> Arfa Javaid, "K Missile Family of India: Here's Everything You Need to Know," *Jagranjosh.Com* (blog), October 6, 2020, <https://www.jagranjosh.com/general-knowledge/k-missile-family-1601983618-1>

<sup>54</sup> Malcolm Claus, Brian Cloughley, and Nick Hansen, "Kill Vehicle, Examining India's ASAT Missile (Standing Tall)," *Janes Intelligence Review*, June 2019

A second new missile under development is the Long-Range Land Attack Cruise Missile (LRLACM). This missile will have a 1,000km range. It is planned for use by all three Indian services with its first tests beginning in early 2023. If successful it could become operational in late 2020s.<sup>55</sup>

## **ISLAMIC REPUBLIC OF PAKISTAN**

Since the Partition, Pakistan has viewed India to be its mortal enemy. All Pakistani deployed missiles were developed with India as their target. Pakistan is closing in on a nuclear triad of its own. The ground-launched ballistic and cruise missiles are the largest portion of this triad. The Mirage 3 fighter-bombers can deliver nuclear bombs and some were probably modified to carry the Ra'ad-1 nuclear capable cruise missile. The Ra'ad-2 longer-range version is planned to replace the older version beginning in 2021. The Babur-3 nuclear-capable cruise missile is the submarine version of the missile and was tested at sea in 2017 and 2018. It may be planned to go on the three current Agosta class submarines and the eight Hangor class AIP submarines ordered from China in 2017.

Pakistan has three active missile test ranges. Liquid fuel Ghauri missiles were tested from the north of the country at the Mashhood firing range also called the Tilla missile test range. Since Pakistan adopted solid propellant missiles, only an occasional troop-training Ghauri launch now takes place at Tilla. The solid fuel ballistic and cruise missiles are launched from two closely spaced test ranges located on the south of the coast of Sonmiani Bay. The newest of these test ranges is called the Winder missile test range where the Shaheen longer range solid propellant and cruise missiles tests take place. The older and larger Sonmiani test center is 19km to the southeast of Winder. The early Hatf-1-3 was tested here and the ground launched cruise missile crew training for the Hatf-9/NASR may be done here.

### **Pakistan's land-based missiles**

All of Pakistan's land-based ballistic and cruise missiles are operationally launched from road-mobile TELs.

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<sup>55</sup> Krishnan M. Anantha, "India Set to Develop Long Range, Land Attack Cruise Missile," *OnManorama*, February 6, 2020, <https://www.onmanorama.com/news/india/2020/02/06/india-defexpo-long-range-land-attack-cruise-missile.html>

The Hatf 1 and 2 shortrange missiles date back to the late 1980s. The Hatf-1A may still be in the field today and a newer version of the Adali Hatf-2 with a range of 200 miles entered service in 2015, and ten may be deployed. The Hatf-3 Ghaznavi is a solid fuel missile with a range of 300km. This missile is derived from the Chinese DF-11 with a conventional warhead transferred to Pakistan in 1992. Pakistan made these missiles nuclear-capable and the first flight was on 26 May 2002. It became operational in February 2004 with the Army Strategic Forces Command. Fewer than fifty of these missiles are deployed and the missile was last tested on 19 August 2019.

Testing of the Hatf-1-3 missiles probably began in the late 1980s to early 1990s at the Sonmiani test range. The the missiles were fired into the desert on a 314 degree azimuth.

### *The Shaheen solid fuel missiles*

The Hatf-4/Shahen 1 missile also was derived from Chinese missiles, the M-11 and M-9. Testing of the solid fuel motor and flight sets was transferred to the Winder test range. Motor test were completed July 1997, the missile was converted to be nuclear-capable and shown to the public in the March 1999 National Day parade. Flight tests from Winder followed and 750km range Hatf-4 was accepted into service in 2006. An improved version of the missile, the Shaheen-1A with a 900km range was tested in November 2014 and is operational. The single stage Shaheen-1 and 1A are 12m long and their diameter is 1.0m. Less than 50 are deployed.

The Shaheen-2/Hatf-6 is a two-stage solid fuel MRBM first seen in the October 2003 National Day parade. Its development may have had help from the Chinese M-18/DF-11. The first test took place in March 2004 from the Winder test range and it went into service in April 2008. The range of this missile is 2,500km and less than fifty are thought to be deployed. Its length is 17.5m and diameter is 1.4m and is carried on a WS21200 Chinese TEL.

The Shaheen-3/Hatf-10 is a two-stage solid fuel MRBM Based on the Shaheen-2 with a 2m lengthened second stage. The first test of the missile was on 9 March 2015 and a second test on 11 December 2015, both successful. A Shaheen-3 missile was seen erected on Pad 2 at Winder on 28 January 2018 during a training exercise and VIP visit, but it was not launched. No additional tests of the Shaheen-3 have been reported. Since this missile is a Shaheen-2 with a longer 2<sup>nd</sup> stage and the Shaheen-2 is operational, it is probable that two tests were adequate. The Shaheen-3 may have

entered service in 2019-2020. The missile is 19.3m in height and 1.4m in diameter. The Shaheen-3 has a range of 2750km and is carried on a Chinese TEL the WS51200.

The Shaheen-3 is the booster for the 3 stage Ababeel MIRVed MRBM. The Chinese also were reported to have helped with the MIRV technology carried on the Ababeel missile. The Ababeel was tested from Winder only once on 24 January 2017 and was reported to have been successful. In a “Statement for the Record: Worldwide Threat Assessment” March 2, 2018, US Lt. General Ashley DIA stated “Pakistan conducted the first test launch of its nuclear-capable Ababeel ballistic missile, demonstrating South Asia’s first MIRV payload.”<sup>56</sup> Why there have been no additional tests is unknown. The missile has not been deployed or seen in a parade.

The Ababeel stands 21.5-22.1m high and the booster and second stage diameter is 1.4m—the same as the Shaheen-3—and the payload faring is 1.7m in diameter. The second stage has been extended in place of the Shaheen nose cone, and a 1.7m third stage added below the payload. This is probably the post-boost vehicle needed to target the warheads. The payload shroud is 3.4m long and separates after second stage ignition. The three war heads are mounted on the third stage and are released independently.<sup>57</sup>

### ***Ghauri/Hatf-5 liquid fuel missiles***

The Ghauri missiles are single stage liquid propellant missiles. Between twelve to twenty-four of the DPRK’s Nodong-1 missiles were purchased by Pakistan in the late 1990s and renamed Ghauri. The first test of the missile launched by a North Korean crew occurred in April 1998 and failed, as did a second test in April 1999. A third test took place in May 2002 and was a success. The Ghauri entered service in January 2003. Three more tests took place in 2004 for troop training. These missiles have a MRBM range of 1,250km.<sup>58</sup>

Pakistan has improved the No dong-1 (Ghauri–I) missiles originally purchased by Khan Research Laboratories (KRL) in Kahuta by extending the propellant tank 1m to get longer range and

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<sup>56</sup> Robert Ashley, “Statement for the Record: Worldwide Threat Assessment,” *Defense Intelligence Agency*, March 6, 2018, <https://www.dia.mil/News/Speeches-and-Testimonies/Article-View/Article/1457815/statement-for-the-record-worldwide-threat-assessment/>

<sup>57</sup> Missile Defense Project, “Ababeel,” Center for Strategic and International Studies, September 12, 2017, last modified July 31, 2021, <https://missilethreat.csis.org/missile/ababeel/>

<sup>58</sup> Feroz Khan, *Eating Grass: The Making of the Pakistani Bomb* (Stanford University Press, 2012).

improving the warhead. In some reports these missiles were identified as Ghauri-2 with a range of 1,800km. The liquid engine test stand at KRL was built for the Ghauri program. Most if not all twelve known Ghauri missiles have been launched from the Mashhood Firing Range (also called the Tilla Missile Test Range) into either the Southwest desert or Arabian Sea.

A planned two stage Ghauri-3 missile with a 3,000km range had its funding cut in 2000 and was terminated in 2004. The last known test launch of a Ghauri was October 2018. If Pakistan only purchased twenty-four missiles and twelve have been launched, then this missile likely is being phased out. The Ghauri-2 is 18m long and 1.35m in diameter.

### ***NASR/Hatf-9***

The NASR/Hatf-9 is a nuclear-capable short-range ballistic missile. It was first tested at Windar on 19 April 2011. It was launched again five times and was seen on pad 3 at Sonmiani on 1 May 2018. The most recent launch was on 24 January 2019. It probably entered service in 2013 after four missile salvo. The NASR missile is probably a modification of the Chinese solid propellant Norico AR series launched from a four tube TEL. It is capable of launching low yield nuclear and conventional weapons to a range of 60-70km. The missile is 6m in length and 0.4m in diameter.<sup>59</sup>

### ***Babur-2/Hatf-7 cruise missile***

The Babur-2/Hatf-7 cruise missile is designed to carry both conventional and nuclear warheads. The missile is boosted from its launch tube by a solid fuel rocket and is then powered by a turbojet engine. The Babur missile may be a reverse-engineered US Tomahawk missile that was recovered unexploded from a US airstrike on Afghanistan on 10 August 1998. The Babur-1 is nuclear-capable and can carry conventional payloads. The missiles were first tested on a single launcher from the Winder test range in August 2005. The range of the Babur-1 was estimated to be 350km. The Babur-2 is launched from a quad TEL with the first launch in April 2018. This missile has an estimated range of 700km and is 6.25m long and 0.52m in diameter.

### ***Babur-3***

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<sup>59</sup> Ankit Panda, "Pakistan Conducts Second Nasr Nuclear-Capable Ballistic Missile Test in a Week," *The Diplomat*, February 4, 2019, <https://thediplomat.com/2019/02/pakistan-conducts-second-nasr-nuclear-capable-ballistic-missile-test-in-a-week/>

The Babur-3 is the first missile that is planned to be Pakistan's sea-based part of the triad. The missile has been tested twice from a barge in the Arabian Sea, in 2017 and again in 2018. It is to be installed on Pakistan's three Agosta submarines and later probably on the ten Hangor submarines ordered from China. Today there is no evidence that this missile has been tested further or deployed. It has an estimated range of 450km.<sup>60</sup>

### ***The Ra'ad/Hatf-8 air launched cruise missile (ALCM)***

These Ra'ad missiles, along with gravity bombs, are the airborne component of Pakistan's triad. It is deployed on the Mirage 3 EA fighter aircraft. They probably plan to deploy the missile on the JF-17 fighter being purchased from China. The heritage of this missile is possibly from a South African missile but has not been confirmed. The test of the first version of the missile was in August 2007 and had a range of 350km. The Ra'ad-2 version has the range extended to 600km. This version was shown in a March 2017 parade and it has been significantly modified. The latest test of the Ra'ad-2 missile was on 16 February 2010 and it achieved a 600km range. The missile is 4.85m long and 0.5m in diameter.<sup>61</sup>

## **DEMOCRATIC PEOPLES REPUBLIC OF KOREA (DPRK)/NORTH KOREA**

The DPRK's nuclear capable missiles today are land based and mobile. They are short to intermediate range operational missiles, with at least three intercontinental range missiles under development. They are also developing a long-range submarine ballistic missile and are modifying a conventionally powered submarine with three launch tubes for these missiles. This submarine is expected to be launch in 2021/22. Their air force also has at least two types of aircraft that are capable of carrying gravity nuclear bombs. There is no publically available data, however, to indicate any of them have been modified to carry these bombs.

### ***Hwasong-5(SCUD A), 6(SCUD B) and 7(Nodong 1&2)***<sup>62</sup>

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<sup>60</sup> Reuters, "Pakistan fires 'first submarine-launched nuclear-capable missile'", Staff Writers, Islamabad (Reuters) Jan 9, 2017, <https://www.reuters.com/article/us-pakistan-missiles-idUSKBN14T1EL>

<sup>61</sup> "Hatf-VIII (Ra'ad)," Wikipedia, accessed August 8, 2021, [https://en.wikipedia.org/w/index.php?title=Hatf-VIII\\_\(Ra%27ad\)&oldid=1037799321](https://en.wikipedia.org/w/index.php?title=Hatf-VIII_(Ra%27ad)&oldid=1037799321)

<sup>62</sup> Please note there are three nomenclatures in use for North Korean missiles: DPRK Hwasong-1-X, US and ROK KN-01-X and some were given names by the U.S. based where or near where they were first launched from,

The DPRK got its start with long-range missiles with Soviet SCUD B missiles obtained from Egypt in the 1970s. The North Koreans reversed engineered these missiles and identified them as Hwasong-5. Tests began in the late 1980s from the Tonghae missile range. They then improved the missiles and called them Hwasong-6 and deployed them internally and sold them to mainly Middle East countries. The DPRK became the largest supplier of missiles to Iran during the Iran-Iraq war from 1980 to 1988 and set up a production facility for these missiles in Iran in 1985. The sales of missiles and the construction of production facilities for missiles became a large source of currency for the DPRK. As of 2020 fewer than 100 of the Hwasong 5/6 and their variants are deployed in the DPRK. The latest variant is the 1,000km extended range Scud first launched in 2016.

The next missiles in the SCUD/Hwasong-5 line were the Hwasong 7, commonly known as Nodong-1(Rodong-1). These were up-scaled Hwasong-6 missiles and tested from the Tonghae missile range from 1990 to 1993. The first customer for the Hwasong 7 missile was Pakistan, which purchased twelve to twenty-four of them and called them Ghauri. They were delivered unassembled in 1997. The DPRK set-up an assembly facility in Pakistan for these missiles but not a full production facility. Iran was the second client for the Hwasong-7 and called them Shahab-3. Tests began in 1998 and it entered Iranian service in 2003. The Shahab-3 is the first stage of the Iranian Safir space launch vehicle. In the DPRK in 2020 there were fewer than 100 Hwasong-7 deployed.<sup>63</sup>

### ***Paektusan (Taepodong-1) and Unha (Taepodong-2) Space Launch Vehicles***

Starting in the mid to late 1990s the missile program seems to have turned into a space launch program. The first of the rockets was called Paektusan (Taepodong-1) and it used a Hwasong-7(Nodong) first stage, a Hwasong-6(SCUD) second stage, and a small solid fuel third stage. It was launched from the Tonghae only once on 31 August 1998. This was a one off mission that failed to put a small satellite into orbit but did prove out staging and control systems. It was not a weapon.

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Taepodong, Nodong and Musudan. To confuse even more, the Musudan was never launched from Musudan. For this section the use of the DPRK Hwasong naming will be used where possible.

<sup>63</sup> Feroz Khan, *Eating Grass: The Making of the Pakistani Bomb* (Stanford University Press, 2012).

Next came the larger Unha (Taepodong-1/2) rocket with a first stage of four clustered Hwasong-7 engines, a second stage with a probable Hwasong-6 engine, and a possible Iranian third stage. The first launch Unha-1 was from Tonghae on 4 July 2006 and it failed after around 40 seconds. The next launch on 5 April 2009 was called an Unha-2. It was another satellite attempt that failed during the third stage. After this mission, the launch program was moved to the Sohae Satellite Center where starting on 12 April 2012 three Unha-3 SLVs have been launched. One failed and two successfully launched satellites into orbit. Since the 7 February 2016 launch they have not attempted another Unha-3 space launch as of November 2021. In a later DPRK article it stated they had six more Unha rockets and had assigned space missions to each of them.

This short discussion of the Paektusan and Unha rockets has been included because in many documents they are listed as missile weapons.

#### ***Hwasong-10(Musudan) and Hwasong-13(KN-08)***

The Hwasong-10 missiles along with the Hwasong-7(Nodong) were first shown to the West in a 10 October 2010 parade in Pyongyang. The Hwasong-13 was first seen in the 15 April 2012 parade. The design of both missiles probably began in the late 1990s. The parade missiles were probably not flight articles. Also propellant for both missiles is probably IRFN/Kerosene similar to the older Hwasong 5, 6 and 7 missiles and the Unha space launch vehicles.

**The Hwasong-10 (Musudan)** is single stage missile 12m in length and 1.5m in diameter. The missile was first reported to be an IRBM but was probably an MRBM. It is mounted on a demilitarized Russian SS-20 TEL that was remilitarized in the DPRK to again carry a missile, the Hwasong-10.

The flight test program began in April 2016 and included eight launches of which only one was successful on 22 June 2016. Testing ended in October 2016. Three or four of these tests exploded on or near the TELs destroying them. None of these tests took place from an established missile test range; they were all from unimproved field sites. The Hwasong-10 was last seen in a parade in 2016 and was not present in the 2017 and 2018 parades. By all accounts the program has probably

been terminated and the TELs given to the Hwasong-12 and other missile programs. The Hwasong -10 was never deployed.<sup>64</sup>

**The Hwasong-13 (KN-08)** is a three-stage liquid fuel mobile missile, reported in the West to have an ICBM range. It was first seen in the 5 April 2012 parade carried on a Chinese 8 axel WS-51200 tractor. Probable Hwasong-13 engine testing was observed at the Sohae Haasong-13 engine test stand first in late 2012 when the first stage was seen on the pad. Testing again started in mid 2013 and in March 2014 and was seen again in August 2014. Testing was terminated by 2015 when construction began to modify the test tower and add two new propellant bunkers and a mobile concealment building. These projects were completed by early 2016 and needed to ready the engine test facility for the higher energy propellants used in the upcoming tests, and Kim's visits.

No confirmed launches of the Hwasong -13 have been reported. There is speculation, however, that one or two of the last Hwasong-10 test failures may have been Hwasong-13s. Four new missiles paraded in 2015 were identified as the KN-14 or KN-08 Mod 2. The missiles were carried by the same TELs as the Hwasong-13 and only seen in the 2015 and 2016 parades. The missiles, six of them, were last seen on a warehouse floor at the Tae-Sung Machine facility in the video taken during Kim's visit to inspect the fission bomb on 9 March 2016. The KN-14 missiles were very probably fakes. Neither missile was ever deployed.<sup>65</sup>

### ***Hwasong-12(KN-17) IRBM and Hwasong-14(KN-20) ICBM***

Starting in September 2016 testing of high-energy propellant rocket engines began at the Sohae test stand. A second major test took place in March 2017. An assessment of the type of engine being tested was it is probably a liquid propellant RD-250 type, based on the Soviet engine. The RD-250 uses hypergolic propellants, UDMH fuel, and N2O4 oxidizer. These tests were very important as Kim attended and heaped praise on the test engineers after they were successful.

**Four Hwasong-12** missiles were first seen in the 17 March 2017 parade carried on TELs that had previously been used by the Hwasong-10 missiles. It is a single stage missile using the RD-250

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<sup>64</sup> Missile Defense Project, "BM-25 Musudan (Hwasong-10)," Center for Strategic and International Studies, August 8, 2016, last modified July 31, 2021, <https://missilethreat.csis.org/missile/musudan/>

<sup>65</sup> David Webb, "KN-08 / Hwasong-13," Missile Defense Advocacy Alliance, January 2017, <https://missiledefenseadvocacy.org/missile-threat-and-proliferation/todays-missile-threat/north-korea/hwasong-13/>

type engine with four vernier steering engines all using high-energy propellants. The missile is 16.5m in length and 1.5m diameter and an estimated range of at least 5500km. The Hwasong-12 was the first of the new missiles to be tested with three tests in April 2017 that all failed. The fourth missile was launched on a lofted trajectory with an apogee of 2,111km. Successful launches on 29 August and 15 September were to long ranges of 2,700km and 3,700km. Both flew over Japan and caused an international incident. In April 2017 Kim threatened to bracket the US island of Guam with four missiles, probably Hwasong-12s, but never did it. The Hwasong-12 is the replacement for the failed Hwasong-10 missile and fills the IRBM range gap.<sup>66</sup>

**The Hwasong-14** is classified in some reports as an ICBM. It is the second of the new missiles to appear. It was first seen in a video of its first launch on July 4, 2017. The second launch occurred on July 28, 2017. Both of these launches were successful. It is carried on the same WS-51200 TEL that had carried the Hwasong-13 (KN-08) missile. Eight of these WS-51200 vehicles were purchased from China in 2011 as logging trucks. These were then converted into Hwasong-14 TELs by the DPRK. They have also probably been copied and produced internally.

A small number of these TELs, one or two, were probably modified in the mid 2010s to launch the Hwasong-14. But when seen in parades starting in 2018 the Hwasong-14 was being carried on a semi-truck trailer and not by the TEL it was launched from in July 2017. At least four of these TELs were also modified to carry an unidentified canister missile in the April 17, 2017 parade.

Four more modified TELs with three additional axils were seen in the October 2020 parade carrying the Hwasong-16 missile. Why the Hwasong-14 was not on a TEL is possibly because of there were no TELs available.

There have been two tests of the second new missile the Hwasong-14. Both were lofted trajectories and impacted in the Sea of Japan. Apogee of the July 4, 2017 test was 2,803km and the 28 July 2017 test was 3,700km. It is not clear that the reentry vehicle survived. The missile is 19.8m in height and 1.85m in diameter and uses a RD-250-type engine and four vernier steering

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<sup>66</sup> Missile Defense Project, "Hwasong-12 (KN-17)," Center for Strategic and International Studies, May 16, 2017, last modified July 31, 2021, <https://missilethreat.csis.org/missile/hwasong-12/>

engines. It is not known how many of these missiles exist or if they are currently deployed. The Hwasong-14 is probably the replacement for the Hwasong-13 that was not deployed.<sup>67</sup>

### ***Hwasong-15(KN-22) ICBM and Hwasong-16(KN-27) ICBM***

**The Hwasong-15** large mobile ICBM was first shown to the world in a video of its first and only launch on 29 November 2017. The video shows Kim inspecting the launch preparations, the launch and the celebration after a successful mission. Four of the missiles were next seen in the 8 February 2018 parade and again in the 10 October 2020 parade. One of the HS-15 missiles was seen on the floor of the EXPO on 11 October 2021 at the military exhibition in Pyongyang. There have been no further sightings or launches of the missile.

The November 2017 test was on a lofted trajectory and it reached an altitude of 4,475km and impacted in the Sea of Japan. Based on the lofted trajectory it has been estimated its operational range could be 13,000km with a payload of 1,000kg. The Japanese reported the reentry vehicle failed, however, other observers disagree. The missile's first stage uses a gimbaled two-chambered RD-250 type engine. The second stage engine is not known but is probably a version of the single chamber RD-250 type. The Hwasong-15 is about 22.5m in length and 2.4m in diameter.

The missile is carried on a modified version of the Chinese WS51200 logging truck with a ninth axel and a new cab. Eight of these trucks were reported to have been imported in 2011. Modifications as a TEL, they were probably done by the March 16 Truck Factory in Pyongsong, DPRK, that added the missile erection system and its controls. Like the Hwasong-12 and 14s, this missile TEL also has a detachable launch stand allowing it to move away in case of a early launch failure.

**The Hwasong-16 (KN-27)** was the October surprise the DPRK said they would have when four of these missiles were paraded in Pyongyang the night of October 10, 2020. The Hwasong-16 is the largest liquid fuel mobile missile ever developed. It has not been flight-tested as of mid November 2021 and its development status is unclear. Therefore, the ICBMs shown at the parade

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<sup>67</sup> Missile Defense Project, "Hwasong-14 (KN-20)," Center for Strategic and International Studies, July 27, 2017, last modified July 31, 2021, <https://missilethreat.csis.org/missile/hwasong-14/>

were likely to have been engineering models. Estimates of its range is over 13,000km with a payloads of 2,000 to 3,500kg kg.

The only available information on the Hwasong-16 missile is the parade imagery provided by the DPRK and the analysis derived from it and the photo from EXPO on 11 October 2021 at the military exhibition in Pyongyang. The close up parade photos of the missiles had measurements that are probably good to plus or minus five percent. Its length is 25.2m and diameter is 2.73m. The length of the first stage is 15.5m, the second stage is 5.0m in length and has the same 2.73m diameter, and the nose cone is 5.1m long and tapers from the second stage to the rounded 1.0m diameter front end.<sup>68</sup>

Because the engines on each missile were covered by a red plastic, it cannot be confirmed the engines were even present or the same RD-250 type used by the Hwasong-15 missile. There are some clues, however, they probably are. The first is on some of the missiles the red plastic is wrapped around each chamber and that can be measured at 0.8m in diameter. That is the diameter of the RD-250 chambers. The red plastic on the missiles shows there are four nozzles at the end of the first stage. The missile's first stage probably uses two gimbaled two-chambered RD-250 type engines and they are movable to provide the steering during first-stage flight. The rear of the first stage is flared out about 0.2 m likely to provide clearance for the nozzle's movement. There is no way to identify the engine used in either the first or second stage, but good assessments are a two two-chambered RD-250 type engine in the first stage and a single two chambered RD-250 in the second stage.

The nose cone is 5.1m long and tapers from 2.73m at its base to 1.0m at its rounded top. It is capable of carrying multiple independently targetable re-entry vehicles (MIRVs) and the required post-boost vehicle needed to target them. However, the DPRK is unlikely to have the technology for these systems. To date, there is no evidence of any testing of more than a single re-entry vehicle or of a post-boost vehicle. They could however deploy multiple re-entry vehicles (MRVs) that are designed for release to bracket a target to ensure its destruction.

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<sup>68</sup> "Hwasong-16," Wikipedia, accessed August 29, 2021, <https://en.wikipedia.org/w/index.php?title=Hwasong-16&oldid=1041233316>

The four 11-axle TELs that transported the four Hwasong-16s in the parade are likely to be the largest ever built. The TEL itself is about 29.5 m long and about 4 m wide. The Hwasong-16 transport-erector portion includes the cab and the carrier that has the erector. The TEL has twenty-two 1,800 mm -wheels controlled independently and driven by a drive shaft from the diesel engine behind the cab. Three hydraulic jacks on each side of the carrier are extended to the ground to stabilize the erection process. The jacks are positioned to support the weight of the carrier as it shifts during the erection process

The big questions are when will the first test launch occur and where will it be launched. With the current data available these cannot be answered. A good guess at the second question is it will not be from an established test range but from a remote unprepared location. The answer to the first question is known only to Kim and his engineers, but probably later in 2021 or 2022.

### **HS-8 Hypersonic Glide Vehicle (HGV)**

September 2021 was full of more surprises as on 29<sup>th</sup> an announcement and a photo just after launch of the HGV, were realest. Then at the EXPO on 11 October 2021, at the military exhibition in Pyongyang, the missile and its TEL were displayed. Almost no information was released on the launch other than it was fired from the western side of the country. From the announcement, it was not clear that it was a complete success. The photos of the HGV taken at the EXPO were more revealing. The booster is a three quarters length HS-12 IRBM. The HGV has orange stripes painted on it that are similar to those on the HGV launched on 29 September. These are use for optical tracking. The TEL is similar to the one that carried the HS-14. More tests can be expected.

### **Shorter-range ground launched ballistic missiles**

#### ***The Pukukson-2 (KN-15)***

The Pukukson-2 is a two stage solid fuel track vehicle-mounted MRBM. The missile was first observed in a video of its first launch on February 11, 2017, at the Riku-dong training facility 4.2km from Kusong, with Kim supervising. Six of these missiles were seen in the April 15, 2017, parade. Kim also attended the second and last known launch on May 21, 2017. Both the February and May tests were lofted trajectories and were successful. Kim then declared the Pukukson-2 ready for mass production. It was reported deployed in 2019.

The Pukkikson-2 is a land-based variant of the submarine based Pukkuksong-1. It is 10m in length and 1.5m in diameter with an estimated range of 1,200 to 2,000km. It is cold launched from a tube in the vertical position from a tracked vehicle. It is probably a replacement for some of the Hwasong-7 (Nodong 1 and 2).<sup>69</sup>

**The KN-23** is a short-range single stage solid fuel missile and either is a Russian-built Iskander-1 missile or a copy of it. It is hot launched off the rear of the TEL. The missile was first seen in the February 8, 2018, military parade. The first of eight launches occurred on May 4, 2018. The missile has been seen launched from both wheeled and tracked TELs. The most recent launch of ~~this version was of~~ the KN-23 was on July 31, 2019.

Both the 4 axle wheeled and tracked TELs carry two missiles. The missiles are 7.5m in length, 0.95m in diameter, and have a range of 450km with a 500kg warhead. These missiles are probably replacing the Hwasongs 5 and 6 SRBMs.<sup>70</sup>

### ***Probable KN-23-2/ KN-28***

In the January 14, 2021, military parade six larger versions of the KN-23 missile were seen mounted on five axle ten-wheel truck TELs. The truck beds have been extended about 1.5m to accommodate the fifth axle and longer missile. The truck bed is similar to the first KN-23, but the cab is a new design. The missile appears to have the same nearly 1m in diameter and is about 1m to 1.5m longer. As of mid-August 2021 no Hwasong number has been identified but the KN-28 may have been assigned to these missiles.

Two of the new missiles were launched on 25 March 2021 at 7:06 am and 7: 25 am (Japan Standard Time) from South Hamgyong Province. According to North Korean's KCNA news agency they impacted in the East Sea for a range of 600km with a 2,500kg warhead and hit their target. Kim did not attend the launches. Senior official, Ri Pyong Chol, supervised the launches.

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<sup>69</sup> Missile Defense Project, "Pukguksong-2 (KN-15)," Center for Strategic and International Studies, March 5, 2017, last modified July 31, 2021, <https://missilethreat.csis.org/missile/pukkuksong-2/>

<sup>70</sup> Missile Defense Project, "KN-23," Center for Strategic and International Studies, July 1, 2019, last modified July 31, 2021, <https://missilethreat.csis.org/missile/kn-23/>

The ROK and Japan probably had sensors that observed some or all of these flights. They take issue with the ranges and warhead weight given by the DPRK. Their conclusions suggest these missiles flew around 450km with a smaller warhead. They believe the DPRK inflated the numbers to make their missile technology look better. The 1-1.5m of additional solid fuel rockets could have increased their range possible out to 600km, however.<sup>71</sup>

### ***Rail launched KN-23/28***

Yet another September 2021 surprise was three KN-23/28 missiles launched from an open rail car, two on September 15 and one on September 28. The DPRK reported both missiles were successful and flew to 800km at an altitude 60km. Photos released by the DPRK of both dates show the missile launches from a mountain location with a railway tunnel in the background. These trains consisted of an engine, boxcar, and the open car with two KN-23/28 missiles. This car appeared to have a similar truck erector launcher system installed in it. The placement of the launch near a rail tunnel was meant tell how they plan on hiding the trains.

**KN-24** is a mobile short-range single stage solid propellant ballistic missile similar in appearance to the US Army MGM-140 ATACM. The missile was first tested on 10 August 2019 when two were launched with Kim in attendance. It was hot launched from the rear of the tracked TEL from inside an open ended rectangular enclosure. Two more were launched on August 16 and the last two launches were on 21 March 2020. The latest sighting of these missiles was in the January 14, 2021, military parade when six tracked TELs were seen, each with two missiles. These missiles were inside rectangular enclosures with the front-end open so the missile warheads were seen.

The KN-24 has been measured to be 4.5-5.5m in length and 0.7-0.85m in diameter. It has flown to ranges from 230km to 410km on non-ballistic trajectories. It is estimated to be able to carry a 400-500kg warhead and has been launched with the two missiles from the same TEL, 5 minutes apart.<sup>72</sup>

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<sup>71</sup> Vann H. van Diepen, "Initial Analysis of North Korea's March 25 SRBM Launches | 38 North: Informed Analysis of North Korea," *38 North* (blog), March 30, 2021, <https://www.38north.org/2021/03/initial-analysis-of-north-koreas-march-25-srbm-launches/>

<sup>72</sup> Missile Defense Project, "KN-24," Center for Strategic and International Studies, April 15, 2020, last modified July 31, 2021, <https://missilethreat.csis.org/missile/kn-24/>

## **DPRK submarine launched ballistic missiles**

The DPRK has demonstrated it has the capability to develop and successfully launch two submarine ballistic missiles, the Pukkuksong-1 and 3. To do this they had to first build the infrastructure that allows the construction and testing of all the elements that make up the weapons system. For the missiles these included the solid rocket motors, the launch tubes, and cold gas ejection system. These were tested first on shore then from a submersible barge and then from a conventional test submarine. On top of this, they were building an extensive hardened submarine base probably for the operational missile submarines near Sinpo. This is a very expensive program.<sup>73</sup>

Probably as result of the costs, Kim took a special interest in the program by visiting most of the elements involved. Among them was a test at the solid motor test facility and a test at the shore-based ejection test facility. He supervised the checkout and loading on the test submarine of the Pukkuksong-1 missile and its launch. He observed most the Pukkuksong-1 launches from the barges and test submarine.

In a most visible appearance he visited the submarine construction hall at Sinpo to assess the progress on the conversion of a 1950s vintage R-class submarine into a Pukkuksong missile submarine with three launch tubes. That was in mid 2019, but this submarine has not entered the water as of October 2021.

### ***Pukkuksong-1 (KN-11)(Bukkeuksong-1) SLBM***

The Pukkuksong-1, based on a range estimate of 1,200km, is considered MRBM range. Development of this missile began in the early 2010s. A dummy mass model missile went through ejection tests at the Sinpo test facility in October and November 2014. In December 2014 it went through more ejection tests from the barge and more tests with a test missile in April and May in 2015. In November 2015 it was reported an ejection test caused some damage to the conning tower of the test submarine so testing went back to the submersible barge. The submarine was repaired and in April and July 2016 missiles from the submarine failed shortly after launch. The first true success was the launch occurred on 24 August 2016 when the missile flew on a lofted

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<sup>73</sup> Nick Hansen, "North Korea Building New, Larger Submarine Pens," *HIS Janes Defence Weekly*, July 27, 2016.

trajectory to a range of 500km. As of October 2021 there have been no additional launches of the Pukkuksong-1.

The Pukkuksong-1 is two-stage solid fuel missile with an estimated range of 1,000 to 1,500km. It is 9m in length and has a diameter on 1.5km. Pukkuksong-1 was first seen in launch videos in 2015. Six missiles on naval trucks were first seen in 15 April 2017 parade. This missile is closely related the land mobile Pukkuksong-2.

The Sinpo-1/ Gorae-SSB is the test submarine for the Pukkuksong-1 missile. It was first seen at the dock in Sinpo in 2014. It was built to test launch the Pukkuksong-1 missile and was reported to have damage to the conning tower during its first launch of the missile on 28 November 2015. This submarine went on to launch three more Pukkuksong-1 missiles in 2016. The last, on 24 August 2016, was successfully launched on the lofted trajectory.

Based on the material above there is a reasonable chance the Pukkuksong-1 program spun off the land launched Pukkuksong-2 system. However, the Pukkuksong-1 may have been only to prove out the various technologies for future SLBMs. Its two main test components are the submersible barge and the Sinpo-1 submarine, both of which will find use in the Pukkuksong-3 missile test program. It was probably this barge towed from Sinpo to Wonsan that launched the Pukkuksong-3 missile on 2 October 2019.<sup>74</sup>

### ***Pukkuksong-3 (KN-26) SLBM***

The Pukkuksong-3 SLBM has been seen twice, the first in a wall poster in August 2017 at the Chemical Materials Institute during Kim's visit and again on 2 October 2019 in three photos released by the DPRK of its only launch. Kim also witnessed a test of what was probably its solid fuel motor at the Magunpo Solid Rocket Motor Test Facility in March 2016. The Pukkuksong-3 has never been seen in a parade and was not displayed at the EXPO on 11 October 2021 at the military exhibition in Pyongyang.

The Pukkuksong-3 is a two-stage solid fuel missile. Because it was seen only in the three still photos just coming out of the water with nothing in the background, its length and diameter

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<sup>74</sup> "Pukkuksong-1," Wikipedia, accessed August 6, 2021, <https://en.wikipedia.org/w/index.php?title=Pukkuksong-1&oldid=1037427898>

measurements are estimates and vary considerably. They range from nearly 8m to 10.6m in length and 1.5m to 1.8m in diameter. Please note these estimates are not far from those of the Pukkuksong-1 that are 9.7m in length and 1.5m in diameter that ~~was~~ can be launched from the submersible barge and the Gorae/Sinpo-1 test submarine. Based on the similar sizes of the Pukkuksong 1 and 3 it is expected the Pukkuksong-3 will use the barge and Gorae test SSB for future tests.

The missile was cold launched from probably the Sinpo submerged barge, off the Wonsan coast and flew a lofted trajectory with an apogee of 910km and a range of 450km. That works out to an estimated range of 1,900km if flown on a normal trajectory. This test was successful. More tests from the barge and Gorae/Sinpo-1 test submarine can be expected probably from the Sinpo area.

The modified R-Class submarine with three launch tubes will probably carry the Pukkuksong-3 SLBM. It has been in the Sinpo submarine construction building since before 2019 and is estimated it will be launched in 2021/2022. It is interesting this building has two submarine construction ways but the video only covered the modified R-Class submarine on the south way.

### ***The Pukkuksong-4 and Pukkuksong-5***

This short write up is placeholder for two new long-range missiles seen in a 2020 and a 2021 parade. The Pukkuksong-4 was on the same type truck trailer as the navy's Pukkuksong-1 seen in the April 2017 parade, but it was painted olive drab and not navy blue. Seated on the bench in front of the missiles were four army soldiers. It is possible it will be a mobile army missile.

The Pukkuksong-5 is a Pukkuksong-4 with an elongated second stage. It is carried on the exact same trucks the Pukkuksong-4 used. The only difference was the missile shroud extended past the bench and the bench was removed. Since it was painted olive drab, it could also be a land mobile missile. Both of these paraded missiles were either fakes or early engineering models. They were not flight articles.

### ***Possible Pukkuksong-6 short range SLBM***

To the surprise of most DPRK analysts the DPRK conducted a test of an underwater launched short-range ballistic missile from Sinpo on October 19, 2021. The missile was probably launched

from the Gorae test submarine, but it could also have come out of the submergible barge. The DPRK did not release the name of the missile, but from the video it is probably a variant of the KN-23. No accurate dimensions can be determined from the photos. The only estimate is the size of the launch tube on the Sinpo-1. The tube had to fit the Pukukson-1 missile that was reported to have a length of 9.3m and a diameter of 1.5m. The KN-23 would easily fit into this launch tube. The mission for the development of the submarine launch short-range missile is unknown.

### **Long-Range cruise missiles**

The DPRK never had a long-range cruise missile until September 12, 2021, when they launched two from a ground TEL. The missiles are a descendent of the Soviet/Russian Kh-55/AS-15 of the mid-1980s. These missiles were then deployed to extend the range on the TU-95 strategic bombers and carried nuclear weapons. These DPRK missiles are ground-launched and probably have a ground attack mission. The big question is what country sold them the technology. Russia, China, and Iran have modern versions of these missiles, and Iran obtained them from Ukraine in 2001.

### **CONCLUSION**

This chapter describes the missiles-deployed or under development by the six nuclear weapons states in the Asia-Pacific region. Nuclear weapons states rely on ballistic missiles for the most part to deliver WMD, especially nuclear warheads, due to their combined speed of delivery and geographical reach to overwhelm any possible defense against nuclear attack. Asia-Pacific states present a myriad of lethal missiles, the development and deployment of which is driven by many domestic and international factors, but especially the presence of an external missile threat leading to offsetting, action-reaction missile development. Thus, it is evident that US-Russian and US-Chinese missile advances are primarily the result of competition, whereas in other cases (the DPRK and India, for example) missile acquisition is a three or even four-way dynamic whereby the most capable missile sets the range and lethality standard that drives the other states to match, albeit often in a-symmetric ways that use new missile technology such as hypersonic missile speeds to leapfrog the old.

Treaties and agreements that controlled missile proliferation by the US and USSR/Russia in the twentieth century have either collapsed or are no longer fit for purpose. The New START treaty needs to be renegotiated to include the new nuclear weapons that did not exist when the original treaty went into effect. This treaty could be the starting point for a more comprehensive agreement to include the other nuclear states. It is urgent, therefore, for states to find ways to reduce the immediate risk of war posed by rapidly advancing missile systems and to resume the search for ways to reverse the tide.

For some states, their strategic context suggests that missile reduction measures must accompany those aimed at missile control in agreements with the United States and Russia, whether undertaken bilaterally or trilaterally. For others, bilateral measures will suffice to meet strategic imperatives and in some instances such as the DPRK, unilateral missile disarmament may be the best available option, provided these are implemented as part of a comprehensive security solution with its adversaries and partners.