

CSIS

CENTER FOR STRATEGIC &
INTERNATIONAL STUDIES

BURKE CHAIR
IN STRATEGY

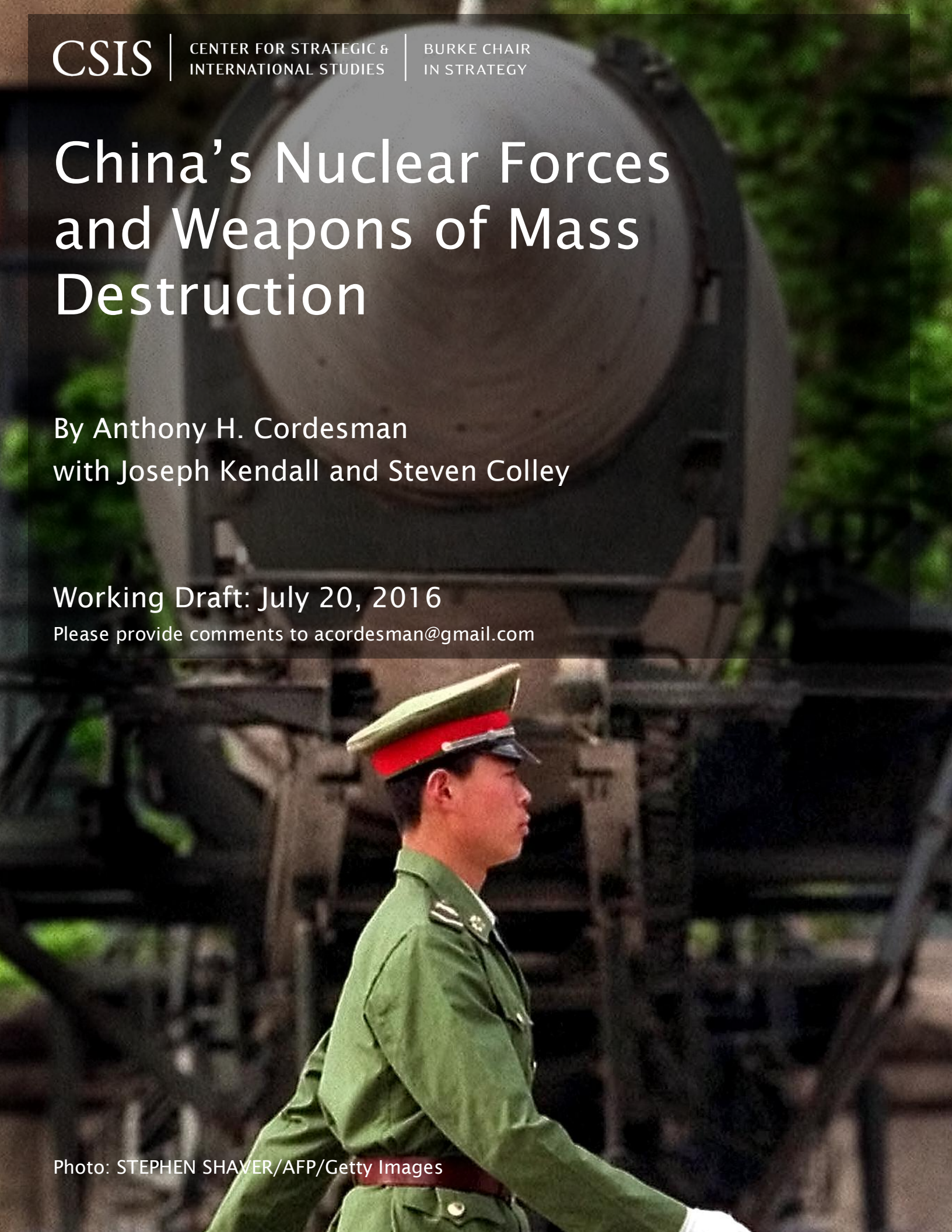
China's Nuclear Forces and Weapons of Mass Destruction

By Anthony H. Cordesman
with Joseph Kendall and Steven Colley

Working Draft: July 20, 2016

Please provide comments to acordesman@gmail.com

Photo: STEPHEN SHAVER/AFP/Getty Images



CHINA'S NUCLEAR FORCES AND WEAPONS OF MASS DESTRUCTION.....	3
CHINESE MILITARY NUCLEAR STRATEGY	3
<i>Change and Missile Defense</i>	<i>6</i>
<i>The Strategic Impact of China's Evolving Nuclear Forces</i>	<i>6</i>
<i>U.S. Assessments of Shifts in Chinese Strategy.....</i>	<i>7</i>
<i>The Impact of Multiple Independently-Targetable Re-entry Vehicles (MIRV)</i>	<i>9</i>
<i>The Possible Impact.....</i>	<i>10</i>
<i>of Chinese Tunnel Facilities.....</i>	<i>10</i>
Figure 1.1: China's Nuclear Tunnel Storage System.....	12
THE STRATEGIC NUCLEAR BALANCE	13
Figure 1.2: Chinese, U.S. and Russian Nuclear Forces- Part One.....	14
Figure 1.2: Chinese, U.S. and Russian Nuclear Forces – Part Two.....	15
Figure 1.2: Chinese, U.S. and Russian Nuclear Forces – Part Three.....	16
Figure 1.3: Comparative Estimate of Global Holdings of Nuclear Weapons.....	18
Figure 1.4: Nuclear Competition and Uncertainty	19
DETAILED ASSESSMENTS OF CHINA'S NUCLEAR FORCES.....	19
<i>The Nuclear Threat Initiative (NTI) Estimate.....</i>	<i>19</i>
<i>The Bulletin of the Atomic Scientists Estimate.....</i>	<i>22</i>
<i>The Global Security Estimate</i>	<i>26</i>
<i>The Union of Concerned Scientists (UCS) Estimate.....</i>	<i>29</i>
<i>The Federation of American Scientists (FAS) Estimate</i>	<i>31</i>
CHINA AND UNITED STATES NUCLEAR FORCES AND POLICIES	32
<i>The U.S. and Theater Nuclear Weapons</i>	<i>32</i>
<i>The U.S. Focus on Russia at a Time of Rising Chinese Capability.....</i>	<i>35</i>
CHINESE REACTIONS AND NORTH AND SOUTH KOREAN DEVELOPMENTS.....	37
<i>North Korean Developments from 2010 to 2013</i>	<i>37</i>
<i>The Impact of the 2013 North Korean Test</i>	<i>38</i>
<i>The Impact of DPRK, ROK, and U.S. Developments Through 2016</i>	<i>40</i>
<i>The Impact of Broader ROK Reactions</i>	<i>42</i>
<i>Chinese and Russian Reactions</i>	<i>44</i>
INDIA AND PAKISTAN	45
CHINESE REACTIONS TO RUSSIAN NUCLEAR DEVELOPMENTS	48
CHINESE BIOLOGICAL AND CHEMICAL WEAPONS PROGRAMS.....	50

CHINA'S NUCLEAR FORCES AND WEAPONS OF MASS DESTRUCTION

There is no way to assess the exact probability that China or the United States will ever make threats to use nuclear weapons in a regional conflict or escalate to their actual use, but the probability they would even make explicit threats seems extremely low. This does not mean, however, that the strength and capability of China's nuclear weapons will not play a steadily greater role in giving it strategic leverage and defining its role as a world power.

In the case of China and the United States, each side's nuclear weapons already have an important deterrent impact in restraining the other's behavior without overt threats, and continued nuclear modernization and the relative size of each side's force sends all the signals China or the U.S. needs as to the other side's power. Both nations must also take account of the fact that even openly raising the very possibility of an actual nuclear exchange would threaten the stability of Asia, the global economy, and the U.S. and Chinese economies in ways in which the end result could not be calculated.

As for actual nuclear war fighting, China and the United States have every reason to calculate that moving beyond the tacit threat already posed by the existence of the other's nuclear forces to actual nuclear exchanges at any level would almost certainly be so destructive and to be far costlier to both sides than any strategic or military gains could ever be worth.

At the same time, history is a grim warning that deterrence sometimes fails, and escalation occurs in ways that are never properly planned or controlled. Moreover, despite China's declared strategy of limited deterrence, China must look beyond the U.S. nuclear stance and to the fact that North Korea, Russia, India and Pakistan have nuclear weapons and the possibility that the ROK or Japan might eventually develop nuclear weapons.

China must also recognize that Russia and other powers will inevitably use China's nuclear forces as a key metric in judging its status. Regardless of the rhetoric of restraint that China uses in discussing nuclear weapons, they remain important tools in shaping its influence and perceptions of its power through out the world.

Chinese Military Nuclear Strategy

China has long been cautious is openly discussing nuclear weapons, and its statements have evolved as it has emerged as major global power. In the period before China has nuclear weapons, Mao derided them as "paper tigers," and China never emphasized their importance while Mao was alive and its forces were limited and weak.¹

Since the Mao era, Chinese official documents have so far treated nuclear weapons as important but ultimately of limited use. This philosophy is reflected in Chinese military doctrine – *The Science of Military Strategy* (2013 edition) – and the force structure changes in the SAF. Conventional missiles make up the bulk of China's ballistic missile forces and have grown dramatically faster than China's nuclear forces.

Nevertheless, China's nuclear weapons play a key role in shaping its overall military capabilities and strategy. China is in a heavily nuclearized part of the world, with three neighboring countries

that have nuclear arsenals that number thousands of warheads. Deterring nuclear attack and coercion under threat of nuclear attack may still be the primary goal of China's nuclear forces, but China's steadily improving strategic nuclear delivery capabilities, and ability to use nuclear weapons on a theater basis speaks for itself. Other nations react at least as much to China's actual nuclear warfighting capability as to what it says about its nuclear forces.

China has also continued to modernize its nuclear forces while only providing limited transparency as to their size and modernization. As a result, the potential differences between the way China is characterizing the trends in its nuclear forces and the doctrine they will operate under, and their actual current and future size and capability has been the subject of growing discussion.

Some sources characterize China's nuclear forces as small and operating under the concept of minimum deterrence, similar to France and Great Britain. A report by the Union of Concerned Scientists issued in 2015, analyzed the 2013 edition of *The Science of Military Strategy* regarding China's guidance on the limited role of nuclear weapons in its military strategy and stating that:²

Their sole purpose is to deter other nuclear-armed states from using or threatening to use nuclear weapons against China. In the words of the authors [of *The Science of Military Strategy*]:

As it has been for a long time, the objective of China's development and utilization of nuclear weapons is concentrated on preventing enemy nations from using or threatening to use nuclear weapons against us.

According to the report by the Union of Concerned Scientists, Chinese strategy continues to reaffirm China's "no first use" (NFU) policy regarding the employment of their nuclear weapons by specifically stating, that:³

1. China will not use nuclear weapons to attack or threaten non-nuclear states;
2. China will not use nuclear weapons to respond to conventional attacks; and
3. China will use nuclear weapons only after it has confirmed an incoming nuclear attack.

The report continues to explain the three aspects of Chinese nuclear deterrence policy by citing *The Science of Military Strategy*:⁴

The directed nature of the target of deterrence. From the first day China possessed nuclear weapons it openly declared and committed not to use nuclear weapons, or threaten to use nuclear weapons, against non-nuclear weapons states or regions. This restricted the use of our country's nuclear weapons, and the target of nuclear deterrence, to nuclear-armed states. China's nuclear deterrent is only directed at nuclear weapons states; it is only in effect against nuclear-armed states.

The limited objective of deterrence. China's nuclear deterrent will not be used to deter nonnuclear hostile military activity and its effect in other non-nuclear military also is not evident. Strictly limiting the scope of the effect of nuclear deterrence to the hostile nuclear activities of nuclear-armed states makes the objective and the scope of the effect of China's nuclear deterrent progressively more focused

The defensive nature of the method of deterrence. China upholds a policy of no first use of nuclear weapons, only using nuclear weapons in self-defense after an enemy country uses nuclear weapons against us. Chinese nuclear deterrence is built on the foundation of effective retaliation, and through the actual strength as well as the possibility of creating for the enemy unbearable nuclear destruction, accomplishes the objective of preventing an enemy nuclear attack. This is defensive nuclear deterrence.

According to this assessment, "assured retaliation" and "uncertainty" both help describe Chinese thinking about nuclear strategy. Assured retaliation states that China can be certain that a significant portion of their nuclear forces will survive a nuclear first strike in order to launch a

second-strike. This second-strike only has to be large enough to inflict a degree of damage that the enemy sees as unacceptable.⁵

The concept of uncertainty helps achieve the “assured” portion of the assured retaliation doctrine. Uncertainty in this context points to an enemy not confident in its ability to significantly damage or destroy China's nuclear arsenal. Not disclosing the size of the nuclear arsenal, mobility, hardening, and tunneling, all contribute to uncertainty.⁶

According to the Union of Concerned Scientists report, Chinese strategy states:⁷

On the question of nuclear deterrence, maintaining an appropriate degree of ambiguity, allowing opponents to guess about China's nuclear capability, the scale and timing of a Chinese nuclear retaliatory attack, etc. increases the degree of difficulty for the opponent's policy, helping raise the effective deterrent function of China's limited nuclear force.

However, the report also notes that the Chinese have talked about trying to limit retaliation if deterrence fails, in part because they do not feel that their nuclear forces are yet secure or capable enough to target enemy military forces in a way that would give them a significant military advantage. According to unclassified sources, Chinese nuclear forces remain limited. Jin-class SSBNs are new and are presumably still somewhat noisy and detectable. Land based missiles are detached from warheads when in storage, and missile units signal their deployment by the use of a large group of ground vehicles and helicopters when on the move.⁸

This helps explain why the Union of Concerned Scientists report indicates that the *The Science of Military Strategy* provides the following guidelines regarding its limited retaliatory nuclear attack:⁹

1. A Chinese retaliatory nuclear attack will be limited. An unstated number of China's surviving nuclear capabilities must be held in reserve for additional acts of retaliation;
2. A Chinese retaliatory nuclear attack will target enemy cities, not enemy military capabilities;
3. The objective of a Chinese retaliatory nuclear attack is to cause the enemy to cease future nuclear attacks against China.

Targeting cities (countervalue) and not military targets (counterforce) reduces the requirements for effective targeting and retaliation against the enemy's military capabilities and the Chinese believe that attacking cities would cause a large loss of life and break the will of the enemy. *The Science of Military Strategy* explains this concept as follows:¹⁰

There are in principle two targets for a nuclear attack, military targets and urban targets. Politically, attacking military targets is comparatively more acceptable. Militarily it enables gaining the initiative, which is beneficial to controlling the war situation. But it requires comparatively high requirements for the number, precision, and destructive function of nuclear weapons.

In order to effectively destroy an opponent's nuclear forces a preemptive nuclear attack is generally required. This is the choice commonly pursued by large nuclear countries with aggressive nuclear strategies. Targeting cities can cause great damage to an enemy society and a large loss of life, which creates the effect of strong shock while having comparatively lower requirements for the scale of the force of a nuclear attack, the capabilities of nuclear weapons, the timing of a nuclear attack, etc.

There are experts, however, who feel that China may actually have more nuclear weapons than unclassified sources report, and place more emphasis on the possible use of such weapons in theater and tactical situations. It is also unclear that the restraint China shows while it is still an emerging power and faces massive U.S. (and Russian) strategic nuclear superiority, will continue

once it fully emerges as a major global power. Some aspects of China's current nuclear modernization indicate that it may already be placing more emphasis on nuclear forces.

Change and Missile Defense

Chinese nuclear forces and strategy are changing. One reason has been that global advances in ballistic missile defense (BMD) have raised concerns in China that they may threaten assured retaliation and uncertainty. As BMD systems become increasingly effective, assured retaliation will depend not only on nuclear weapons surviving a first-strike but also on the ability of warheads to penetrate missile defenses and reaching their targets. Likewise, Chinese nuclear weapons must develop in a way such that an enemy cannot be certain that its missile defenses can minimize damage to an acceptable level or destroy all oncoming warheads.

Although strategic and theater ballistic missile defense systems are still under development, and can be saturated and overwhelmed in their current form, Chinese strategists have been forming their analyses based on a worst-case scenario where BMD systems are very effective. Even though some U.S. BMD systems have been curtailed or even scrapped, Chinese analysts tend to believe that the American missile defense project never truly ends.¹¹ Consequently, the need to consider the effects of BMD systems in shaping Chinese nuclear strategy has become a fixture in Chinese nuclear strategy.

The perceived threats to Chinese nuclear strategy by programs like national missile defense (NMD) and prompt global strike (PGS) have also led to debates within China about whether or not to add caveats to the NFU policy or even scrap it altogether. Western analysts began debating the status of China's NFU policy especially after Phillip Karber released his report on the extensive tunnel systems that the SAF uses to store, hide, and protect its nuclear weapons.¹² Chinese officials have grudgingly admitted that such debates have taken place, but have decided that it was in China's best interest to maintain the NFU.¹³

At the same time, China is concerned about the deployment of theater missile defense systems in Japan, and the potential deployment of theater missile defense systems in South Korea. China's stated rationale is similar to Russia's in claiming that such systems might potentially be used against its strategic missile forces and upset the balance of mutual assured destruction – either by destroying strategic nuclear missiles or by improving warning.

Like Russia, however, China's scientists and military experts are fully aware of the acute limits on the ability of any theater missile defense system to intercept a strategic nuclear missile because of its location, vector, apogee and reentry velocity. It is also aware of the fact that U.S. satellite systems can warn of the launch and vector of Chinese strategic missiles, and actual battle management of a strategic missile defense system will rely on radars nearer to, or in U.S. territory. In practice, such Chinese objections to theater missile defense systems again seem to be based more on the same criteria as Russia's. Any theater missile defense does limit Chinese ability to use its missiles in theater attacks (as well as limit North Korea's), and the strategic leverage such missile forces give to China.

The Strategic Impact of China's Evolving Nuclear Forces

More broadly, many other factors drive the changes in China's nuclear forces. China is one of the five nuclear weapons states acknowledged in the Nuclear Non-Proliferation Treaty (NPT). China's first nuclear test occurred in 1964. Since then, China has conducted 45 nuclear tests, including thermonuclear weapons and a neutron bomb.¹⁴ It has also become a party to the

Comprehensive Test Ban Treaty, the Biological and Toxin Weapons Convention, and the Chemical Weapons Convention.

Despite the omission of no-first-use policy in the 2013 Defense White Paper—leading to some international consternation—China has long maintained a no-first-use policy.

China's 2008 Defense White Paper stated that:¹⁵

The Second Artillery Force is a strategic force under the direct command and control of the CMC, and the core force of China for strategic deterrence. It is mainly responsible for deterring other countries from using nuclear weapons against China, and for conducting nuclear counterattacks and precision strikes with conventional missiles.

The Second Artillery Force sticks to China's policy of no first use of nuclear weapons, implements a self-defensive nuclear strategy, strictly follows the orders of the CMC, and takes it as its fundamental mission the protection of China from any nuclear attack. In peacetime the nuclear missile weapons of the Second Artillery Force are not aimed at any country. But if China comes under a nuclear threat, the nuclear missile force of the Second Artillery Force will go into a state of alert, and get ready for a nuclear counterattack to deter the enemy from using nuclear weapons against China.

If China comes under a nuclear attack, the nuclear missile force of the Second Artillery Force will use nuclear missiles to launch a resolute counterattack against the enemy either independently or together with the nuclear forces of other services. The conventional missile force of the Second Artillery Force is charged mainly with the task of conducting medium- and long-range precision strikes against key strategic and operational targets of the enemy.

Similarly, China's 2010 White Paper argued that:¹⁶

China has never evaded its obligations in nuclear disarmament and pursues an open, transparent and responsible nuclear policy. It has adhered to the policy of no-first-use of nuclear weapons at any time and in any circumstances, and made the unequivocal commitment that under no circumstances will it use or threaten to use nuclear weapons against non-nuclear-weapon states or nuclear-weapon-free zones. China has never deployed nuclear weapons in foreign territory and has always exercised the utmost restraint in the development of nuclear weapons, and has never participated in any form of nuclear arms race, nor will it ever do so. It will limit its nuclear capabilities to the minimum level required for national security

China reiterated this position in *China Military Strategy* in 2015:¹⁷

The nuclear force is a strategic cornerstone for safeguarding national sovereignty and security. China has always pursued the policy of no first use of nuclear weapons and adhered to a self-defensive nuclear strategy that is defensive in nature. China will unconditionally not use or threaten to use nuclear weapons against non-nuclear-weapon states or in nuclear-weapon-free zones, and will never enter into a nuclear arms race with any other country. China has always kept its nuclear capabilities at the minimum level required for maintaining its national security. China will optimize its nuclear force structure, improve strategic early warning, command and control, missile penetration, rapid reaction, and survivability and protection, and deter other countries from using or threatening to use nuclear weapons against China.

U.S. Assessments of Shifts in Chinese Strategy

China's 2013 and 2015 Defense White Papers did not address the changes in China's nuclear forces and strategy in detail. China is, however, in the process of a major modernization of its nuclear-armed missile forces and is developing a "stealth" strike aircraft – the J-20 and J-31. It is also adopting multiple independently targetable re-entry vehicle (MIRV) warheads for its strategic missiles. MIRV systems are ballistic missiles with a payload containing several warheads, each capable of being aimed to hit one of a group of targets. By contrast, China's present missiles have a unitary warhead—a single warhead on a single missile. China seems to have bypassed intermediate improvements like multiple re-entry vehicle (MRV) missiles which

carries several warheads which are dispersed but are all aimed at the same target or maneuverable re-entry vehicle (MaRV) missiles which allows warhead movement to be adjusted midflight. Only China, the United States, Russia, and France, are known to have developed MIRV missiles.

The U.S. DoD report on Chinese military power for 2016 provided the following analysis of how these developments interact with China's no first use policy.¹⁸

China's nuclear weapons policy prioritizes maintaining a nuclear force able to survive an attack and to respond with sufficient strength to inflict unacceptable damage on an enemy. China insists the new generation of mobile missiles, with warheads consisting of multiple independently targeted reentry vehicles (MIRVs) and penetration aids, are intended to ensure the viability of China's strategic deterrent in the face of continued advances in U.S. and, to a lesser extent, Russian strategic ISR, precision strike, and missile defense capabilities. Similarly, India's nuclear force an additional driver behind China's nuclear force modernization. The PLA has deployed new command, control, and communications capabilities to its nuclear forces to improve control of multiple units in the field. Through the use of improved communications links, ICBM units now have better access to battlefield information and uninterrupted communications connecting all command echelons. Unit commanders are able to issue orders to multiple subordinates at once, instead of serially, via voice commands.

China has long maintained a "no first use" (NFU) policy, stating it would use nuclear forces only in response to a nuclear strike against China. China's NFU pledge consists of two stated commitments: China will never use nuclear weapons first and China will never use or threaten to use nuclear weapons against any non-nuclear-weapon state or in nuclear-weapon-free zones. There is some ambiguity over the conditions under which China's NFU policy would apply. Some PLA officers have written publicly of the need to spell out conditions under which China might need to use nuclear weapons first; for example, if an enemy's conventional attack threatened the survival of China's nuclear force or of the regime itself. However, there has been no indication that national leaders are willing to attach such nuances and caveats to China's NFU doctrine.

China will probably continue to invest considerable resources to maintain a limited, but survivable, nuclear force to ensure that the PLA can deliver a damaging responsive nuclear strike. Recent press accounts suggest China may be enhancing peacetime readiness levels for these nuclear forces to ensure responsiveness.

The 2016 DoD report described the current status of Chinese developments of land-based and sea-based platforms, as well as future efforts, as follows:¹⁹

Land-Based Platforms. China's nuclear arsenal currently consists of approximately 75-100 ICBMs, including the silo-based CSS-4 Mod 2 (DF-5A) and Mod 3(DF-5B); the solid-fueled, road-mobile CSS-10 Mod 1 and Mod 2 (DF-31 and DF-31A); and the more-limited-range CSS-3 (DF-4). This force is complemented by road-mobile, solid-fueled CSS-5 Mod 6 (DF-21) MRBM for regional deterrence missions.

Sea-based Platforms. China continues to produce the JIN-class nuclear-powered ballistic missile submarine (SSBN), with four commissioned and another under construction. The JIN will eventually carry the CSS-NX-14 (JL-2) SLBM with an estimated range of 7,200 km. Together these will give the PLAN its first credible long-range sea-based nuclear capability. JIN SSBNs based at Hainan Island in the South China Sea would then be able to conduct nuclear deterrence patrols.

Future Efforts. China is working on a range of technologies to attempt to counter U.S. and other countries' ballistic missile defense systems, including maneuverable reentry vehicles (MaRVs), MIRVs, decoys, chaff, jamming, and thermal shielding. China has acknowledged that it tested launched a hypersonic glide vehicle in 2014. China's official media also cited numerous training exercises featuring maneuver, camouflage, and launch operations under simulated combat conditions, which are intended to increase survivability. Together with the increased mobility and survivability of the new generation of missiles, these technologies and training enhancements strengthen China's nuclear force and bolster its strategic strike capabilities. Further increases in the number of mobile ICBMs and the beginning of SSBN deterrence

patrols will force the PLA to implement more sophisticated C2 systems and processes that safeguard the integrity of nuclear release authority for a larger, more dispersed force.

The Impact of Multiple Independently-Targetable Re-entry Vehicles (MIRV)

China was slow to miniaturize warheads and to begin 'MIRVing,' although it long had the technology to develop such a capability. According to one report, the CIA predicted that the DF-5 MIRV payload could consist of three warheads developed for the DF-31 more than a decade ago.²⁰

The attempt of the *New York Times* to explain China's decision is as follows, "a succession of Chinese leaders deliberately let it [MIRV technology] sit unused; they were not interested in getting into the kind of arms race that characterized the Cold War nuclear competition between the United States and the Soviet Union"²¹.

This situation changed in the late 1990s. In 1999, a U.S. National Intelligence Estimate (NIE) concluded that China had the capability to develop multiple re-entry vehicles (MRV) and that MIRV technology, capable of "maneuvering to several different release points to provide targeting flexibility" was several years away.²²

Actual deployment took several years as China began upgrading its DF-5s into MIRVs. The DoD's 2015 report to Congress²³ marked the first acknowledgment of China's MIRV capability. The 2016 DoD report further stated that,²⁴

The PLARF continued to modernize its nuclear forces by enhancing its silo-based intercontinental ballistic missiles (ICBM) and adding more survivable, mobile delivery systems. China's ICBM arsenal to date consists of approximately 75-100 ICBMs, including the silo-based CSS-4 Mod 2 (DF-5) and multiple independently-targetable reentry vehicle (MIRV)-equipped Mod 3 (DF-5B); the solid-fueled, road-mobile CSS-10 Mod 1 and 2 (DF-31 and DF-31A); and the shorter range CSS-3 (DF-4). The CSS-10 Mod 2, with a range in excess of 11,200 km, can reach most locations within the continental United States. China also is developing a new road-mobile ICBM, the CSS-X-20 (DF-41) capable of carrying MIRVs.

According to the Bulletin of the Atomic Scientists:²⁵

Some of the DF-5As have been upgraded to carry multiple independently targetable reentry vehicles (MIRVs). The MIRVed version is known as DF-5B (CSS-4 Mod 3) (U.S. Defense Department 2015, 8). China had the ability to deploy multiple warheads on the DF-5 (and later the DF-5A) for decades but did not; it appears to have started doing so in response to the U.S. deployment of a ballistic-missile defense system. We estimate that China has a total of approximately 20 DF-5s of both versions, of which perhaps half have been equipped with MIRVs.

Seen through the lens of traditional Western nuclear strategy and deterrence theory, China has a unique rationale for MIRVing. When the United States and Soviet Union became the first countries to develop MIRVs in the 1960s, it was partly in reaction to the development of missile defense technology. More significantly Soviet and American deployment of MIRVs, and the major improvement in missile accuracy and reliability of MIRV missiles gave Moscow and Washington the ability to change strategy from a reliance on countervalue targets (cities and large military area targets) to counterforce targets (the other side's nuclear forces and small, critical military targets).

As previously noted, China still states that it remains committed to the equivalent of countervalue targeting, and China still lacks the substantial number of warheads necessary to

deploy a viable counterforce targeting strategy. However, declaring a public strategy based on current capabilities is not a reliable indicator of future intentions and capabilities.

Jeffrey G. Lewis states in *The Lure and Pitfalls of MIRVs*:²⁶

For decades, Chinese leaders have sought to match the technical achievements of other nuclear powers, without necessarily replicating the number of weapons or adopting foreign doctrines. One Chinese official has characterized this behavior as the pursuit of the “minimum means of reprisal” — a concept that Western academics have come to describe as “assured retaliation.” One element of this approach is that Chinese decisionmakers have tended to emphasize China’s possession of the same technologies as other powers.

The credibility of China’s deterrent depends at least in part on the perception that it is modern. From the 1950s, China has sought to develop thermonuclear weapons that could arm ICBMs rather than, say, a regional force of theater nuclear weapons. Chinese leaders have viewed deterrence as arising more from the possession of equivalent nuclear capabilities than from the numerical calculations of exchange ratios and windows of vulnerability that have dominated Western discourse. Chinese experts, to be sure, are aware of the possibilities created by new technologies, but at least until the present, Chinese decisions about modernizing the country’s nuclear forces have followed a technological trajectory marked by milestones rather than a strategic trajectory marked by requirements.

This means that China could embrace many technologies associated with counterforce targeting while not necessarily embracing that strategy or the exacting requirements to implement them.

The Possible Impact of Chinese Tunnel Facilities

There also are debates over the size of China’s nuclear stockpile and nuclear-armed missile forces. One such debate focuses on the fact the PLA has been building underground tunnels to protect and conceal key military assets since the early 1950s. According to some sources, the total length of China’s network of underground tunnels could stretch for over 5,000 km.²⁷

Experts like Phillip Karber have noted the value of these tunnels for both missile deployments and their potential ability to stockpile much larger numbers of nuclear weapons than are normally estimated to be in China’s forces.²⁸ **Figure 1.1** shows a *Washington Post* image, the assessment made by Phillip Karber about China’s tunnel system and its potential ability to hide China’s nuclear capabilities.

While U.S. DoD reports have seen the tunnel network as a defensive asset, the 2015 DoD report did highlight the level of uncertainty caused by China’s lack of transparency, and acknowledged the role PLA underground facilities can play in denial and deception.²⁹

China maintains a technologically advanced underground facility (UGF) program protecting all aspects of its military forces, including command and control, logistics, and missile and naval forces. Given China’s no first use (NFU) nuclear policy, China has assumed it might have to absorb an initial nuclear blow while ensuring leadership and strategic assets survive and can respond.

China determined it needed to update and expand its military UGF program in the mid- to late-1980s. This modernization effort took on a renewed urgency following China’s observation of U.S. and coalition air operations during the 1991 Gulf War and their use in the 1999 NATO ALLIED FORCE. A new emphasis on “winning high tech battles” in the future precipitated research into advanced tunneling and construction methods. These military campaigns convinced China it needed to build more survivable, deeply buried facilities, resulting in the widespread UGF construction effort we have detected throughout China for the last decade.

Denial and Deception

In historical and contemporary PLA texts, Chinese military theorists routinely emphasize the importance of secrecy and deception for both the protection of personnel and infrastructure and the concealment of

sensitive military activities. In 2012 and 2013, the Chinese press featured the PLA using a variety of denial and deception (D&D) methods, including camouflage, decoys, and satellite avoidance activities during training events to protect PRC forces from enemy surveillance and targeting. Key D&D principles identified in official PLA monographs include:

- Conforming to what the enemy expects and creating false images that correspond to the target's psychological tendencies and expectations;
- Detailed pre-planning, centralized control, and operational integration to ensure strategic coherence at the political, diplomatic, and economic levels;
- Extensive, current, and sophisticated understanding of enemy psychology, predisposition, capabilities (particularly C4ISR), intentions, and location; and
- Operational flexibility, rapid response, and the ability and willingness to employ new D&D techniques and devices.

Contemporary PLA writings also indicate the Chinese view D&D as a critical enabler of psychological shock and force multiplication effects during a surprise attack, allowing the PLA to offset the advantages of a technologically superior enemy and to reinforce its military superiority against weaker opponents.

Lieutenant General Michael Flynn, former Director of the DIA, also noted the importance of tunnel facilities in protecting nuclear assets and improving denial and deception tactics:³⁰

The use of underground facilities (UGFs) to conceal and protect critical military and other assets and functions is widespread and expanding. UGFs conceal and increase the survivability of weapons of mass destruction, strategic command and control, leadership protection and relocation, military research and development, military production and strategic military assets.

A significant trend of concern is the basing of ballistic and cruise missiles and other systems designed for anti-access/area denial weapons directly within UGFs. In addition, Russia, China, Iran, and North Korea operate national-level military denial and deception programs. These four states are devoting increased resources, and particular attention, to improving the denial and deception tactics, techniques, and procedures, for their road-mobile missile and cruise missile forces.

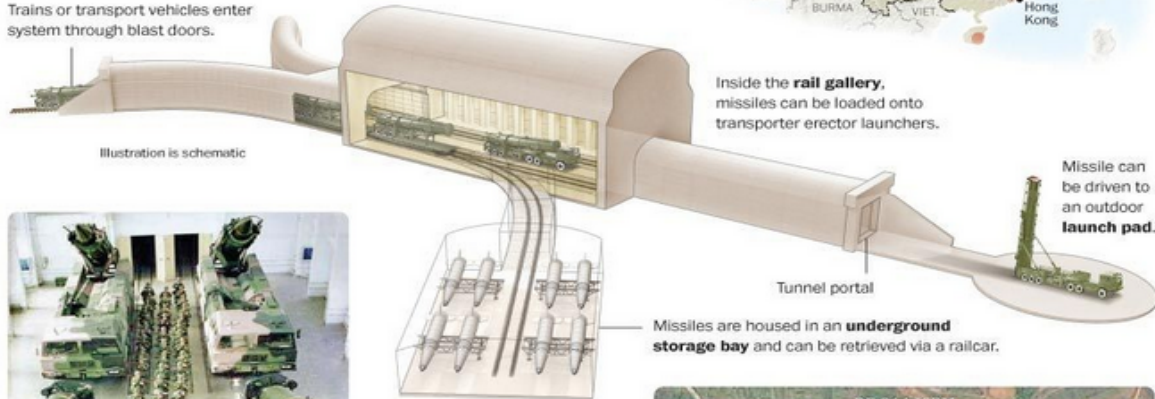
Figure 1.1: China's Nuclear Tunnel Storage System

The military branch in charge of China's nuclear arsenal has acknowledged building a network of tunnels more than 3,000 miles long. For the past three years, a team of Georgetown University students has studied those tunnels, led by their professor, a former senior Pentagon strategist. Using translated documents, satellite imagery and online video reports, the students and their professor concluded that China could have many more nuclear weapons than previously assumed hidden in those tunnels.

MOBILIZING A MISSILE IN THE CHINESE TUNNEL SYSTEM

Each network of tunnels leads out to multiple, redundant portal openings in case of attack, in which an enemy may try to block missiles from getting out to launch.

Trains or transport vehicles enter system through blast doors.



UNCONVENTIONAL RESEARCH
The students based their findings on not only traditional sources, such as major books, journals and strategy manuals, but also on nontraditional sources, including the mapping software Google Earth, Chinese television coverage (right) and military Web sites and blogs (left).



THE WORLD'S NUCLEAR STOCKPILES, 2011

While some countries share numbers about their nuclear arsenals, China has maintained strict secrecy. In past years, government and independent studies have estimated the number of China's nuclear warheads at anywhere from 80 to 400. The Georgetown study argues that a much greater number may be hidden in China's tunnels.



As few as 75 ICBMs

*The Natural Resources Defense Council estimated in 2002 that China had 400 warheads. The Federation of American Scientists, one of the most widely sourced agencies for nuclear warhead counts, estimated in 2011 that China had 240 nuclear missiles.

Source: "Evidence of China's Nuclear Storage System," *Washington Post*, November 29, 2011, https://www.washingtonpost.com/world/national-security/evidence-of-chinas-nuclear-storage-system/2011/11/29/gIQAR2GUAO_graphic.html.

The Strategic Nuclear Balance

These uncertainties in Chinese forces also affect estimates of the nuclear balance. Unclassified estimates of the present structure of U.S., Chinese, and other outside nuclear forces are shown in the following figures:

- **Figure 1.2** compares the overall strength of U.S. and major Northeast Asian nuclear powers.
- **Figure 1.3** provides an estimate of the global holdings of nuclear weapons between the latest assessments made by the Federation of American Scientists in 2015 and Center for Arms Control and Non-Proliferation in 2013.
- **Figure 1.4** draws from various reports compiled by Henry Sokolski of George Mason University which shows the number of operationally deployed warheads by the world nuclear powers and the trends extending to 2021.

These nuclear balances include Russia, and it is important to note that most U.S. official policy and estimates of the nuclear balance and arms control still focus on Russia, North Korea, and Iran in the aftermath of Joint Comprehensive Plan of Action (JCPOA) – not on China. The forces on each side are also anything but static. The U.S. is simultaneously pursuing a reduction in nuclear forces while planning for a substantial nuclear modernization program. China is increasing its forces and their capabilities, although there is little credible unclassified data on Chinese plans and activities.

It is also unclear how much weapons numbers shown in these figures will actually affect future contingencies unless events forced both sides into a major nuclear engagement. The fact the U.S. will have much larger weapons numbers for the foreseeable future might mean the U.S. could theoretically “win” in terms of inflicting the most strikes and damage, but such a victory would be as pyrrhic a “victory” as a feared Cold War-era exchange between the U.S. and Russia.

Nevertheless, it is clear that the U.S. and China are major nuclear powers with boosted and thermonuclear weapons and advanced missile delivery capabilities. While neither is likely to use these weapons, they have the capability and – at a minimum – their possession of nuclear weapons plays a major role in the balance of deterrence and in shaping the risks of asymmetric escalation.

As noted earlier, North Korea's growing missile forces and nuclear programs, create an unstable wild card that might trigger U.S. threats to use nuclear weapons or even the development of a nuclear weapons capability by Japan and South Korea, leading to further regional nuclear instability. North Korea now, at most, has very limited numbers of nuclear weapons and no nuclear armed missiles; but if North Korea can create larger and more effective nuclear weapons, both China and the U.S. would confront the risk of North Korean use of such weapons – or even a serious threat to use such weapons – which could force the U.S. to respond and ultimately confront China with a nuclear crisis on its borders.

*Figure 1.2: Chinese, U.S. and Russian Nuclear Forces- Part One***CHINA**

Quantity	Role/Type
Strategic Missiles (figures are estimates)	
ICBM	
8	DF-31 (CSS-10 Mod 1)
24	DF-31A (CSS-10 Mod 2)
10	DF-4 (CSS-3)
10	DF-5A (CSS-4 Mod 2)
10	DF-5B (CSS-4 Mod 3)
MRBM	
80	DF-21/21A (CSS-5 Mod 1/2)
36	DF21C (CSS-5 Mod 3)
18	DF-21D (CSS-5 Mod 5 – ASBM)
12	DF-16 (CSS-11 Mod 1)
IRBM	
6	DF-3A (CSS-2 Mod)
SRBM	
108	DF-11A/M-11A (CSS-7 Mod 2)
81	DF-15B (CSS-6 Mod 3)
LACM	
54	CJ-10 (DH-10)
Navy	
1	Xia <i>With 12 JL-1(CSS-N-3) strategic SLBM</i>
4	Jin <i>With up to 12 JL-2 (CSS-NX-4) strategic SLBM</i>

Figure 1.2: Chinese, U.S. and Russian Nuclear Forces – Part Two
UNITED STATES

Quantity	Role/Type
Navy	
14	Ohio SSBN 730 <i>Each with up to 24 UGM-133A Trident D-5 strategic SLBM</i>
Air Force	
5	SQN with 71 B-52H Stratofortress <i>Each with up to 20 AGM-86B nuclear ALCM</i>
2	SQN with 19 B-2A Spirit <i>Each with up to 16 free-fall bombs</i>
9	SQN with 450 LGM-30G Minuteman III <i>Each with a capacity of 1-3 MIRV Mk12/Mk12A per missile</i>

Source: Based primarily on material in IISS, *The Military Balance 2016* and IHS 2016. Figures do not include equipment used for training purposes. Some equipment and personnel figures are estimates. All equipment figures represent equipment in active service. Adapted by Anthony H. Cordesman and Joseph Kendall at the Center for Strategic and International Studies.

Figure 1.2: Chinese, U.S. and Russian Nuclear Forces – Part Three**RUSSIA**

Quantity	Role/Type
Navy	
3	Kalmar (Delta III) <i>Each with 16 RSM-50 (SS-N-18 Stingray) strategic SLBM</i>
6	Delfin (Delta IV) <i>Each with 16 R-29RMU Sineva (SS-N-23Skiff) strategic SLBM (1 vessel in repair, 2014 expected return to service)</i>
1	Akula (Typhoon) <i>Each with 20 RSM-52 Sturgeon strategic SLBM</i>
3	Borey <i>Each with 16 Bulava (SS-N-X-32) SLBM (missiles not yet operational), (1 additional units completed sea trials with notional ISD 2014; 2 further units in build)</i>
Strategic Rocket Force Armies	
3	Strategic Rocket Forces is a separate branch of the Russian Armed Forces, directly subordinate to the General Staff. Strategic Rocket Forces include three missile armies: the 27th Guards Missile Army (HQ in Vladimir), the 31st Missile Army (Orenburg), the 33rd Guards Missile Army (Omsk). The 53rd Missile Army (Chita) was disbanded in 2002. It appears that the 31st Missile Army (Orenburg) will be liquidated by 2016. As of 2015, the missile armies included 11 missile divisions.* As of January 2015, the Strategic Rocket Forces were estimated to have 305 operational missile systems of five different types. Intercontinental ballistic missiles of these systems could carry 1166 warheads.*†
Strategic Missiles	
54	RS-20 (SS-18) Satan (mostly mod 5, 10 MIRV per msl)
108	RS-12M (SS-25) Sickle
30	RS-18 (SS-19) Stiletto (mostly mod 3, 6 MIRV per msl)
60	RS-12M2 Topol-M (SS-27M1), silo based
18	RS-12M2 Topol-M (SS-27M1), road mobile
58	RS-24 Yars (SS-27M2; estimated 3 MIRV per msl, 4 are silo-based)

Long-Range Aviation Command

1	Sqn Tu-160 Blackjack <i>16 Tu-160 each with up to 12 Kh-55SM (AS-15A/B Kent) nuclear ALCM</i>
3	Sqn Tu-95MS Bear <i>31 Tu-95MS6 (Bear H-6) each with up to 6 Kh-55 (AS-15A/B Kent) nuclear ALCM 31 Tu-95MS16 (Bear H-16) each with up to 16 Kh-55 nuclear ALCM; (Kh-102 likely now in service on Tu-95MS</i>

* Based on "Strategic Nuclear Forces" section of Russian Forces Project, <http://russianforces.org/missiles/>.

†Based on *The Military Balance 2016*, from IISS, the Strategic Rocket Force Troops have 378 strategic missiles and are divided into 3 armies, further divided into 12 divisions. Launcher groups normally have 10 silos (6 for RS-20/SS-18), or 9 mobile launchers, and one control center.

Source: Based primarily on material in IISS, *The Military Balance 2016*. Figures do not include equipment used for training purposes. Some equipment and personnel figures are estimates. All equipment figures represent equipment in active service. Adapted by Anthony H. Cordesman and Joseph Kendall at the Center for Strategic and International Studies.

Figure 1.3: Comparative Estimate of Global Holdings of Nuclear Weapons

Country	Russia		U.S.		China		DPRK	
	FAS ³¹ 2016	CAC ³² 2013	FAS 2016	CAC 2013	FAS 2016	CAC 2013	FAS 2016	CAC 2013
Operational: Strategic	1,790	1,740	1,750	1,950	0	n/a	0	n/a
Operational: Non-strategic	0	0	180	200	?	n/a	n/a	n/a
Non-deployed/ Reserve	2,700	2,700 (+ 4,000 awaiting dismantlement)	2,570	2,650 (+ 3,000 awaiting dismantlement)	260	240- 300	<10	<10
Total Inventory	7,300	8,500	7,000	7,700	260	300	<10	<10
Growth Trend	Decreasing		Decreasing		Growing		Growing	

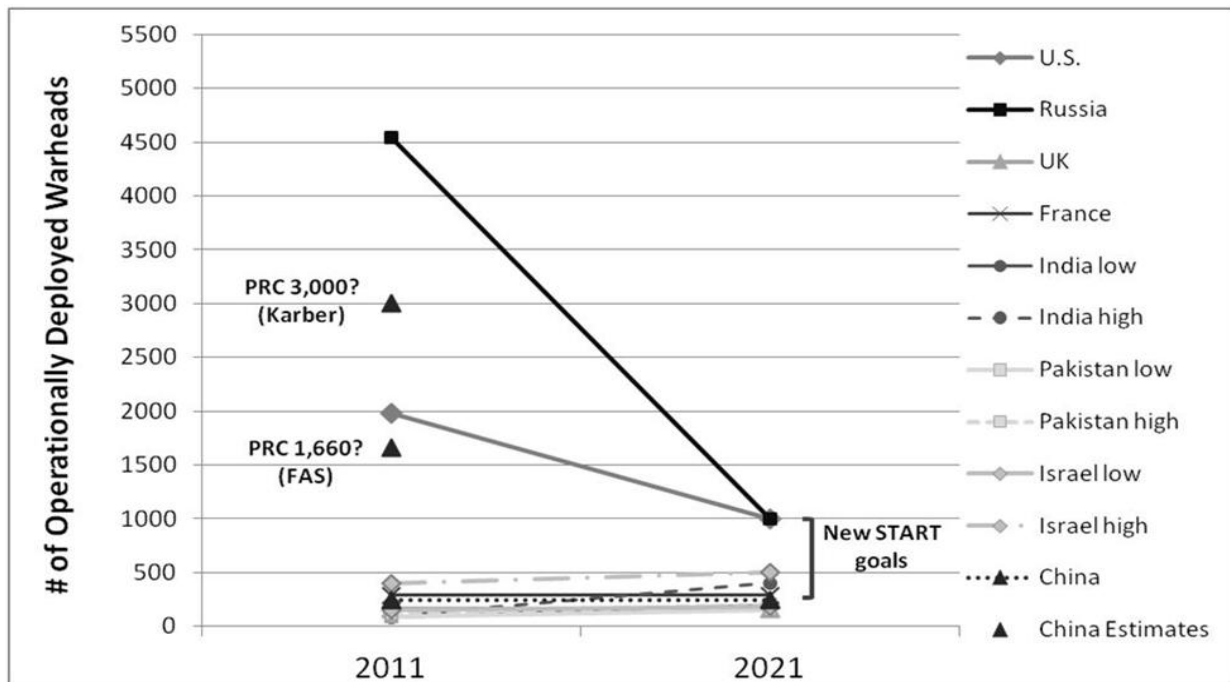
Country	UK		Israel		Pakistan		India		France	
	FAS 2016	CAC 2013	FAS 2016	CAC 2013	FAS 2016	CAC 2013	FAS 2016	CAC 2013	FAS 2016	CAC 2013
Operational: Strategic	120	<160	0	n/a	0	n/a	0	n/a	280	<300
Operational: Non-strategic	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	50
Non-deployed/ Reserve	95	65	80	80	110- 130	90-110	100- 120	80- 100	10	n/a
Total Inventory	215	225	80	80 (200)	110- 130	90-110	100- 120	80- 100	300	298- 300
Growth Trend	Decreasing		Steady		Growing		Growing		Steady	

Note: FAS – Federation of American Scientists; CAC – Center for Arms Control and Non-Proliferation

Source: FAS, Status of World Nuclear forces, May 26, 2016, <https://fas.org/issues/nuclear-weapons/status-world-nuclear-forces/> Fact Sheet: Global Nuclear Weapons Inventories in 2013, Center for Arms Control and Non-Proliferation, March 2013, <http://armscontrolcenter.org/issues/nuclearweapons/articles/>

fact sheet global nuclear weapons inventories in 2012/. Adapted by Anthony H. Cordesman and Joseph Kendall at the Center for Strategic and International Studies.

Figure 1.4: Nuclear Competition and Uncertainty



Source: Henry Sokolski, “China’s Nuclear Weapons and Fissile Materials Holdings: Uncertainties and Concerns, George Mason University, March 26, 2012.”³³

Detailed Assessments of China’s Nuclear Forces

The U.S. government has not provided detailed unclassified data on Chinese nuclear forces, nor has the U.S. made them a key focus of its arms control efforts. The U.S. only gives them passing mention in its recent unclassified reporting on U.S. doctrine for sizing and employing U.S. nuclear forces. A number of leading sources on nuclear forces and arms control do, however, provide considerable detail. The data involved are sometime contradictory, but generally provide a common picture of Chinese nuclear weapons stockpiles and designs.

The Nuclear Threat Initiative (NTI) Estimate

At the same time, nuclear watchdogs like the Nuclear Threat Initiative (NTI) do provide estimates with considerable detail. They do lack access to intelligence sources, but often provide a good picture of the issues being reviewed and debated within the U.S. government. The NTI described China’s nuclear forces as follows in a July 2015 assessment, although it made no attempt to project China’s future holdings of strategic, theater, and tactical nuclear weapons:³⁴

On 16 October 1964 China exploded its first nuclear device. China has since consistently asserted that its nuclear doctrine is based on the concept of no-first-use, and Chinese military leaders have characterized the country’s nuclear weapons as a minimum deterrent against nuclear attacks. Although the exact size of China’s nuclear stockpile has not been publicly disclosed, reports indicate that as of 2011 China has produced a total of 200 to 300 nuclear warheads. In 2011, Robert S. Norris and Hans M. Kristensen estimated the size of China’s current nuclear stockpile to be approximately 254 warheads. Roughly 190 of these warheads are currently considered operational.

Since the inception of its nuclear weapons program, China has relied on a mixture of foreign and indigenous inputs to steadily develop and modernize its nuclear arsenal from its first implosion device to the development of tactical nuclear weapons in the 1980s. As a result, The Federation of American Scientists assesses China to have at least six different types of nuclear payload assemblies: a 15-40 kiloton (kt) fission bomb; a 20 kt missile warhead; a 3 megaton (mt) thermonuclear missile warhead; a 3 mt thermonuclear gravity bomb; a 4-5 mt missile warhead; and a 200-300 kt missile warhead. China is thought to possess a total of some 150 tactical nuclear warheads on its short-range ballistic, and possibly cruise missiles.

In its most recent (2013) Annual Report to Congress on the Military and Security Developments of the People's Republic of China, the U.S. Department of Defense stated that China's nuclear-capable missile arsenal consists of a total of 50-75 intercontinental ballistic missiles (ICBMs), including: silo-based, liquid-fueled DF-5 (CSS-4) ICBMs; solid-fueled, road-mobile DF-31 (CSS 10 Mod-1) and DF-31A (CSS-10 Mod 2) ICBMs; limited-range DF-4 (CSS-3) ICBMs; and liquid-fueled DF-3 (CSS-2) intermediate-range ballistic missiles; and DF-21 (CSS-5) road-mobile, solid-fueled MRBMs.

Three JIN-class SSBNs have been delivered to the People Liberation Army Navy (PLAN), which will eventually carry JL-2 submarine-launched ballistic missiles (SLBMs). China also possesses DF-15 (CSS-6) and 700-750 DF-11 (CSS-7) short-range ballistic missiles (SRBMs), though China maintains significantly fewer launchers, and 200-500 DH-10s (a cruise missile thought to be able to support a nuclear payload). The Department of Defense assesses that all Chinese SRBMs are deployed near Taiwan. Most recently, China has developed the long-range DF-31 and DF-31A ICBMs.

There is an ongoing effort to shift from liquid-fueled missiles to solid-fueled missiles. China has also continued to develop new missile launch sites and underground storage facilities in remote inland regions, including the Gobi Desert and the Tibetan highlands. As there is no evidence of long-range missiles being deployed to these new locations, the launch sites appear to be intended primarily as forward bases for potential launches against Russia and India.

Even as it continues to develop its arsenal, however, China has also slowly moved towards increased openness in its willingness to share a limited amount of deployment information and strategy. For example, the 2010 China Defense White Paper details Beijing's no-first-use policy and roughly outlines several stages of nuclear alert. The paper states that "nuclear-weapon states should negotiate and conclude a treaty on no-first-use of nuclear weapons against each other." The White Paper also states China's "unequivocal commitment that under no circumstances will it use or threaten to use nuclear weapons against non-nuclear-weapon states or nuclear-weapon-free zones." China's 2013 Defense White Paper did not specifically use the words "no first use." However, the director of the Chinese Academy of Military Science subsequently reiterated that there is "no sign that China is going to change a policy it has wisely adopted and persistently upheld for half a century."

The NTI's 2015 report on Chinese weapons developments provided the following assessment of China's nuclear testing and arms control policy,³⁵

China's nuclear tests in the late-1980s and 1990s were geared toward further modernizing its nuclear forces. Although China officially declared in 1994 that these tests were for improving safety features on existing warheads, they were also likely intended for the development of new, smaller warheads for China's next-generation solid-fueled ICBMs (e.g., DF-31 and DF-31A), and possibly to develop a multiple warhead (MRV or MIRV) capability as well. China's last test was on 29 July 1996, and less than two months later on 24 September 1996 Beijing signed the Comprehensive Nuclear Test Ban Treaty (CTBT). In order to sign the treaty China overcame several of its initial concerns, including allowing an exemption for Peaceful Nuclear Explosions and the use of national technical means and on-site inspections for verification. The National People's Congress, however, has yet to ratify the treaty.

China's 1996 signing of the CTBT was the latest in a series of policy shifts on nuclear nonproliferation issues. In fact, it was during the 1980s that China's position on nuclear proliferation first started to change. Since the 1960s, Beijing had criticized the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) as imbalanced and discriminatory, but by the 1980s the country had also indicated that it accepted in principle the norm of nuclear nonproliferation. In 1984, China joined the IAEA and agreed to place all of its exports under international safeguards; that same year, during a trip to the United States,

Chinese Premier Zhao Ziyang provided Washington with verbal assurances that China did not advocate or encourage nuclear proliferation. In 1990, though still not a member of the NPT, China attended the fourth NPT review conference and, while it criticized the treaty for not banning the deployment of nuclear weapons outside national territories and for not including concrete provisions for general nuclear disarmament, it also stated that the treaty had a positive impact and contributed to the maintenance of world peace and stability. In August 1991, shortly after France acceded to the NPT, China also declared its intention to join, though it again expressed its reservations about the treaty's discriminatory nature.

China formally acceded to the NPT in March 1992, as a nuclear weapon state. In its statement of accession, the Chinese government called on all nuclear weapon states to issue unconditional no-first-use pledges, to provide negative and positive security assurances to non-nuclear weapon states, to support the development of nuclear weapon-free zones, to withdraw all nuclear weapons deployed outside of their national territories, and to halt the arms race in outer space. Since its accession, China has praised the NPT's role in preventing the proliferation of nuclear weapons, and also supported the decision to indefinitely extend the NPT at the 1995 Review and Extension Conference.

However, China has continued to state that it views nonproliferation not as an end in itself, but rather as a means to the ultimate objective of the complete prohibition and thorough destruction of nuclear weapons. Despite this, China was embroiled in nuclear proliferation scandals throughout the late 1980's and early 1990's, particularly with respect to its sale of ring magnets to Pakistan in 1995. China provided Pakistan with a nuclear bomb design (used in China's October 1966 nuclear test). These designs were later passed to Libya by the A.Q. Khan network, and discovered by IAEA inspectors in 2004 after then President Muammar Qadhafi renounced his nuclear weapons program and allowed inspectors to examine related facilities. The plans contained portions of Chinese text with explicit instructions for the manufacture of an implosion device.

The NTI web site described the future of China's Nuclear Modernization as follows in July 2015.³⁶

There is much speculation that China's nuclear modernization program may be geared toward developing the capacity to move from a strategy of minimum deterrence to one of limited deterrence. Under a "limited deterrence" doctrine, China would need to target nuclear forces in addition to cities, which would require expanded deployments. However, such a limited deterrence capability may still be a long way off. According to Alastair Johnston, "It is fairly safe to say that Chinese capabilities come nowhere near the level required by the concept of limited deterrence."

China is working to expand its nuclear deterrent by developing an SSBN force. According to the Department of Defense's 2013 Annual Report to Congress on the Military and Security Developments of the People's Republic of China, these developments will give the PLA Navy its "first credible sea-based nuclear deterrent."

Meanwhile, tensions between China and Taiwan have declined, and in the wake of Japan's 2011 nuclear crisis, China and Taiwan are taking concrete measures to cooperate on nuclear safety issues. Such cross-strait cooperation includes establishing a formal nuclear safety agreement and an official contact mechanism between the two sides, which will be used to facilitate information exchanges and emergency responses in case of an accident.

While China's decreased threat perception may not slow its nuclear modernization efforts, which are seen simply as representing the replacement of obsolete equipment, it does have the potential to slow acquisitions in key areas — for example, the buildup of short-range missiles. If sustained, the shift may also make both sides more amenable to nonproliferation efforts such as ratification of the Comprehensive Nuclear Test Ban Treaty.

Only limited data are available on Chinese military nuclear facilities. The NTI reported that:³⁷

China possesses a comprehensive nuclear infrastructure for both military and civilian purposes, including enrichment and reprocessing capabilities. China initially constructed its military nuclear facilities with Soviet assistance, but after withdrawing in 1959, completed them independently. In the late 1960s China constructed numerous military nuclear facilities as a part of its "Third Line" policy of duplicating essential military infrastructure.

Beginning in the late 1980s, China initiated a policy of “military to civilian” conversion of industries, including nuclear energy, and has established many nuclear corporations for civilian nuclear energy programs. China currently has 17 nuclear power reactors in operation and 28 under construction, in addition to 15 operational research reactors.

The Chairman of the Central Military Commission (CMC) is the ultimate authority with regards to China's nuclear weapons, and the management of relevant facilities. The CMC has delegated authority over the Chinese military's nuclear facilities to the General Armaments Department (GAD) under the People's Liberation Army, which oversees the China Academy of Engineering Physics (CAEP). CAEP is responsible for most of the research, development, testing and production of China's nuclear weapons.

Soviet assistance was critical in the early stages of China's nuclear facility construction. Between 1955 and 1958 the two nations signed six accords on the development of China's nuclear science, industry, and weapons program. In these accords, Soviet assistance included the supply of a nuclear reactor, cyclotron, aid in building China's nuclear industries and research facilities, and a prototype atomic bomb.

The Sino-Soviet Split prevented the transfer of a prototype weapon, and the Chinese had to independently finish the construction of the gaseous diffusion plant at Lanzhou, Jiuquan's plutonium-producing reactor and plutonium-processing plant, and the Baotou Nuclear Fuel Component Plant.[18] China duplicated these facilities in its Third Line Policy with the construction of the Heping Uranium Enrichment Plant, Guangyuan facility (Plant 821), and the Yibin Nuclear Fuel Factory.

Highly enriched uranium (HEU) production was based primarily in the Lanzhou and Heping gaseous diffusion plants. Both facilities stopped HEU production in 1979 and 1987 respectively. China's current inventory of HEU for weapons is estimated to total 16 ± 4 tons. China has produced plutonium for weapons at two sites, the Jiuquan Atomic Energy Complex and Guangyuan plutonium production complex.

China's current inventory of weapon-grade plutonium is estimated to total 1.8 ± 0.5 tons. Many HEU research reactors in China are being converted to low enriched uranium (LEU) or shut down. In 2007 the Nuclear Power Institute of China converted its high flux engineering test reactor (HFETR) as well as the HFETR Critical Assembly from HEU to LEU. China shut down the MNSR-SH at the Shanghai Testing and Research Institute in March 2007, and confirmed the shutdown of the MNSR-Shandong reactor in December 2010.

The Bulletin of the Atomic Scientists Estimate

The Bulletin of the Atomic Scientists, another respected source outside the U.S. government, addressed the distribution of China's nuclear forces in a 2016 report. It is important to note that its assessments – like those of other sources – only cover deployed nuclear weapons and not total stockpiles – which have to take into account the need to service weapons and deal with modernization. Equally, there is no practical way to assess the modernization existing systems in terms of accuracy and reliability.

Improvement in these areas can, however, greatly increase the lethality and target coverage of existing systems since the aim point can be hit with much greater probability, lethality estimates become more reliable, and fewer missiles may need to be targeted on a single target.³⁸

During the past decade, China has fielded a more diverse and capable nuclear arsenal than it did previously. Since our Nuclear Notebook on China in July 2015 (Kristensen and Norris 2015), the trend has continued: China's nuclear modernization efforts have resulted in a new version of an existing nuclear medium-range mobile ballistic missile, as well as a new dual-capable intermediate-range mobile ballistic missile. The country has also test-flown a new follow-on mobile intercontinental ballistic missile, and reorganized its nuclear missile command structure.

Although there is no sign that the Chinese government has officially diverted from its nuclear policy – which includes a pledge not to use nuclear weapons first, not to use them against non-nuclear countries or in nuclear-weapon-free zones, and to maintain a minimum deterrent designed only to ensure a survivable

second-strike capability – its modernization program is adding significant new capabilities. These qualitative improvements may in turn alter Chinese nuclear policy and strategy.

We estimate that China has a stockpile of approximately 260 nuclear warheads for delivery by nearly 150 land-based ballistic missiles, 48 sea-based ballistic missiles, and bombers. This stockpile is likely to grow further over the next decade as new nuclear-capable missiles become operational. Moreover, in response to the U.S. deployment of missile defense systems in the Pacific, China has now begun to equip its silo-based missiles with the capability to carry multiple warheads (Table 1). This development could potentially further increase the size of the Chinese nuclear warhead inventory.

We continue to observe that China does not normally deploy nuclear warheads on its missiles, but stores them separately in central storage facilities. There are new and disturbing reports, however, that Chinese military officials are advocating increasing the readiness of China's nuclear missiles (Kulacki 2016). Thus far, we have not seen evidence that the government has decided to follow their advice.

The Bulletin of the Atomic Scientists described China's land-based nuclear forces as follows,

The modernization of China's land-based nuclear-capable missile force has progressed significantly over the past year, with the introduction of a new version of an existing medium-range road-mobile ballistic missile and the fielding of a new intermediate-range road mobile ballistic missile. There are reports that some existing missiles are being re-equipped to carry multiple warheads. China has also test-launched a new follow-on intercontinental road-mobile ballistic missile, which may carry multiple warheads.

The modernization, which began in the 1990s, is part of a transition from older, transportable, liquid fuel, slow-launching missiles to longer-range, road mobile, solid-fuel, and quicker-launching missiles. The modernization also involves the nuclear command and control systems needed to operate the missiles. The end result will be a land-based missile force that will be better able to survive U.S. (and to some extent Russian) surprise attacks. The modernized force is more mobile, responsive, and accurate, and can overwhelm a limited U.S. ballistic missile defense system.

The U.S. Defense Intelligence Agency says that “China has the world's largest and most comprehensive missile force” (Stewart 2016, 11). While technically that may be true, most of the missile force is made up of non-nuclear short-range missiles. The nuclear portion of China's missile force is significantly smaller than the nuclear missile arsenal of either Russia or the United States. Most of China's nuclear missiles are medium and intermediate-range, with launchers for intercontinental ballistic missiles (ICBMs) numbering between 50 and 75. The size of the ICBM force has remained relatively stable over the past five years, following an increase during the previous five years. The number of missiles for the ICBM launchers is a little higher because the oldest type (DF-4) has one or two extra reloads per launcher (Kristensen 2016).

Fifteen years ago, the U.S. intelligence community estimated that by 2015, China would have 75–100 warheads on ICBMs, primarily targeted at the United States (CIA 2001, 3). This prediction did not come to pass. Of China's 50–75 ICBMs, an estimated 40–50 – capable of carrying 60–70 warheads in total – can target the continental United States...Nonetheless, the Chinese ICBM force will probably continue to grow slowly, and with the addition of multiple warheads on the DF-5B and possibly the DF-41 in the future, the number of ICBM warheads primarily targeted against the United States may exceed 100 a decade from now.

Overall, we estimate that China possesses approximately 143 nuclear-capable land-based missiles that can carry 163 nuclear warheads. The force is slowly increasing in both number and variety.

The 2016 edition of the Pentagon's annual report on Chinese military developments no longer lists the old DF-3A (CSS-2) (U.S. Defense Department 2016). A liquid-fueled, single-stage, intermediate-range ballistic missile, the DF-3A was first deployed in 1971 and could deliver a 3.3-megaton warhead up to 3000 kilometers (km). The last remaining DF-3A brigade at Dengshahe in northeast China has now been upgraded to the DF-21 medium-range ballistic missile (Kristensen 2014b).

China continues to maintain one brigade of the DF-4 (CSS-3) ICBM. This two-stage, liquid-fueled missile was first deployed in 1980 and can deliver a 3.3 megaton warhead more than 5500 km, a sufficient range to target India, part of Russia, and Guam. The brigade has approximately 10 transportable launchers, some or all of which may be based in caves with a roll-out-to-launch capability. Each launcher has one or two

reloads of additional missiles. The remaining DF-4s will probably be replaced by the DF-31 in the near future.

China's DF-5A (CSS-4 Mod 2) – a liquid-fueled, two-stage, silo-based ICBM – has a range that exceeds 13,000 km and has been targeted at the United States and Russia since the early 1980s. The DF-5A is an upgraded version of the original DF-5 (CSS-4 Mod 1), which was first deployed in 1981. Apparently, some of the DF-5As have been upgraded to carry multiple independently targetable reentry vehicles (MIRVs). The MIRVed version is known as DF-5B (CSS-4 Mod 3) (U.S. Defense Department 2015, 8). China had the ability to deploy multiple warheads on the DF-5 (and later the DF-5A) for decades but did not; it appears to have started doing so in response to the U.S. deployment of a ballistic-missile defense system (Sanger and Broad 2015; Kristensen 2015; U.S. Defense Department 2015, 8, 31). We estimate that China has a total of approximately 20 DF-5s of both versions, of which perhaps half have been equipped with MIRVs.

China's primary regional nuclear missile is the two stage, solid-fuel, road-mobile DF-21 (CSS-5), a medium-range ballistic missile. The DF-21 has existed in two nuclear versions for the past decade and a half: the DF-21 (CSS-5 Mod 1) and the newer DF-21A (CSS-5 Mod 2). The Mod 1 version has a range of at least 1750 km, but the new version probably has a longer range of about 2150 km. The Defense Department recently reported the existence of a third nuclear version of the DF-21, known as the CSS-5 Mod 6 (U.S. Defense Department 2016, 58). We estimate that China has approximately 80 launchers for the nuclear DF-21. China has also deployed two conventional versions of the DF-21: the DF-21C (CSS-4 Mod 4) land-attack missile, and the DF-21D (CSS-5 Mod 5) anti-ship missile.

For the past decade, the focus of China's ICBM modernization has been the DF-31 (CSS-10 Mod 1) and a longer-range version known as DF-31A (CSS-10 Mod 2). The DF-31, which was first deployed in 2006 but now appears to have been terminated with fewer than 10 launchers, is a three-stage, road-mobile missile that is transported in a 15-meter-long canister on a six-axle transporter-erector-launcher (TEL). The DF-31 has a range of more than 7000 km, but cannot reach the continental United States. It is presumed to have taken over much of the regional targeting – of Russia, India, and Guam – previously done by the DF-4. The reasons for the slow introduction of the DF-31 are unclear.

The DF-31A (CSS-10 Mod 2) – a solid-fueled, three stage, road-mobile ICBM – is an extended-range version of the DF-31, designed to reach targets in most of the continental United States. We estimate that China deploys about 25 DF-31A ICBMs in four brigades.

Perhaps the biggest missile event in 2015 was China's public unveiling of the new DF-26 intermediate-range road-mobile missile during a military parade in Beijing in September. A total of 16 DF-26 launchers took part in the parade. Like the existing DF-4 and DF-31 ICBMs, the 4000-km range DF-26 is capable of targeting important U.S. bases in Guam. Unlike the DF-4 and DF-31, however, the DF-26 is thought to be dual-capable, and so could also be used to target the island with conventional warheads.

The Pentagon has reported for more than two decades that China is developing a new follow-on road mobile ICBM known as the DF-41. After considerable delay, the program appears to have made progress with several flight tests over the past few years, some of which have included multiple payloads. Reporting in the *Washington Free Beacon*, Bill Gertz reported that the "DF-41 is assessed by U.S. intelligence agencies to be powerful enough to deliver between six and 10 warheads up to 7456 miles – far enough to reach every corner of the United States from launch areas in eastern China" (Gertz 2016).

However, Gertz did not provide a specific source for the assessment, which may be an exaggeration. To "reach every corner of the United States," a missile with a range of 7456 miles (about 12,000 km) would have to launch from the most northeastern provinces of China, at least 400 km northeast of Beijing. But Chinese ICBMs tend to be based much further inside China to protect them against preemptive attacks.

Moreover, given China's limited nuclear testing program, it seems reasonable to assume that the warhead intended for the DF-41 may be similar in size to the warhead used on the DF-31A and DF-5B. If so, a payload of six to 10 warheads would weigh more than twice as much as the payload on the DF-5B, which probably has a range of some 12,000 km with three warheads. The DF-5B is a liquid-fuel missile, but the DF-41, according to one expert, appears to be a modified variant of the post-boost stage of the DF-5B that has been placed on a larger solid rocket motor (Gertz 2016).

Gertz cited unidentified Pentagon officials who say that the DF-41 flight-tested on 19 April 2015, carried two warheads, closer to the three warheads thought to be carried by the DF-5B (Gertz 2016). The U.S. Defense Department says the DF-41 is “capable of carrying MIRVs” (U.S. Defense Department 2016, 25). In this case, the DF-41 is probably intended to replace the DF-5 and be equipped with a few warheads and penetration aids to ensure that it can penetrate the U.S. missile defense system.

Most of China's short-range ballistic missiles are conventional with one exception: the nuclear capable DF-15 (CSS-6). After reporting that the nuclear test China conducted on 16 August 1990 may have been “related to development of a warhead for a Chinese short-range ballistic missile” (CIA 1990, 1), a CIA memorandum concluded in September 1993 “that China will begin to field nuclear-armed CSS-X-6's next year.” The memorandum went on, “China almost certainly has already developed the warhead for this system. Testing might be needed for formal weaponization or for additional warhead options” (CIA 1993, 5). Despite the apparent nuclear capability developed at the time, it is unclear whether China ever completed and fielded a nuclear warhead for the DF-15. Instead, it might have developed the capability as a possible option for future warhead miniaturization efforts

The same report provided the following assessment of Chinese sea-based nuclear forces:

China currently operates a fleet of four Jin-class (Type 094) nuclear-powered ballistic missile submarines (SSBNs). All are based at the Longposan naval base near Yulin on Hainan Island.

It is not known with certainty in the West how many SSBNs China plans to build. The U.S. Office of Naval Intelligence predicted nearly a decade ago that China might build five Jin SSBNs (Kristensen 2007). A 2015 Pentagon report agreed with that projection, saying “up to five may enter service” before China begins work on a next-generation SSBN (U.S. Defense Department 2015, 9). Yet in early 2015, other U.S. government sources suggested that China might build more. In his prepared testimony before the Senate Armed Services Committee in February 2015, Director of National Intelligence James Clapper said that China “might produce additional JIN-class nuclear-powered ballistic missile submarines” (Clapper 2015, 7). He repeated the assessment in 2016 (Clapper 2016, 7). Admiral Samuel J. Locklear, commander of the U.S. Pacific Command, said in 2015 that “up to five more [Jin SSBNs] may enter service by the end of the decade” (Locklear 2015, 9), although that projection seems unrealistic.

The 2016 Pentagon report seems to clear up the confusion, saying that four Jin-class SSBNs are in service and a fifth is being built. Although the Jin-class is more advanced than China's first experimental SSBN – the single and now inoperable Xia (Type 092) – it is still a very noisy design (Kristensen 2009b). It seems likely that China will end production after five boats and develop and produce a third-generation (Type 096) SSBN over the next decade. The next SSBN is expected to carry a new missile, the JL-3.

The Jin SSBNs are designed to carry the new JL-2 (CSS-NX-14), a submarine-launched ballistic missile (SLBM) that is a modified version of the DF-31. Each JL-2 is equipped with a single warhead (and, possibly, penetration aids). The JL-2 has not been tested to its full range of 7000-plus km. The 2015 Pentagon report estimated its range is 7400 km (U.S. Defense Department 2015, 9), but the 2016 Pentagon report estimates a range of 7200 km (U.S. Defense Department 2016, 26). That would be sufficient to target Alaska, Guam, Hawaii, Russia, and India from waters near China – but unless the submarine carrying the weapon sailed significantly eastward, it could not target the continental United States. We estimate that 4 warheads have already been produced for the 48 JL-2s that the four existing SSBNs can carry.

Confusion continues about whether the JIN submarines have sailed on deterrent patrols with nuclear weapons on board. U.S. Chief of Naval Operations Vice Adm. Joseph Mulloy said in early 2015 that one Chinese SSBN had gone on a 95-day patrol (Osborn 2015). In late 2015, STRATCOM Commander Adm. Cecil Haney said Chinese SSBNs had been at sea, and that while he didn't know if they had nuclear weapons on board, he had to assume they did (Gertz 2015). In early 2016, the head of the U.S. Defense Intelligence Agency said that the Chinese navy “deployed the JINclass nuclear-powered ballistic missile submarine in 2015” on an extended patrol far from Chinese waters (Stewart 2016, 12).

These statements indicate that although one of the JIN submarines apparently sailed on an extended voyage in 2015, it is not clear that Chinese SSBNs have ever conducted a deterrent patrol with nuclear-armed JL-2 SLBMs onboard. The 2016 Pentagon report says that “China will probably conduct its first SSBN nuclear deterrent patrol in 2016” (U.S. Defense Department 2016, 26).

The Chinese SSBN fleet faces several doctrinal, technical, and operational constraints. Our analysis suggests that China's Central Military Commission currently does not allow the military services to have warheads deployed on missiles under normal circumstances. Handing over custody of nuclear warheads to deployed submarines in peacetime would constitute a significant change of Chinese policy.

Moreover, China's navy and the Central Military Commission will have to build up experience operating an SSBN force during realistic military operations. This will require development of new command-and-control technologies and procedures. The submarines will also need a destination. Even if China deployed nuclear-armed SSBNs to sea in a crisis, where would they sail? For a JL-2 to be able to strike targets in the continental United States, a Jin SSBN would have to sail through the East China Sea and well into the Pacific Ocean, through dangerous choke points where it would be vulnerable to hostile antisubmarine warfare (see Figure 1).

China's main concern is making sure that its minimum nuclear deterrent would survive a first strike, and for that reason it spends considerable resources on modernizing and hiding its land-based missiles. This frankly makes its submarine program puzzling, for it seems much riskier for China to deploy nuclear weapons at sea, where submarines can be sunk by unfriendly forces, than to hide the nuclear weapons deep inside China's landmass (Kristensen 2014a).

The Global Security Estimate

Global Security provided the following summary of China's historical development of nuclear weapons and potential future steps in July 2015. It has many similarities to the NTI and Bulletin of Atomic Scientist assessments, but provides considerable additional historical background:³⁹

By 1953 the Chinese, under the guise of peaceful uses of nuclear energy, had initiated research leading to the development of nuclear weapons. The decision to develop an independent strategic nuclear force was made no later than early 1956 and was to be implemented within the Twelve-Year Science Plan presented in September 1956 to the Eighth Congress of the CCP. The decision to enter into a development program designed to produce nuclear weapons and ballistic missile delivery systems was, in large part, a function of the 1953 technology transfer agreements initiated with the USSR.

In 1951 Peking signed a secret agreement with Moscow through which China provided uranium ores in exchange for Soviet assistance in the nuclear field. In mid-October 1957 the Chinese and Soviets signed an agreement on new technology for national defense that included provision for additional Soviet nuclear assistance as well as the furnishing of some surface-to-surface and surface-to-air missiles. The USSR also agreed to supply a sample atomic bomb and to provide technical assistance in the manufacture of nuclear weapons. The Soviets provided the Chinese with assistance in building a major gaseous diffusion facility for production of enriched uranium. Subsequently the Chinese accused Moscow of having abrogated this agreement in 1959, and having "refused to supply a simple atomic bomb and technical data concerning its manufacture."

China began developing nuclear weapons in the late 1950s with substantial Soviet assistance. Before 1960 direct Soviet military assistance had included the provision of advisors and a vast variety of equipment. Of the assistance provided, most significant to China's future strategic nuclear capability were an experimental nuclear reactor, facilities for processing uranium, a cyclotron, and some equipment for a gaseous diffusion plant.

When Sino-Soviet relations cooled in the late 1950s and early 1960s, the Soviet Union withheld plans and data for an atomic bomb, abrogated the agreement on transferring defense technology, and began the withdrawal of Soviet advisers in 1960. Despite the termination of Soviet assistance, China committed itself to continue nuclear weapons development to break "the superpowers' monopoly on nuclear weapons," to ensure Chinese security against the Soviet and United States threats, and to increase Chinese prestige and power internationally.

When China decided in 1955 to develop atomic bombs it faced a number of technological choices as to the most appropriate route to follow. At that time China could only work on one path, and had to choose between producing Pu239 from a reactor, or developing the method of producing U235 through isotope separation. The uranium path offered two alternatives, either system, either chemical separation or

physical separation. Chemical separation of Pu235 from the mixed system of U235 and U238 would have been easier than physical separation, but the separation of plutonium and uranium was difficult due to the high radioactivity of the Pu-U system, and the severe toxicity of plutonium. Therefore, the chosen path was the physical separation of U235 and U238 isotopes. The implosion method of detonating an atomic bomb was considered more technically advanced, though there were questions as to whether China was capable of producing a uranium bomb detonated by the implosion method.

China made remarkable progress in the 1960s in developing nuclear weapons. In a thirty-two-month period, China successfully exploded its first atomic bomb (October 16, 1964), launched its first nuclear missile (October 25, 1966), and detonated its first hydrogen bomb (June 14, 1967).

The first Chinese nuclear test was conducted at Lop Nor on 16 October 1964 (CHIC 1). It was a tower shot involving a fission device with a yield of 25 kilotons. Uranium 235 was used as the nuclear fuel, which indicates Beijing's choice of the path of creating high-yield nuclear weapons right away. Of the ten test shots that followed by 29 September 1969, six are believed to have been related to thermonuclear development. The others had as their goals the adaptation of CHIC 1 for bomber delivery and test of a missile warhead (CHIC 4). The third nuclear test was conducted on 9 September 1966 using a Tu-16 bomber. In addition to uranium 235, this nuclear device, with a yield around 100 KT, this time contained lithium 6, which attested to China's readiness to test a thermonuclear explosion. CHIC 6, an airdrop test on 17 June 1967, was the first full-yield, two-stage thermonuclear test.

Although the Cultural Revolution disrupted the strategic weapons program less than other scientific and educational sectors in China, there was a slowdown in succeeding years. The successes achieved in nuclear research and experimental design work permitted China to begin series production of nuclear (since 1968) and thermonuclear (since 1974) warheads.

Subsequent nuclear tests (CHIC 12, CHIC 13) were suggestive of a new phase of the PRC test programs. Both were low yield weapons. It appeared possible that CHIC 13 was delivered by an F-9 fighter aircraft and may have been a proof test of a weapon.

The PRC's nuclear weapons intelligence collection efforts began after the end of the Cultural Revolution in 1976, when the PRC assessed its weaknesses in physics and the deteriorating status of its nuclear weapons programs. The PRC's warhead designs of the late 1970s were large, multi-megaton thermonuclear weapons that could only be carried on large ballistic missiles and aircraft. The PRC's warheads were roughly equivalent to U.S. warheads designed in the 1950s. The PRC may have decided as early as that time to pursue more advanced thermonuclear warheads for its new generation of ballistic missiles.

In addition to the development of a sea-based nuclear force, China began considering the development of tactical nuclear weapons. PLA exercises featured the simulated use of tactical nuclear weapons in offensive and defensive situations beginning in 1982. Reports of Chinese possession of tactical nuclear weapons remained unconfirmed in 1987. In 1988 Chinese specialists tested a 1-5 KT nuclear device with an enhanced radiation yield, advancing the country's development of a very low yield neutron weapon and laying the foundation for the creation of nuclear artillery.

The PRC has already begun working on smaller thermonuclear warheads. During the 1990s, the PRC was working to complete testing of its modern thermonuclear weapons before it signed the Comprehensive Test Ban Treaty in 1996. The PRC conducted a series of nuclear tests from 1992 to 1996. Based on what is known about PRC nuclear testing practices, combined with data on PRC warhead yield and on PRC missile development, it is clear that the purpose of the 1992 to 1996 test series was to develop small, light warheads for the PRC's new nuclear forces.

One of the objectives of the final series of Chinese nuclear tests was to miniaturize China's nuclear warheads, dropping their weight from 2200 kgs to 700 kgs in order to accommodate the next generation of solid-fueled missile systems. This series of PRC nuclear weapons test explosions from 1992 to 1996 began a debate in the U.S. Government about whether the PRC's designs for its new generation of nuclear warheads were in fact based on stolen U.S. classified information. The apparent purpose of these PRC tests was to develop smaller, lighter thermonuclear warheads, with an increased yield-to-weight ratio.

The United States did not become fully aware of the magnitude of the counterintelligence problem at Department of Energy national weapons laboratories until 1995. In 1995, a "walk-in" approached the Central Intelligence Agency outside the PRC and provided an official PRC document classified "Secret" that contained specific design information on the W-88 Trident D-5, and technical information on other thermonuclear warheads. The CIA later determined that the "walk-in" was directed by the PRC intelligence services. Nonetheless, CIA and other Intelligence Community analysts that reviewed the document concluded that it contained U.S. warhead design information.

Completing the development of its next-generation warhead poses challenges for the PRC. The PRC may not currently be able to match precisely the exact explosive power and other features of U.S. weapons. Nonetheless, the PRC may be working toward this goal, and the difficulties it faces are surmountable. Work-arounds exist, using processes similar to those developed or available in a modern aerospace or precision-guided munitions industry. The PRC possesses these capabilities already.

Assessing the extent to which design information losses accelerated the PRC's nuclear weapons development is complicated because so much is unknown. The full extent of U.S. information that the PRC acquired and the sophistication of the PRC's indigenous design capabilities are unclear. Moreover, there is the possibility of third country assistance to the PRC's nuclear weapons program, which could also assist the PRC's exploitation of the stolen U.S. nuclear weapons information.

There is some uncertainty in published estimates of the size of the Chinese nuclear weapons stockpile. Between January 1971 and late 1972 a second set of new nuclear facilities was identified in the West. This included a gaseous diffusion plant at Chinkouho which was estimated to be able to produce more U-235 than the original plant at Lanchou. This new facility was predicted to begin partial production in late 1972 with full operation in late 1974. There was an additional reactor for production of plutonium at Kuangyuan and additional weapons grade material could enter the stockpile by 1974-75. Also, there was a possible new weapons fabrication facility located at Tzutung. All of these new facilities would give the PRC the capability of becoming the third largest nuclear power in the world. Based on their production capability, DIA assessed in 1972 that the Chinese could have as many as 120 thermonuclear warheads and 260 fission nuclear weapons in their stockpile.

In the late 1980s it was generally held that China was the world's third-largest nuclear power, possessing a small but credible nuclear deterrent force of 225 to 300 nuclear weapons.

Other estimates of the country's production capacities suggested that by the end of 1970 China had fabricated around 200 nuclear weapons, a number which could have increased to 875 by 1980. With an average annual production of 75 nuclear weapons during the 1980s, some estimates suggest that by the mid-1990s the Chinese nuclear industry had produced around 2,000 nuclear weapons for ballistic missiles, bombers, artillery projectiles and landmines.

The retired Russian General Viktor Yesin, former chief of staff of the Russian Strategic Missile Forces, claimed that China's HEU stockpile was actually 40 tons, and a plutonium inventory of up to 10 tons. He says that these are the best estimates of Russian experts. Based on these estimates of nuclear weapon material production, Yesin estimates that China could have 1,600 to 1,800 warheads.

Jeffrey Lewis writes that "China operated exactly two nuclear reactors for the production of military plutonium through 1991. Open-source estimates reliably band China's production of plutonium at 2-5 metric tons. Classified Department of Energy estimates, leaked to the press, provide a narrower band of 1.7-2.8 metric tons. (Hui Zhang, a former colleague of mine at Harvard who previously worked in the Chinese nuclear weapons establishment, calculates Chinese production as being on the low end of that estimate in the most recent International Panel on Fissile Materials report.) Using a conservative estimate of 4-8 kilograms of plutonium per warhead, that yields a total force of probably no more than 375 warheads, with an extreme upper bound of no more than 700 warheads."

China's nuclear forces, in combination with the PLA's conventional forces, served to deter both nuclear and conventional attack. Chinese leaders repeatedly have pledged never to be the first to use nuclear weapons, and they have accompanied the no first-use pledge with a promise of certain nuclear counterattack if nuclear weapons are used against China. China envisioned retaliation against strategic and tactical attacks and would probably strike countervalue rather than counterforce targets. The combination of China's few nuclear weapons and technological factors such as range, accuracy, and response time

might further limit the effectiveness of nuclear strikes against counterforce targets. China is seeking to increase the credibility of its nuclear retaliatory capability by dispersing and concealing its nuclear forces in difficult terrain, improving their mobility, and hardening its missile silos.

The Union of Concerned Scientists (UCS) Estimate

The Union of Concerned Scientists (UCS) provided another unclassified summary of China's nuclear weapons programs in October 2011. Once again, there are striking similarities to other assessments, but many details differ and there is no clear agreement on the number of nuclear weapons deployed.⁴⁰

U.S. governmental and non-governmental assessments¹ indicate China currently possesses a small nuclear arsenal, with an estimated 155 nuclear warheads ready to be deployed on six different types of land-based missiles. Approximately 50 of those missiles can reach the continental United States.

...Warheads: Estimates of the current number of Chinese nuclear warheads vary, but China is believed to have manufactured a total of between 200 and 300 warheads, roughly 50 of which have been used for nuclear tests. Currently, approximately 155 of those are believed to be prepared for deployment.

China's stocks of military plutonium limit how much it could expand its arsenal without restarting plutonium production. Estimates of the size of China's existing plutonium stocks are uncertain, but imply that the number of new warheads China could produce from existing stocks ranges from very few to possibly several hundred.

China has halted production of military plutonium but has not declared an official moratorium. Its dedicated military plutonium production facilities have been decommissioned. However, China recently began operating a pilot plant for reprocessing spent fuel from its commercial reactors and is discussing plans for a larger commercial reprocessing facility. These facilities extract plutonium that is created in the reactor from the spent fuel. China also operates an experimental fast breeder reactor, which is optimized to produce plutonium that would be used as fuel, and is considering purchasing two additional fast breeder reactors from Russia. If necessary, China could divert plutonium extracted from these experimental and commercial facilities for military use.

Satellite observations of the production facilities suggest they are not producing plutonium but they are well maintained. China officially supports negotiation of a Fissile Material Cut-off Treaty (FMCT) that would ban all future production for military use. This would cap China's capability to produce new warheads and place an upper bound on the size of its nuclear arsenal.

...China has conducted 45 nuclear tests. This relatively small number of tests (the United States conducted 1,054 and the Soviet Union/Russia conducted 715) suggests there are a limited number of tested Chinese warhead designs certified for deployment. China accelerated the pace of its nuclear testing during the three years it took to negotiate the Comprehensive Test Ban Treaty (CTBT) in the mid- 1990s in order to complete a series of tests on a smaller warhead design...U.S. analyses of that final test series suggest this smaller warhead is still too large for China to place multiple warheads on the long-range mobile missile designed deliver it, the DF-31...

...Unlike other nuclear weapons states, China keeps all of its warheads in storage. China's nuclear warheads and nuclear-capable missiles are kept separate and the warheads are not mated to the missiles until they are prepared for launch. Interestingly, for this reason under the counting rule for New START the number of Chinese weapons would be counted as zero...

...Estimates of the number, ranges, and payloads of Chinese nuclear-capable missiles vary. The estimates indicate China deploys approximately 150 land- based missiles that can carry nuclear payloads, fewer than 50 of which are long-range and can reach the United States....China is not believed to currently place multiple warheads on its missiles. However, some sources say DF-4 and DF- 5 missile tests have included testing of multiple re-entry vehicles...These tests may allow China to replace the older, larger single warheads on these two liquid-fueled missiles with smaller warheads and penetration aids. Chinese reports indicate that these may be tests of dummy warheads and penetration aids designed to defeat missile defenses...

China is experimenting with submarine-launched ballistic missiles but the one nominally operational nuclear-armed ballistic missile submarine it currently possesses does not patrol and Chinese experts describe it as a failure...China built two new ballistic missile submarines and is rumored to be building more, but the nuclear-capable missile designed for deployment on those submarines failed initial flight tests...

...U.S. governmental and non-governmental reports indicate China possesses a stockpile of air-deliverable nuclear weapons but they have no "primary mission," according to U.S. assessments. Chinese cruise missiles can be armed with nuclear payloads but U.S. assessments state they are not. U.S. observations of China's military facilities, equipment, and training suggest China does not maintain a stockpile of tactical nuclear weapons...

...Chinese nuclear experts believe the risk that a nuclear-armed adversary would threaten to use nuclear weapons in an attempt to coerce China in some way is greatly reduced if this adversary doubts its ability to launch a strike that could eliminate China's ability to retaliate. China therefore values secrecy over transparency, since China believes transparency undermines its confidence in the survivability of its nuclear arsenal. Moreover, this confidence waxes and wanes in response to perceived trends in technological development. Technological improvements by a potential adversary that may increase its willingness to risk an attack against China with nuclear weapons, or an attack against China's nuclear weapons with conventional weapons, decreases Chinese confidence in its ability to retaliate. This precipitates requests by China's leadership to adjust or improve its arsenal.

Because of this sensitivity to technological change, China's defense scientists and engineers play a decisive role in determining China's nuclear posture. The open source literature published by this technically oriented community over the past several decades suggests it sees improvements in space and missile defense technology as the most significant and likely challenges to the credibility of China's ability to retaliate with nuclear weapons. For example, China is concerned that improvements in satellite reconnaissance may reveal the location of Chinese weapons and command and control facilities, and may increase the ability of adversaries to track and target mobile weapons. Or that missile defenses may increase the willingness of foreign adversaries to threaten a strike against China's nuclear arsenal, thus exposing Chinese leaders to the "nuclear blackmail" their arsenal is designed to prevent.

...A comparative look at China's arsenal relative to the arsenals of its principal rivals reveals that the evolution of China's nuclear weapon systems has occurred more slowly and on a smaller scale than that of the United States and the Soviet Union/Russia... China's modernization efforts are focused on developing solid-fueled missiles that can be deployed on mobile platforms, to reduce the likelihood its missiles could be destroyed in a first strike, compared to its original liquid-fueled missiles at fixed launch sites. In the past few years it

...The small size and limited capabilities of China's nuclear arsenal make the threat of a first use of nuclear weapons against the United States or Russia highly unlikely and not at all credible, since it would invite massive nuclear retaliation as well as international condemnation. None of the improvements to China's arsenal that are currently underway would present Chinese decision-makers with a more credible ability to threaten the first use of nuclear weapons against the United States or Russia. Therefore, it is reasonable to assume that the improvements being made to the Chinese nuclear arsenal are limited to maintaining a credible threat to retaliate.

...Because of the lack of nuclear testing, China is not modernizing or improving the design or nuclear components of its warheads. If China needs to manufacture warheads for the new nuclear-capable missiles it is deploying, these warheads would be manufactured according to existing, tested warhead designs certified for deployment before it stopped testing in 1996. As noted above, the size of China's existing stocks of military plutonium will place a limit on how many additional warheads it could build without producing more plutonium.

...China is also deploying a 1,700-km range nuclear missile, the DF-21, which is mobile and uses solid fuel. As with China's other missiles, the nuclear-capable DF-21 has been produced in small batches and progressively modified to accommodate different conventional military objectives, such as to launch the anti-satellite interceptor China tested in 2007 and the anti-ship

...Chinese efforts to develop a submarine-launched nuclear missile, despite decades of effort, have yet to

produce a deployable capability. This may be in part because it is not a high priority. Based on the history of Soviet submarines, if these first-generation submarines are eventually deployed they are expected to be noisy enough to be easily detectable at sea, which would restrict them to patrolling in shallow areas around the Chinese coast inside its territorial waters and beyond interference from U.S. forces.

Moreover, should China eventually begin to deploy submarine-launched missiles, deployment would require placing both the warheads and missiles on the submarine, giving the commander greater responsibility and independence under conditions in which continuous secure and reliable communications with the political leadership are more difficult to maintain than with China's land-based missiles. This would be a major change, and could be seen as weakening the Chinese leadership's tight control over its development and testing of penetration aids. The development of these aids may be responsible for the increase in Chinese missile testing observed by U.S. satellites during the past decade.

The Federation of American Scientists (FAS) Estimate

Finally, the Federation of American Scientists (FAS) provided the following additional historical detail on Chinese tests and weapons developments in a November 2006 report:⁴¹

When China decided in 1955 to develop atomic bombs it faced a number of technological choices as to the most appropriate route to follow. At that time China could only work on one path, and had to choose between producing Pu239 from a reactor, or developing the method of producing U235 through isotope separation. The uranium path offered two alternatives, either system, either chemical separation or physical separation. Chemical separation of Pu235 from the mixed system of U235 and U238 would have been easier than physical separation, but the separation of plutonium and uranium was difficult due to the high radioactivity of the Pu-U system, and the severe toxicity of plutonium. Therefore, the chosen path was the physical separation of U235 and U238 isotopes. The implosion method of detonating an atomic bomb was considered more technically advanced, though there were questions as to whether China was capable of producing a uranium bomb detonated by the implosion method.

China made remarkable progress in the 1960s in developing nuclear weapons. In a thirty-two-month period, China successfully exploded its first atomic bomb (October 16, 1964), launched its first nuclear missile (October 25, 1966), and detonated its first hydrogen bomb (June 14, 1967).

The first Chinese nuclear test was conducted at Lop Nor on 16 October 1964 (CHIC 1). It was a tower shot involving a fission device with a yield of 25 kilotons. Uranium 235 was used as the nuclear fuel, which indicates Beijing's choice of the path of creating high-yield nuclear weapons right away. Of the ten test shots that followed by 29 September 1969, six are believed to have been related to thermonuclear development. The others had as their goals the adaptation of CHIC 1 for bomber delivery and test of a missile warhead (CHIC 4). The third nuclear test was conducted on 9 September 1966 using a Tu-16 bomber. In addition to uranium 235, this nuclear device, with a yield around 100 KT, this time contained lithium 6, which attested to China's readiness to test a thermonuclear explosion. CHIC 6, an airdrop test on 17 June 1967, was the first full-yield, two-stage thermonuclear test.

Although the Cultural Revolution disrupted the strategic weapons program less than other scientific and educational sectors in China, there was a slowdown in succeeding years. The successes achieved in nuclear research and experimental design work permitted China to begin series production of nuclear (since 1968) and thermonuclear (since 1974) warheads.

Subsequent nuclear tests (CHIC 12, CHIC 13) were suggestive of a new phase of the PRC test programs. Both were low yield weapons. It appeared possible that CHIC 13 was delivered by an F-9 fighter aircraft and may have been a proof test of a weapon.

One of the objectives of the final series of Chinese nuclear tests was to miniaturize China's nuclear warheads, dropping their weight from 2200 kgs to 700 kgs in order to accommodate the next generation of solid-fueled missile systems.

In addition to the development of a sea-based nuclear force, China began considering the development of tactical nuclear weapons. PLA exercises featured the simulated use of tactical nuclear weapons in offensive and defensive situations beginning in 1982. Reports of Chinese possession of tactical nuclear weapons remained unconfirmed in 1987. In 1988 Chinese specialists tested a 1-5 KT nuclear device with an

enhanced radiation yield, advancing the country's development of a very low yield neutron weapon and laying the foundation for the creation of nuclear artillery.

There is considerable uncertainty in published estimates of the size of the Chinese nuclear weapons stockpile. In the late 1980s it was generally held that China was the world's third-largest nuclear power, possessing a small but credible nuclear deterrent force of 225 to 300 nuclear weapons. Other estimates of the country's production capacities suggested that by the end of 1970 China had fabricated around 200 nuclear weapons, a number which could have increased to 875 by 1980. Assuming an average annual production of 75 nuclear weapons during the 1980s, some estimates even suggested that by the mid-1990s the Chinese nuclear industry had produced around 2,000 nuclear weapons for ballistic missiles, bombers, artillery projectiles and landmines.

While these analyses differ in detail, they still track broadly with what several experts in the U.S. government felt could be said about Chinese nuclear weapons on an unclassified basis. There are other U.S. experts, however, who believe that China may be concealing a much larger nuclear effort, have much larger stockpiles – including theater and smaller tactical weapons – and be moving more aggressively towards MIRV deployment and improving its strategic nuclear warhead numbers.

China and United States Nuclear Forces and Policies

The United States had over 1,750 deployed strategic warheads as of May 2016. It had an additional 180 active theater nuclear weapons. The FAS reported that the United States had an estimated 2,570 warheads in central storage. In addition to these warheads, approximately 2,340 retired by intact warheads under the control of the U.S. Department of Energy are in storage, bringing the total U.S. inventory of roughly 7,000 warheads. The United States has cut a total of 158 strategic warheads and 88 launchers since February 2011 and plans on making further reductions by 2018.⁴²

The United States summarized its strategy in dealing with deterrence and nuclear forces as follows in its FY2017 defense budget overview.⁴³

Nuclear Deterrence: Strengthening the nuclear enterprise remains one of the Air Force's highest priorities. The Air Force continues its actions to deliver safe, secure, and effective nuclear capabilities within its Nuclear Deterrence Operations (NDO) portfolio. The Air Force's intercontinental ballistic missiles and bombers provide two legs of the nation's Nuclear Triad and dual-capable fighters and bombers extend deterrence and provide assurance to our allies and partners.

Intercontinental Ballistic Missile (ICBM): The FY 2017 budget request funds additional investments to sustain and modernize the ICBM force, including Ground Based Strategic Deterrent (GBSD) integrated design and development.

The United States and Theater Nuclear Weapons

Theater nuclear weapons present another set of complex issues because U.S. policy has changed and the current status of such forces in contingencies outside Europe remains somewhat ambiguous. Since the end of the Cold War, the U.S. has been removing its deployed tactical and theater nuclear weapons from Europe and Asia. In 2008, the U.S. informed Japan it would be retiring its sea-based nuclear warhead Tomahawk cruise missiles (TLAM-N) from the region.⁴⁴

A report by Amy Woolf of the U.S. Congressional Research Service in February 2015 provides important insights into U.S. policy towards the use of nuclear weapons in theater conflicts – although it does not fully address possible U.S. reactions to the increasing Russian threats to use

theater nuclear weapons to defend itself against NATO or developments like North Korea's expanding stockpile of nuclear weapons,⁴⁵

In the past, U.S. discussions about nonstrategic nuclear weapons have also addressed questions about the role they might play in deterring or responding to regional contingencies that involved threats from nations that may not be armed with their own nuclear weapons. For example, former Secretary of Defense Perry stated that, "maintaining U.S. nuclear commitments with NATO, and retaining the ability to deploy nuclear capabilities to meet various regional contingencies, continues to be an important means for deterring aggression, protecting and promoting U.S. interests, reassuring allies and friends, and preventing proliferation (emphasis added)."

Specifically, both during the Cold War and after the demise of the Soviet Union, the United States maintained the option to use nuclear weapons in response to attacks with conventional, chemical, or biological weapons. For example, in 1999, Assistant Secretary of Defense Edward Warner testified that "the U.S. capability to deliver an overwhelming, rapid, and devastating military response with the full range of military capabilities will remain the cornerstone of our strategy for deterring rogue nation ballistic missile and WMD proliferation threats. The very existence of U.S. strategic and theater nuclear forces, backed by highly capable conventional forces, should certainly give pause to any rogue leader contemplating the use of WMD against the United States, its overseas deployed forces, or its allies." These statements do not indicate whether nonstrategic nuclear weapons would be used to achieve battlefield or tactical objectives, or whether they would contribute to strategic missions, but it remained evident, throughout the 1990s, that the United States continued to view these weapons as a part of its national security strategy.

The George W. Bush Administration also emphasized the possible use of nuclear weapons in regional contingencies in its 2001 Nuclear Posture Review. The Bush Administration appeared to shift towards a somewhat more explicit approach when acknowledging that the United States might use nuclear weapons in response to attacks by nations armed with chemical, biological, and conventional weapons, stating that the United States would develop and deploy those nuclear capabilities that it would need to defeat the capabilities of any potential adversary whether or not it possessed nuclear weapons. This does not, by itself, indicate that the United States would plan to use nonstrategic nuclear weapons. However, many analysts concluded from these and other comments by Bush Administration officials that the United States was planning for the tactical, first use of nuclear weapons. The Bush Administration never confirmed this view, and, instead, indicated that it would not use nuclear weapons in anything other than the most grave of circumstances.

The Obama Administration, on the other hand, seemed to foreclose the option of using nuclear weapons in some regional contingencies. Specifically, it stated, in the 2010 NPR, that "the United States will not use or threaten to use nuclear weapons against non-nuclear weapons states that are party to the Nuclear Non-Proliferation Treaty (NPT) and in compliance with their nuclear nonproliferation obligations." Specifically, if such a nation were to attack the United States with conventional, chemical, or biological weapons, the United States would respond with overwhelming conventional force, but it would not threaten to use nuclear weapons if the attacking nation was in compliance with its nuclear nonproliferation obligations and it did not have nuclear weapons of its own. At the same time, though, the NPR stated that any state that used chemical or biological weapons "against the United States or its allies and partners would face the prospect of a devastating conventional military response—and that any individuals responsible for the attack, whether national leaders or military commanders, would be held fully accountable."

Force Structure

Through the late 1990s and early in George W. Bush Administration, the United States maintained approximately 1,100 nonstrategic nuclear weapons in its active stockpile. Unclassified reports indicate that, of this number, around 500 were air-delivered bombs deployed at bases in Europe. The remainder, including some additional air-delivered bombs and around 320 nuclear-armed, sea-launched cruise missiles, were held in storage areas in the United States. After the Clinton Administration's 1994 Nuclear Posture Review, the United States eliminated its ability to return nuclear weapons to U.S. surface ships (it had retained this ability after removing the weapons under the 1991 PNI). It retained, however, its ability to restore cruise missiles to attack submarines, and it did not recommend any changes in the number of air-

delivered weapons deployed in Europe. During this time, the United States also consolidated its weapons storage sites for nonstrategic nuclear weapons. It reportedly reduced the number of these facilities “by over 75%” between 1988 and 1994. It eliminated two of its four storage sites for sea-launched cruise missiles, retaining only one facility on each coast of the United States. It also reduced the number of bases in Europe that store nuclear weapons from over 125 bases in the mid-1980s to 10 bases, in seven countries, by 2000.

The Bush Administration did not recommend any changes for U.S. nonstrategic nuclear weapons after completing its Nuclear Posture Review in 2001. Reports indicate that it decided to retain the capability to restore cruise missiles to attack submarines because of their ability to deploy, in secret, anywhere on the globe in time of crisis. The NPR also did not recommend any changes to the deployment of nonstrategic nuclear weapons in Europe, leaving decisions about their status to the members of the NATO alliance.

Nevertheless, according to unclassified reports, the United States did reduce the number of nuclear weapons deployed in Europe and the number of facilities that house those weapons during the George W. Bush Administration. Some reports indicate that the weapons were withdrawn from Greece and Ramstein Air Base in Germany between 2001 and 2005. In addition, reports indicate that the United States withdrew its nuclear weapons from the RAF Lakenheath air base in the United Kingdom in 2006. According to unclassified reports, the United States now deploys 160-200 bombs at six bases in Belgium, Germany, Italy, the Netherlands, and Turkey. Some of these weapons are stored at U.S. bases and would be delivered by U.S. aircraft. Others are stored at bases operated by the “host nation” and would be delivered by that nation’s aircraft if NATO decided to employ nuclear weapons.

The Obama Administration has not announced any further reductions to U.S. nuclear weapons in Europe and has indicated that the United States would “consult with our allies regarding the future basing of nuclear weapons in Europe.” In the months prior to the completion of NATO’s new Strategic Concept, some politicians in some European nations did propose that the United States withdraw these weapons. For example, Guido Westerwelle, Germany’s foreign minister, stated that he supported the withdrawal of U.S. nuclear weapons from Germany. Some reports indicate that Belgium and the Netherlands also supported this goal. As was noted above, NATO did not call for the removal of these weapons in its new Strategic Concept, but did indicate that it would be open to reducing them as a result of arms control negotiations with Russia.

Moreover, in the 2010 NPR, the Obama Administration indicated that it would take the steps necessary to maintain the capability to deploy U.S. nuclear weapons in Europe. It indicated that the U.S. Air Force would retain the capability to deliver both nuclear and conventional weapons as it replaced aging F-16 aircraft with the new F-35 Joint Strike Fighter. The NPR also indicated that the United States would conduct a “full scope” life extension program for the B61 bomb, the weapon that is currently deployed in Europe, “to ensure its functionality with the F-35.” This life extension program will consolidate four versions of the B61 bomb, including the B61-3 and B61-4 that are currently deployed in Europe, into one version, the B61-12. Reports indicate that this new version will reuse the nuclear components of the older bombs, but will include enhanced safety and security features and a new “tail kit” that will increase the accuracy of the weapon.

On the other hand, the NPR indicated that the U.S. Navy would retire its nuclear-armed, sea-launched cruise missiles (TLAM-N). It indicated that “this system serves a redundant purpose in the U.S. nuclear stockpile” because it is one of several weapons the United States could deploy forward. The NPR also noted that “U.S. ICBMs and SLBMs are capable of striking any potential adversary.” As a result, because “the deterrence and assurance roles of TLAM-N can be adequately substituted by these other means,” the United States could continue to extend deterrence and provide assurance to its allies in Asia without maintaining the capability to redeploy TLAM-N missiles.

The documents the President submitted with his proposed FY2017 U.S. defense budget described several other current U.S. plans for strategic forces, deterrence, and defense. It is not clear how they will affect the future U.S. stockpile of nuclear weapons, but they do reflect the impact of both budget cutbacks and ongoing improvements in other areas. The U.S. Department of Defense Fiscal Year 2017 Budget Request that the United States issued in February 2016 stated that:⁴⁶

The FY 2017 budget request funds the development and deployment of ballistic missile defense (BMD) capabilities to support the Administration's commitment to protect the U.S. homeland, deployed forces, allies, and partners. The FY 2017 budget request for missile defense is \$9.1 billion, which includes \$7.5 billion for the Missile Defense Agency and reflects a decrease of \$.7 billion below the FY 2016 enacted level of \$9.8 billion.

For homeland defense, the FY 2017 budget request maintains the commitment to increase the number of deployed Ground-Based Interceptors (GBI) to 44 (by delivering an additional 14 interceptors over the FY 2016 level of 30 fielded interceptors); continue development of the Redesigned Kill Vehicle (REKV); and proceed with the development of the Long-Range Discrimination Radar (LRDR). When combined with the planned GBI reliability, system engineering, and discrimination improvements, these enhancements will enable the missile defense system to deal effectively with the Intercontinental Ballistic Missile (ICBM) threat from North Korea and a potential ICBM threat from Iran.

The FY 2017 budget request also reflects the Department's commitment to building the regional missile defense forces that are interoperable with the North Atlantic Treaty Organization (NATO) Air Command and Control and Patriot Systems, Israeli Arrow and Patriot Weapon Systems, and Japan Aerospace Defense Ground Environment (JADGE), and Aegis Weapon Systems and SM-3 interceptors deployed by international partners.

The Department continues to support the European Phased Adaptive Approach (EPAA), which is designed to protect U.S. deployed forces and allies in Europe from ballistic missile attacks from the Middle East. The FY 2017 budget request supports the implementation of Phase 3 of the EPAA, to include the deployment of Aegis Ashore to Poland in the FY 2018 timeframe. The Aegis Ashore will be capable of launching Standard Missile-3 (SM-3) Blocks IA, IB, and IIA (delivery in 2018) variants.

The FY 2017 budget request also:

- Provides additional funding for key capabilities to meet the maturing threat from North Korean ICBMs and the potential threat from Iranian ICBMs, including GBI reliability and system engineering enhancements, GBI modifications to address the root causes of previous flight test failures, and operation of the Sea-Based X-band radar;
- Provides funding for advanced technologies to meet the future threat, including discrimination improvements, directed energy research, and multiple kill technologies;
- Provides funding for Terminal High Altitude Area Defense (THAAD) concept development and risk reduction activities for follow-on capabilities; and procures 24 THAAD interceptors in FY 2017;
- Procures 85 new Missile Segment Enhancement (MSE) missiles. The MSE is a significant evolutionary improvement over the Patriot Advanced Capability-3 (PAC-3) missile, and provides greater agility and lethality;
- Continues U.S. contributions to the Iron Dome system to defeat short-range missiles and rockets; continues support for the Arrow Weapon System, Israeli Upper Tier Interceptors, and the David's Sling Weapon System; and
- Continues conversion of Aegis ships to provide BMD capability and procures 35 SM-3 Block IB missiles to be deployed on Aegis BMD ships and at the Romania Aegis Ashore site.

The U.S. remains committed to civil nuclear programs as well. It has 99 nuclear power reactors producing approximately 20% of U.S. energy needs.⁴⁷

The U.S. Focus on Russia at a Time of Rising Chinese Capability

The U.S. has promoted significant U.S. and Russian nuclear weapons reductions, while not addressing Chinese nuclear forces. President Obama declared in April 2009 that the U.S. was committed to the long-term goal of zero nuclear weapons, and there has been a unilateral Congressional moratorium on nuclear tests since 1992. Although the 2001 Nuclear Posture Review suggested that the U.S. might develop new types of nuclear weapons, the 2010 Nuclear

Posture Review reversed course. The new posture is that nuclear weapons research will only involve components based on previous designs, not new capabilities or missions.

After the 2010 Review and the ratification of the New START Treaty, President Obama directed the Departments of State, Energy, Defense, and the intelligence community to analyze U.S. nuclear deterrence requirements and policy in the current security environment. A White House fact sheet released on June 19, 2013 described Obama's new guidance on nuclear employment planning, force structure, and posture decisions, which:⁴⁸

- affirms that the United States will maintain a credible deterrent, capable of convincing any potential adversary that the adverse consequences of attacking the United States or our allies and partners far outweigh any potential benefit they may seek to gain through an attack.
- directs DOD to align U.S. defense guidance and military plans with the policies of the NPR, including that the United States will only consider the use of nuclear weapons in extreme circumstances to defend the vital interests of the United States or its allies and partners. The guidance narrows U.S. nuclear strategy to focus on only those objectives and missions that are necessary for deterrence in the 21st century. In so doing, the guidance takes further steps toward reducing the role of nuclear weapons in our security strategy.
- directs DOD to strengthen non-nuclear capabilities and reduce the role of nuclear weapons in deterring non-nuclear attacks.
- directs DOD to examine and reduce the role of launch under attack in contingency planning, recognizing that the potential for a surprise, disarming nuclear attack is exceedingly remote. While the United States will retain a launch under attack capability, DOD will focus planning on the more likely 21st century contingencies.
- codifies an alternative approach to hedging against technical or geopolitical risk, which will lead to more effective management of the nuclear weapons stockpile.
- reaffirms that as long as nuclear weapons exist, the United States will maintain a safe, secure and effective arsenal that guarantees the defense of the U.S. and our allies and partners. The President has supported significant investments to modernize the nuclear enterprise and maintain a safe, secure, and effective arsenal. The administration will continue seeking congressional funding support for the enterprise.

The DoD's June 12, 2013 *Report on Nuclear Employment Strategy of the United States* referenced China directly, making clear that the United States will continue to seek maintenance of strategic stability with China and Russia:⁴⁹

While addressing the increasingly urgent threats of nuclear terrorism and proliferation, the United States must continue to address the more familiar challenge of ensuring strategic stability with Russia and China....

The United States is concerned about many aspects of China's conventional military modernization efforts and is watching closely the modernization and growth of China's nuclear arsenal. The lack of transparency surrounding its nuclear programs, specifically their pace and scope, as well as the strategy and doctrine that guides them, raises questions about China's long-term intentions.

The United States remains committed to maintaining strategic stability in U.S.-China relations and supports initiation of a dialogue on nuclear affairs aimed at fostering a more stable, resilient, and transparent security relationship with China.

.... The new guidance states that the United States will maintain a nuclear Triad, consisting of intercontinental ballistic missiles (ICBMs), submarine-launched ballistic missiles (SLBMs), and nuclear-capable heavy bombers. Retaining all three triad legs will best maintain strategic stability at reasonable cost, while hedging against potential technical problems or vulnerabilities. These forces should be operated

on a day-to-day basis in a manner that maintains strategic stability with Russia and China, deters potential regional adversaries, and assures U.S. Allies and partners....

Russian President Putin and President Obama discussed non-proliferation at the June 2013 G8 summit, and Obama gave a public speech on the issue on a June 19 visit to Germany, calling for reductions in strategic nuclear weapons stockpiles of one-third.⁵⁰ While concentrating on Russia and the European theatre, it seems that China was not mentioned.

Chinese Reactions and North and South Korean Developments

U.S. intelligence estimates of the Democratic People's Republic of Korea's (DPRK) nuclear weapons program have long warned that the DPRK has an active program. It is clear that Pyongyang has effectively ignored or terminated its past agreements to limit the production of nuclear materials and missile tests, posing very real concerns not only in the region, but also in the International community.

North Korean Developments from 2010 to 2013

According to a May 2010 UN Security Council report on the DPRK's nuclear program, "the Democratic People's Republic of Korea believes ... that its nuclear programme can provide the country a way to achieve its stated goal of becoming a 'strong and prosperous country' (*kangsongdaeguk*) by the year 2012 without succumbing to what they view as 'foreign influences.'"⁵¹

In June 2010, a DPRK Foreign Ministry spokesman stated that "recent developments" have underscored the need for the DPRK "to bolster its nuclear deterrent in a newly developed way."⁵² Given the aggressiveness in the DPRK sinking of the Republic of Korea (ROK) Corvette *Cheonan* in March 2010 and the shelling of Yeonpyeong Island in November, there may be little possibility that the DPRK will give up its nuclear weapons program any time soon.

DNI James R. Clapper noted in 2011 that:⁵³

Based on the scale of the facility and the progress the DPRK has made in construction, it is likely that North Korea has been pursuing enrichment for an extended period of time. If so, there is clear prospect that DPRK has built other uranium enrichment related facilities in its territory, including likely R&D and centrifuge fabrication facilities, and other enrichment facilities. Analysts differ on the likelihood that other production-scale facilities may exist elsewhere in North Korea.

Ironically, the "Arab Spring" may have acted as a further incentive to the DPRK. Some experts feel that North Korea sees Muammar Qaddafi's willingness to give up Libya's nuclear programs as one reason that the UN and NATO were willing to impose a no-fly zone and make a de facto effort to remove him from power. It also sees India, Iran, Israel, and Pakistan as examples of states whose nuclear efforts also give them political and military leverage where they may not have had it. Looking at the examples of Libya and Iraq, countries that gave up their WMD programs, the DPRK state media outlet noted on April 4, 2013 that "the nuclear weapons of Songun Korea are not something for display and the DPRK is very different from Iraq, Libya and the Balkans."⁵⁴

A Rand assessment in 2012 stated that:⁵⁵

It should also be considered that even speculative sources estimate that North Korea cannot have more than a few nuclear weapons available. If they exist, these devices are very precious to the regime, and it seems

unlikely that they would be mounted on inaccurate and unreliable missile systems—the risk of “loosing” a weapon is simply too high. Of course, a singular shot can never be totally ruled out, but the chances of success are very low. And even if this unlikely event was to happen, with North Korea unable to repeat this feat on short notice, this scenario should be seen more like a terrorist attack than nuclear warfare.

In 2013, U.S. officials assessed DPRK nuclear capabilities as “being more for deterrence, international prestige, and coercive diplomacy than for war fighting, and assess that Pyongyang most likely ‘would consider using nuclear weapons only under narrow circumstances.’”⁵⁶ The DPRK noted in a state-run newspaper, “The DPRK was left with no option but to choose the way of accessing nuclear deterrent in order to put an end to the U.S. ever-more intensified nuclear threat and defend the sovereignty, dignity, and vital rights of the country” – making nuclear weapons a matter of defense and dignity, not offense.⁵⁷

That same year, a former DOD official called the DPRK’s nuclear weapons acquisition a “survival game” in that nuclear weapons are the only reason anyone pays attention to the DPRK, which is necessary for the regime to gain aid and assistance. As the poorest country in the region, it would receive little without calling attention to itself so forcefully.⁵⁸

The Impact of the 2013 North Korean Test

In any case, the DPRK’s third nuclear test in February 2013 signaled that it was attempting to establish itself as a nuclear power or, at the very least, a de-facto nuclear state – like Israel, India, and Pakistan – a nation that is implicitly recognized as a nuclear state by the international community, though not formally recognized under the NPT framework. The Institute for Science and International Security (ISIS) also reported in August 2013, that satellite data indicated that the DPRK might have doubled the area used to enrich uranium at its Yongbyon reactor complex – its key source of weapons grade material – over the previous months.⁵⁹

It is also clear that the DPRK stepped up its nuclear research and production activity in 2014, as well as gave indications that it planned new nuclear tests in June and November.⁶⁰ Gen. Curtis M. Scaparrotti, the Commander of U.S. forces in the ROK stated publically on October 24, 2014 that he believed that the DPRK had probably developed a nuclear weapon small enough to be used in a nuclear warhead on a ballistic missile.⁶¹

Scaparrotti’s public statement at a Pentagon press conference was particularly significant because of an intelligence incident in April 2013, when the Defense Intelligence Agency had issued a statement that it had concluded with “moderate confidence” that the DPRK now had the technology to make a nuclear weapon small enough to fit a ballistic missile warhead. A few days later, James R. Clapper Jr., the Director of National Intelligence, stated that the DIA’s one-paragraph assessment had been declassified by mistake, and was inadvertent disclosure that revealed competing views on the country within the United States’ spy agencies.⁶²

On November 18, 2014, the U.S.-Korea Institute at SAIS at Johns Hopkins University, issued a report that recent commercial satellite imagery of the Yongbyon nuclear facility indicated the DPRK might be preparing to reprocess spent nuclear fuel to extract weapons-grade plutonium. When a United Nations committee recommended that the leaders of the DPRK should be prosecuted for human rights violations on November 19th, the DPRK threatened to conduct a fourth nuclear test.⁶³

It is also unclear how reliable or safe such a warhead would be, what the risks would be if it might malfunction, how well it could survive an accident, and whether the DPRK could predict its operational yield in kilotons.⁶⁴

The nuclear test as led to new tensions between the DPRK and the U.S. and the ROK. While initial reports indicated no sign of imminent DPRK military action accompanying a February 2013 nuclear test, by March 29, extra troop and vehicle movements at the DPRK's mid- and long-range missile sites were reported in the South Korean news. On March 28, the U.S. had flown two radar-evading B-2 spirit bombers over South Korea, flying from the U.S. and back, dropping inert munitions as a practice run in the South for the first time.

The following day, the DPRK put its missile units on standby to attack U.S. military bases, with Kim Jong-un reportedly signing a plan to technically prepare the country's strategic rockets to be on standby. In previous periods of U.S.-ROK joint military exercises, the DPRK has similarly put its military on highest readiness to fight, and Kim Jong-un has also previously given "final orders" for the DPRK military to wage revolutionary war with the ROK.⁶⁵

At the end of March, the DPRK announced a "new strategic line" to build both its nuclear arsenal and its economy simultaneously – because a growing nuclear deterrent would allow the DPRK to reduce military spending and invest more resources into light industries and the agricultural sector. In order to promote the new guidelines, the Central Committee of the ruling Workers' Party met for the first time since 1993, with Kim Jong-un presiding; the next day the Supreme People's Assembly – the DPRK's rubber-stamp Parliament – was expected to follow up and pass the guidelines.⁶⁶

In early April 2013, the DPRK passed a decree at the 7th session of the 12th Supreme People's Assembly on "further consolidation of the self-defense nuclear power status."⁶⁷ The North also announced that, as part of a plan to put all of its nuclear facilities to use in expanding its nuclear arsenal, it would restart its plutonium reactor at Yongbyon, the cooling tower of which had been destroyed pursuant to the Six Party Talks in 2007 – and continue construction on other reactors. The DPRK also cited the need to generate more electricity as a motivation for its actions.

Siegfried Hecker noted that it could take six months to a year for the DPRK to restart the aging plutonium reactor, and another three years to reprocess and extract enough fissile material for more weapons. Hecker has stated that the DPRK could do so without needing foreign materials or equipment, and, once operational, could produce 6 kg of plutonium per year.⁶⁸

Simultaneously, the U.S. reported that an Aegis-class warship had been moved to the ROK's southwest coast, and an SBX-1 sea-based radar platform was being moved to the western Pacific to monitor the DPRK as well.⁶⁹

In addition, the DPRK moved what appeared to be two Musudan missiles (unveiled in 2010 but not yet tested) and seven mobile launchers to its east coast in early April, and a ROK military source noted on April 21, 2013 that satellite images showed that the DPRK had moved an additional two short-range Scud mobile missile launchers to South Hamgyeong Province (also on the east coast). These missiles appeared to have been removed by early May 2013.⁷⁰

In response to the Musudan missiles on the east coast, Japan deployed ballistic missile interceptors near Tokyo.⁷¹ The U.S. repositioned two Aegis missile destroyers – the John McCain and the Decatur – in waters near the Korean Peninsula, and announced it would deploy a second TPY-2 missile-defense tracking radar in Japan,⁷² along with the Terminal High-Altitude

Area Defense (THAAD) system – a land-based missile defense system that includes a truck-mounted launcher, a component of interceptor missiles, an AN/TPY-2 tracking radar, and an integrated fire control system – to Guam within the next several weeks.⁷³

The United States deployed B-2 and B-52 bombers, both with nuclear capabilities, over the ROK, and used F-22s in drills with the ROK.⁷⁴ On April 10, ROK-U.S. combined forces raised their alert level to WATCHCON 2 to increase surveillance monitoring, while the ROK had raised its alert level to “vital threat,” as it appeared that at least one of the Musudan missiles was fueled and ready for launch.⁷⁵

The United States also announced that it would deploy additional ballistic missile interceptors in California and Alaska, increasing the number of ground-based interceptors from 30 to 44 at a cost of just under \$1 billion. While the system has only been successful in 50% of tests, the weapons send a signal of credible deterrence, showed the ROK and Japan that the U.S. remained committed, and also warned Beijing to restrain the DPRK or face an expanding U.S. military focus in the Asian-Pacific region; according to one senior government official, “We want to make it clear that there’s a price to be paid for letting the North Koreans stay on the current path.” The missiles could also be used to deter Iran.⁷⁶ At the same time, in an attempt to avoid misperception by the DPRK, a long-scheduled test of Minuteman-3 ICBMs was delayed.⁷⁷

The Impact of DPRK, ROK, and U.S. Developments Through 2016

Several foreign companies operating in the ROK announced they were considering contingency plans for their employees’ safety,⁷⁸ while the ROK stock market was negatively affected by the growing tension on the Peninsula. One expert noted that the DPRK was attempting to use extreme propaganda to damage foreign direct investments in South Korea, a type of asymmetrical psychological warfare attack on the ROK’s economic strength.⁷⁹ While on a visit to China, Secretary of State John Kerry attempted to garner increased Chinese support of the U.S. position towards the DPRK – meaning, a reduction in Chinese support of the North – and reportedly offered to reduce U.S. missile defense in the Asia-Pacific if the DPRK abandoned its nuclear program.⁸⁰

However, in early 2015 the United States made it increasingly clear to the ROK that it should install the THAAD system as a deterrent to the DPRK’s missile threats. This issue brought increased tension between Seoul and Beijing because China worries that the THAAD system would compromise its own strategic deterrent capabilities by having U.S. radar sensors extend deeper into Chinese territories.⁸¹

On January 6th, 2016 North Korea completed its fourth nuclear weapons test, which they claimed to be the detonation of a thermonuclear bomb. While North Korea released a statement noting the test was a “complete success”, numerous experts questioned the validity of the claim that it was thermonuclear weapon.⁸² Arms Control Association noted, “Monitoring stations from the Comprehensive Nuclear Test Ban Treaty Organization detected the seismic activity from the test. The type of device tested remains unclear, although experts doubt it was of a hydrogen bomb based on seismic evidence.”⁸³ Nevertheless, the test was another mark of North Korea’s nuclear resolve and presaged the uptick in Pyongyang’s nuclear posturing throughout 2016.

On February 7th, the DPRK used a Unha-3 rocket to launch the satellite Kwangmyongsong-4 into space.⁸⁴ However, most experts believe the launch was simply a pretext to test long-range

ballistic missile technology as the Unha rocket is also integral to the Taepodong-2—North Korea's ICBM in development. In a State Department press statement, John Kerry criticized the test as, “a flagrant violation of UN Security Council Resolutions related to the D.P.R.K. use of ballistic missile technology.”⁸⁵

On March 10th—days after DPRK officials claimed they had the capability to miniaturize nuclear warheads⁸⁶—North Korea launched two short-range ballistic missiles into the sea in response to the annual U.S.-ROK military exercise.⁸⁷ On April 8th, a new solid-fuel ICBM engine was successfully tested marking a substantial technological step forward from liquid to solid fuel.⁸⁸ Further troubling the international community, North Korea conducted an SLBM test on April 23rd, though it appeared to be unsuccessful.⁸⁹

North Korea also conducted six tests of its Musudan (KN-07) IRBM between April 15th and June 22nd. While the first five tests were failures, the sixth was assessed as a success by both the DPRK and independent experts.⁹⁰ WikiLeaks released the description of the Musudan made available to members of the Missile Technology Control Regime (MTCR):⁹¹

Recently, North Korea has developed a new land-mobile IRBM --called the Musudan by the United States. The Musudan is a single-stage missile and may have a range of up to 4,000 km with a 500 kg payload. The Musudan is derived from the SS-N-6 submarine-launched ballistic missile (SLBM) and represents a substantial advance in North Korea's liquid propellant technology, as the SS-N-6 had a much more advanced engine and used more energetic propellants -- unsymmetrical dimethylhydrazine (UDMH) and nitrogen tetroxide (N2O4) -- than those used in Scud-type missiles. Development of the Musudan with this more advanced propulsion technology allows North Korea to build even longer-range missiles -- or shorter range missiles with greater payload capacity -- than would be possible using Scud-type technology.

The successful test is of concern to the United States — assuming the maximum range estimates for the Musudan are correct — because it means North Korea has the capability to strike the U.S. territory of Guam.⁹² Additionally, as *The New York Times* notes, it could lead to further DPRK technological breakthroughs:⁹³

“Mr. Lewis said the development of the Musudan is especially worrisome because it also advances the North's KN-08 program — the development of its first intercontinental ballistic missile with a range to reach the continental United States. The first stage of the KN-08 missile comprises a pair of Musudan-type engines, he said.”

Despite the progress of the DPRK's nuclear and missile program, it is also unclear whether the DPRK has mastered the ability to efficiently and reliably weaponize a nuclear device it can deploy on a missile. The detonation of a nuclear explosive device is a significant scientific achievement, but creating a device that can be included in a small bomb or a missile warhead presents a number of difficult engineering problems.⁹⁴ Theoretically, the DPRK could use an aircraft, a ship, or even a vehicle to deliver a nuclear weapon, but these platforms are either vulnerable or unreliable.

ROK intelligence believes, however, that DPRK engineers were able to make significant progress in warhead miniaturization between 1999 and 2001, and the national defense ministry — along with ROK experts — now believes the DPRK has warheads that can be mounted on ballistic missiles.⁹⁵ Furthermore, ROK intelligence sources told the ICG in 2009 they believe the DPRK has deployed nuclear warheads for *Nodong* missiles in the northern part of the country.⁹⁶ As noted earlier, U.S. intelligence experts and senior officers also indicate in 2013 and 2014, however, that the DPRK may have reached the point where it has the technical capability to deploy a nuclear missile warhead.

The Impact of Broader ROK Reactions

China has not been able to ignore the fact that the creation of a ROK nuclear weapons program became the subject of a new political debate after the DPRK's new military provocations in 2010. Conservatives of the Saenuri party wanted the U.S. to redeploy tactical nuclear weapons, while an August 2011 survey of 2,000 South Koreans revealed that 63% supported the idea that the ROK should indigenously develop nuclear weapons to counteract the DPRK.

A similar survey in 2010 reported that 56% supported such development. In 2012, 66% were in favor of a weapons program; approximately the same results were seen in a 2013 poll that was taken several weeks after the DPRK's third nuclear test. From 2010 to 2012, the number of those who "strongly supported" such a program rose from 13% to 25%. At the same time, the 2013 poll results show that the "most salient" issue facing the country was job creation (40%), not North-South relations (8-15%).⁹⁷

Outgoing President Lee Myung-bak gave qualified support for the idea in mid-February, saying, "There are some people saying South Korea should also have nuclear weapons. Those remarks are patriotic and I think highly of them. I don't think the comments are wrong because they also serve as a warning to North Korea and China." Yet Lee still added, "It is premature and improper for our government to discuss nuclear armament because the ultimate goal is for Pyongyang to give up its nuclear program through international cooperation, in spite of the DPRK announcement that it was no longer interested in denuclearization."⁹⁸ This announcement meant the ROK could make a case that the 1992 Korean Peninsula denuclearization agreement was dead.

Some ROK analysts have argued that the DPRK's third nuclear test was the ROK's Cuban missile crisis. Many in the South are now convinced that the DPRK may never give up its nuclear weapons, leading some to argue that the ROK should either develop its own or the U.S. should restore the nuclear balance on the Peninsula by reintroducing U.S. nuclear weapons, which had been removed in 1991.⁹⁹

A small but growing number of South Koreans are concerned that the U.S., either because of budget cuts or a lack of will, might not provide its nuclear umbrella indefinitely – perhaps even pulling out of the country, like in Vietnam. Koreans are also frustrated that the U.S. and international community has been unable to end the DPRK's nuclear program.¹⁰⁰

One prominent national assemblyman (and the controlling interest in Hyundai) recently spoke at the April 2013 Carnegie International Nuclear Policy Conference, arguing that the ROK could potentially think about temporarily withdrawing from the NPT. As the U.S. was not stopping the DPRK's development of nuclear weapons, and the U.S. would not trade Seattle for Seoul, Chung argued that the ROK might need to develop nuclear capabilities of its own. It has also been noted that if there was not powerful (government) support for his comments in the ROK, he would not be saying such things in a public forum.¹⁰¹

Facing an extraordinary threat to national security, South Korea may exercise the right to withdraw from the NPT as stipulated in Article X of the treaty. South Korea would then match North Korea's nuclear program step by step, while committing to stop if North Korea stops.... South Korea should be given this leeway as a law-abiding member of the global community who is threatened by a nuclear rogue state.... The alliance has failed to stop North Korea from acquiring nuclear weapons. Telling us not to consider any nuclear weapons option is tantamount to telling us to simply surrender.

However, in the aftermath of the North Korea's 2016 nuclear test, support for South Korea possessing nuclear weapons decreased significantly according to polling. Toby Dalton of the Carnegie Endowment of International Peace states:¹⁰²

Contrary to the effective doubling of media coverage in 2016 as compared to 2013, public support for the nuclear option seems to have decreased. Moreover, polling in 2016 shows considerable variability regarding support for nuclear possession, casting doubt on earlier polling that seems to show consistent support in excess of 60 percent.

The most valid comparison of public attitudes between the two periods comes from Gallup Korea, which administered polls within two weeks of the 2013 and 2016 nuclear tests using consistent questions and an identical methodology. Those polls, which have equivalent margins of error, show an unambiguous overall decline in support for South Korean nuclear weapons possession from 64 percent in 2013 to 54 percent in 2016. That is matched by a ten-point increase in opposition, from 28 percent to 38 percent (see figure 1). The polls also reveal a decline in the percentage of respondents who view the North Korean nuclear tests as threatening to peace on the Korean Peninsula, from 76 percent in 2013 to 61 percent in 2016 (see figure 2). This drop is unexpected given North Korea's claim that it tested a hydrogen bomb in 2016, indicating a qualitative increase in the lethality of its weapons design.

Developing nuclear weapons would create major problems for the ROK's nuclear program and energy security. The ROK would run out of nuclear fuel and might not be able to access imported fossil fuels, while the U.S. might remove its security guarantee as punishment. The ROK would also have to drop out of the NPT, freezing relations with China, Japan, and Russia, and correspondingly increasing the likelihood of a DPRK attack.¹⁰³

The ROK possesses a large and extensive civilian nuclear power industry – the world's fifth-largest, with 21 reactors providing almost 40% of the ROK's electricity.¹⁰⁴ It has plans for a total of 40 reactors providing 59% of the ROK's electricity by 2030. Coupled with past weapons research, some estimate this technology could serve as a basis for any plans to develop nuclear weapons in the future should it feel that DPRK nuclear threats or a potential downturn in the U.S.-ROK alliance warrant such a move.

The ROK is also interested in developing an indigenous, plutonium fuel cycle for its civilian power program and had negotiated with the IAEA and the U.S. Department of Energy over safeguards for a "partially constructed, pilot pyroprocessing facility" that it wanted to complete by 2012, with a semi-commercial facility in place by 2025.¹⁰⁵ While ROK officials have claimed that the desire for such a facility was the result of "scientific curiosity" or part of plans to localize the production of nuclear fuel, it should be noted that these actions do have applications for weapons development, and questions remain about past activities that appear to have had more direct weapons applications.¹⁰⁶

Bill Gates visited the ROK in April 2013 to meet with President Park Geun-hye in order to promote his project of developing a next-generation nuclear reactor. His plan is for his nuclear start-up (TerraPower) and the Korea Atomic Energy Research Institute to jointly develop a 600 megawatt prototype by 2022, after which a final decision could be made on the feasibility of more large-scale production. Gates argued that it could be an effective means of dealing with the ROK's nuclear waste stockpiles – discussed further in the following sections – and that TerraPower was developing a safer and more economical next-generation reactor.

One ROK nuclear expert with links to the current administration said it agreed to do a three-month feasibility study with Gates. The reactor is called a "traveling wave reactor," similar to the ROK's sodium-cooled fast reactor development project. Both types use spent fuel from

conventional reactors, and can greatly reduce the volume of nuclear waste and its toxicity, compared to existing reactors.¹⁰⁷

Chinese and Russian Reactions

Traditionally, there seems to be a debate among Chinese citizens, government officials, and academics as to how much the DPRK's nuclear program should affect China's support of the DPRK. While one Chinese academic was suspended from his job after publishing an article pushing for abandonment of the DPRK – as discussed previously in this chapter – Xi Jinping, China's new president, said in a 2013 speech that no Asian country “should be allowed to throw a region and even the whole world into chaos for selfish gain,” an indirect though clear criticism of the DPRK.¹⁰⁸

According to U.S. Joint Chiefs of Staff Chairman General Martin E. Dempsey, the Chinese government wants to limit the DPRK's nuclear ambitions though it remains unclear what China would do to realize that goal. General Dempsey stated, “Chinese leadership is as concerned as we are with North Korea's march toward nuclearization and ballistic missile technology. And they have given us an assurance that they are working on it, as we are. But I didn't gain any insights into particularly how they would do that.”¹⁰⁹ His interlocutor, Chief of the General Staff Gen. Fang Fenghui, said Beijing is firmly opposed to the DPRK's nuclear weapons program and believes it should be addressed through dialogue.¹¹⁰

Yet, in the aftermath of the January nuclear test and February rocket launch, the United Nations Security Council enacted Resolution 2270 that levied the strongest round of sanctions ever imposed on North Korea. The sanctions were not only noteworthy for their strength, but also for the agreement between the U.S. and China regarding their necessity. *The New York Times* noted¹¹¹:

“The development also reflected closer cooperation between the United States and China on a longstanding dispute. The 15-member Council approved a resolution, negotiated for weeks by American and Chinese officials, that called for inspecting all cargo going in and out of the country, banning all weapons trade and expanding the list of individuals facing sanctions.”

Furthermore, there are early signs that China is taking the sanctions regime more seriously than it has previously. A project by the Center for Strategic and International Studies entitled *Beyond Parallel* tracked China-North Korean trade through satellite images in the aftermath of the January 2016 nuclear test and concluded that trade has decreased. Though satellite evidence itself is not fully conclusive, the evidence is interesting nonetheless. The *Beyond Parallel* report notes:¹¹²

Six specific areas were examined to assess potential presence of trade: Sinuiju Cheongnyeong Railroad Station, Sinuiju Customs Area, Sino-Korean Friendship Bridge, Dandong Customs Area, Dandong Railroad Station, and the Yalu River that separates the cities. North Korea-China trade was measured by the presence of 1) railcars at the stations; 2) trucks in customs areas; 3) trucks on the bridge; and 4) undocked boats in the Yalu River. Imagery analysis resulted in two particularly interesting conclusions.

First, the satellite images indicate a substantive reduction of economic activity on the Sino-North Korean border measured by the fewer trucks, trains, and boats in the February 2016 image compared to a similar timeframe in 2015. While snowfall was present in both cities in the later image, this can be assumed not to be a factor leading to reduced trade because other roads have been plowed and cars are seen on the city streets. In the aftermath of North Korea's January 2016 nuclear test, this observed downturn in activity was comprehensive across customs areas, railway, and road traffic.

Second, the images also suggest that independent Chinese actions were taken to reduce trade in this region after the nuclear test and prior to China's signing on to UN Security Council Resolution 2270. These findings run contrary to some estimates that Sino-North Korean trade (particularly Chinese exports) increased in the first quarter of 2016, and might confirm large anomalies in trade data as reported by China's customs statistics, KOTRA (Korea Trade-Investment Promotion Agency), and other organizations. Trends in North Korea data tend to be incomplete and opaque, especially for economic indicators. Adjusting our aperture to include data from satellite imagery can help supplement existing information, bringing on-the-ground reality into clearer focus. With a clearer understanding of events taking place in the region, policymakers and stakeholders can better plan for the future, including planning for unification.

Russia has not taken a strong stand against DPRK nuclear weapons, but has expressed concern about the risk of escalation on the Korean Peninsula – at least in the period before the Ukraine crisis in 2014. Prime Minister Vladimir Putin remarked in early April 2013 that, “I would make no secret about, we are worried about the escalation on the Korean peninsula because we are neighbors... And if, God forbid, something happens, Chernobyl which we all know a lot about, may seem like a child's fairy tale. Is there such a threat or not? I think there is... I would urge everyone to calm down... and start to resolve the problems that have piled up for many years there at the negotiating table.”¹¹³

Chinese Reactions to Nuclear Developments in India and Pakistan

North Korea is not the only regional nuclear power that can be a wild card in China's military development, and that needs to be considered in any U.S. and Chinese dialogue or negotiations on nuclear weapons. South Korea, Japan, and Iran are all potential nuclear forces. More importantly China faces current potential nuclear threats from India and must consider the risk Pakistan might lose control of some of its nuclear weapons.

At present, both countries continue to build up their nuclear-armed missile forces and stockpiles of nuclear weapons. While unclassified estimates are very uncertain and differ greatly in detail,

The Bulletin of the Atomic Scientists reported in November 2015 that India's nuclear weapons stocks and missiles could be summarized as follows:¹¹⁴

India's drive to develop a nuclear triad reached an important milestone in 2014 with the first nuclear-powered ballistic missile submarine deploying on its initial, brief, sea-trial voyage. Now, with several long-range ballistic missiles in development, the Indian nuclear posture is entering an important and dynamic new phase. After nearly two decades of concentrating on competition with Pakistan, India's nuclear outlook now seems to be focused more toward its future strategic relationship with China.

India is estimated to have produced approximately 540 kilograms (kg) of weapon-grade plutonium (IPFM, 2013: 21), sufficient for 135 to 180 nuclear warheads; however, not all of the material has been converted into nuclear warheads. Based on available information about its nuclear-capable delivery vehicles, we estimate that India has produced 110 to 120 nuclear warheads. It will need more than that to arm new missiles it is developing. In addition to the Dhruva plutonium production reactor near Mumbai, India plans to construct a second reactor near Visakhapatnam, on the east coast.

India has four types of land-based nuclear capable missiles that appear to be operational: the short-range Prithvi-2 and Agni-1, the medium-range Agni-2, and the intermediate-range Agni-3. At least two other longer-range Agni missiles are under development: the Agni-4 and Agni-5 (see Table 1).

It remains unclear how many of these missile types India plans to keep in its arsenal. Some may serve as technology development programs for longer range missiles. Although the Indian government has made no statements about the future composition of its land-based missile force, intermediate-range and medium-range missiles could potentially be discontinued, with only short and long-range missiles deployed in the future to provide a mix of strike options against near and distant targets. Otherwise India appears to plan a very diverse and expensive missile force.

The Indian ballistic missile force remains dominated by the short-range Prithvi system. Initially, the 150 km range Prithvi-1 was thought to be nuclear, but it appears that the system might be conventional and being replaced with the Prahaar short-range missile system. The Indian government stated in 2013 that the Prithvi-2 missile was the first to be developed under the country's prestigious Integrated Guided Missile Development Program (IGMDP) for India's nuclear deterrence (Government of India, 2013). The Prithvi-2 can deliver a nuclear or conventional warhead to a range of 250 kilometers (155 miles). After test launches in 2011, 2012, and 2013, the Indian government reported the range as 350 km (see, for example, Government of India, 2012), but the U.S. National Air and Space Intelligence Center (NASIC) lists the range as 250 km (NASIC, 2013: 13). The 350-km range version is sometimes called Prithvi-3 and has been converted to the ship-launched Dhanush missile. Given its small size (9 meters long and 1 meter in diameter), the Prithvi is difficult to spot in satellite images and therefore little is known about where it is deployed.

The two-stage, solid fuel, road-mobile Agni-1 missile became operational in 2007, three years after its introduction into the armed forces. The short-range missile is capable of delivering a nuclear or conventional warhead to a distance of approximately 700 km (435 miles). The mission of the Agni-1 is thought to be focused on targeting Pakistan, and an estimated 20 launchers are deployed in western India, possibly with the 334th Missile Group.

The two-stage, solid-fuel, rail-mobile Agni-2 is an improvement on the Agni-1, and can deliver a nuclear or conventional warhead more than 2,000 km (1,243 miles). The missile possibly began being introduced into the armed forces in 2004, but technical issues delayed operational capability until 2011. Fewer than 10 launchers are thought to be deployed in northern India, possibly with the 335th Missile Group. Targeting is likely focused on western, central, and southern China.

The Agni-3, a two-stage, solid-fuel, rail-mobile, intermediate-range ballistic missile is capable of delivering a nuclear warhead 3,200-plus km (1,988-plus miles). The Indian Ministry of Defence declared in 2014 that the Agni-3 is in the arsenal of the armed forces (Indian Ministry of Defence, 2014: 86), and the Indian military's Strategic Forces Command conducted its third user trial on April 16, 2015 from the Wheeler Island Test Range. If the Agni-3 is operational, there are probably fewer than 10 launchers. Several years ago an army spokesperson remarked that "with this missile, India can even strike Shanghai (IndoAsian News Service, 2008), but this would require launching the Agni-3 from the northeastern corner of India.

India is also developing the Agni-4 missile, a two-stage, solid fuel, rail-mobile intermediate-range ballistic missile capable of delivering a single nuclear warhead 3,500-plus km (2,175-plus miles). The Indian Ministry of Defence lists the range as 4,000 km (2,486 miles) (Indian Ministry of Defence, 2014). Following the final development test on January 14, 2014, the Ministry declared that Agni-4 serial production will begin shortly (Indian Ministry of Defence, 2014: 86). A second flight test conducted on December 2, 2014 was the Army's first Agni-4 launch (Indian Ministry of Defence, 2014). The missile will undergo a small number of induction tests before it becomes operational.

Although the Agni-4 will be capable of striking targets in nearly all of China from northern India, including Beijing and Shanghai, India is also developing the longer-range Agni-5, a three-stage, solid-fuel, rail-mobile, intercontinental ballistic missile (ICBM) capable of delivering a warhead more than 5,000 km (3,100-plus miles). The extra range will allow the Indian military to establish Agni-5 bases in central and southern India, further away from China.

India is modifying the Agni-5 launcher to carry the missile in a sealed canister. The new canister design will reduce the reaction time drastically ... just a few minutes from stop-to-launch, according to Avinash Chander (Pandit, 2013b), the Agni program engineer who headed India's Defence Research and Development Organisation from 2013 until he was sacked by the government of new Prime Minister Narendra Modi in January 2015 the same month the organization launched the Agni-5 from a canister launcher for the first time. The missile was in its deliverable configuration that enables launch of the missile within a very short time as compared to an open launch, the organization later stated (Defence Research and Development Organisation, 2015: 4).

Moreover, unlike previous Agni-5 flight tests that took place from rail mobile launchers, the January 2015 flight test appeared to use a new road-mobile launcher with the canister erected by four hydraulic arms from a six- or seven-axle trailer towed by a three-axle truck. Although the Defence Research and Development Organisation released a video of the 2015 launch, the frame did not show the new road-mobile launcher (Defence Research and Development Organisation, undated a), unlike videos of the 2012 and 2013 launches that clearly showed the rail-mobile launchers (Defence Research and Development Organisation, undated b, undated c).

Despite widespread speculation in news media articles and on social media that the Agni-5 will be equipped with multiple warheads even multiple independently targetable reentry vehicles (MIRVs) there is good reason to doubt that India can or will add multiple warheads or MIRVs to its arsenal in the near future. There are no reports of MIRV technologies being flight-tested, and loading multiple warheads on the Agni-5 would reduce its extra range, which was a key reason for developing the missile in the first place. The Agni-5 is estimated to be capable of delivering a payload of 1.5 tons (the same as the Agni-3 and -4), and India's first- and second generation warheads, even modified versions, are relatively heavy compared with warheads developed by other nuclear weapon states that deploy MIRVs. It took the Soviet Union and the United States hundreds of nuclear tests and many years of effort to develop reentry vehicles small enough to equip a ballistic missile with a MIRV. Moreover, deploying missiles with multiple warheads would invite serious questions about the credibility of India's minimum deterrent doctrine; using MIRVs would reflect a strategy aimed at quickly striking many targets, and would also run the risk of triggering a warhead race with India's adversaries. It remains to be seen whether China's decision to equip some of its silo-based ICBMs with MIRVs will trigger a similar development in India.

The Bulletin of Atomic Scientists described Pakistan's nuclear program in November 2015 as including the following nuclear and missile capabilities:¹¹⁵

We estimate that Pakistan has a nuclear weapons stockpile of 110 to 130 warheads, an increase from an estimated 90 to 110 warheads in 2011 (Kristensen and Norris, 2011). The U.S. Defense Intelligence Agency projected in 1999 that by 2020 Pakistan would have 60 to 80 warheads (U.S. Defense Intelligence Agency, 1999), but it appears to have reached that level more than a decade early, in 2006 or 2007 (Norris and Kristensen, 2007). In January 2011, our then-estimate of Pakistan's stockpile was confirmed in The New York Times by officials and outsiders familiar with the American assessment who said that the official U.S. estimate for deployed weapons ranged from the mid-90s to more than 110 (Sanger and Schmitt, 2011).

With several delivery systems in development, four operating plutonium production reactors, and its uranium facilities, however, Pakistan's stockpile will likely increase over the next 10 years. By how much will depend on many things. Two key factors will be how many nuclear-capable launchers Pakistan plans to deploy, and how much the Indian nuclear arsenal grows. Speculations that Pakistan may become the world's third largest nuclear weapon state with a stockpile of some 350 warheads a decade from now are, we believe, exaggerated because that would require a buildup two to three times faster than growth over the past two decades. Pakistan simply does not have the industrial capacity to develop, produce, and deploy that many additional nuclear weapon systems in a decade. Based on Pakistan's performance over the past 20 years and its current and anticipated weapons deployments, we estimate that its stockpile could more realistically grow to 220 to 250 warheads by 2025. If that happens, it would make Pakistan the world's fifth largest nuclear weapons state.

Pakistan appears to have six operational nuclear-capable ballistic missiles, three more than in 2011 (Kristensen and Norris, 2011): the short-range Abdali (Hatf-2), Ghaznavi (Hatf-3), Shaheen-1 (Hatf-4), and NASR (Hatf-9); and the medium-range Ghauri (Hatf-5) and Shaheen-2 (Hatf-6). At least two other nuclearcapable ballistic missiles are under development: the short-range Shaheen-1 A and medium-range Shaheen-3.

... Pakistan is developing two new cruise missiles, the ground-launched Babur (Hatf-7) and the air-launched Raad (Hatf-8). According to the Pakistani government, the Babur and Raad both have stealth capabilities and pinpoint accuracy, and each is described as a low altitude, terrain-hugging missile with high maneuverability (ISPR 2011a, 2011c). They are both much slimmer than Pakistan's ballistic missiles, suggesting some success with warhead miniaturization based on plutonium instead of uranium.

So far, China has shown only limited overt concern about the risks posed by regional nuclear weapons and proliferation, but almost certainly sees these risks as all too real and thus sizes and deploys its forces accordingly.

Chinese Reactions to Russian Nuclear Developments

It is unlikely that Russian forces would be involved in a high level of conflict against China or in Northeast Asia, but Russia's status as a nuclear power cannot be ignored. The IISS estimated that Russia has 1,499 warheads that could be deployed on SLMs, ICBMs, and heavy bombers. However, there is no accurate count of the country's tactical nuclear weapons, so the current total stockpile of tactical and strategic warheads is unknown. Furthermore, it is estimated that Russia possesses 737 metric tons of weapons grade-equivalent HEU and approximately 128 metric tons of plutonium; however, it should be noted that transparency in these areas is limited.¹¹⁶

All three arms of the Russian military are working to restructure its nuclear triad. The Russian Air Force was planning to deploy a new strategic cruise missile in 2012, the Navy is building Borei-class SSBN (Project 995), and the Strategic Rocket Forces are looking into a new liquid-propelled ballistic missile while continuing to use the solid-fueled RS-24 Yars. It does not look like much progress has been made on previous proposals to create a unified strategic command. According to the Nuclear Threat Initiative,¹¹⁷

The Kh-101/Kh-102 (AS-2X) likely entered service with the Russian air force in 2012, carried on the Tupolev Tu-95MS Bear H. The Kh-102 is the nuclear variant of this large cruise missile, with the Kh-101 a conventionally armed derivative. It is not known if the missile also entered service during 2012 with the half-dozen or so Tu-160 Blackjack bomber aircraft the air force has operational at any one time.

The Kh-101/102 programme has been under way since at least the latter half of the 1980s. Development was hampered by the collapse in defence expenditure in the 1990s and 2000s, but funding has improved in the last few years. After nearly 20 years in the doldrums the Russian air force now has a fifth-generation fighter in flight-test and also harbours ambitions to introduce a new strategic bomber (PAK-DA) after

2025. Tupolev, the USSR's main bomber design house, was selected in 2009 to develop the aircraft in preference to a bid from Sukhoi. Though the decision may seem obvious in that Tupolev has design history in bomber fleets, it has fared poorly since the collapse of the Soviet Union. Sukhoi, by comparison, has emerged as the country's pre-eminent combat-aircraft manufacturer. The government and industry finally concluded a contract in May 2012 covering the purchase of five Project 955A Borei SSBNs following prolonged negotiations over price and the schedule for the delivery of boats.

Russia has been working to modernize its rocket forces with both silo-based and mobile ICBMs as well as MIRVed variants. The country has had technical issues developing a new generation of SLBMs, though tests in 2011 of the new Bulava SLBM were reported successful. Other modified and new missiles have also been under development since then.¹¹⁸

Russia is also working to increase its missile air defense capabilities. The IISS reports that Russia created an Aerospace Defense Command on December 1, 2011, in order to unify as one force (the Aerospace Defense Forces) the country's Space Forces, Air Force air-defense units, and Air-Space Defense Strategic Command.

It has been reported that air-defense units that were previously part of the Air Force have been reorganized into 11 brigades that include both radio-radar and anti-aircraft missile regiments. It seems that this new Command will focus on medium- and upper-tier threats, leaving lesser threats to the geographical areas in which they appear. The IISS provides the following detail description of Russia's missile defense capabilities:¹¹⁹

Equipment includes early-warning systems (in two echelons – space and ground), space-tracking systems, Russia's Ballistic Missile Defence System (A-135) and missile systems in the service of AA brigades. The early-warning space echelon presently consists of only three satellites, providing limited surveillance with significant time gaps, a problem due to be solved by the introduction of new satellites. The ground echelon consists of seven independent radio-radar centres equipped with Dnepr, Daryal, Volga and Voronezh over-the-horizon radar stations. These systems can acquire a ballistic target at ranges from 4,000 to 6,000 kilometres. The only gap in the ground echelon's coverage is presently in the north-east, which will be closed when Voronezh-DM radars are put into service (possibly in Barnaul, Yeniseisk and Omsk). The A-135 system is deployed around Moscow and has only a 150km operational radius. It consists of a warning and monitoring system, silos of 53T6 Gazelle short-range anti-ballistic missiles and 51T6 Gorgon long-range anti-ballistic missiles. Though the system is relatively old, no modernisation plans have been announced. Meanwhile, the in-service date of the S-500 missile system, billed as a replacement, has slipped further.

The State Armaments Programme 2011–2020 allocated R4tr (U.S.\$136bn) for aerospace defence, and the plan is for around 100 SAM and Pantsyr-S1 systems, as well as more than 30 Vityaz medium-range missile systems, to be in service by 2020. Vityaz is currently in development and, according to media reports, will replace some S-300 systems. It is believed that the system uses the 9M96 and 9M100 missiles. Three anti-aircraft brigades were transferred from the air force and are deployed in the central industrial region, with 12 AA regiments (32 batteries in total) mainly armed with the S-300. Two AA regiments, with two batteries of S-400 in each, are deployed in Electrostal and Dmitrov. Two more S-400 regiments are deployed in the Baltic Fleet AOR and in the city of Nakhodka (Primorsk Territory). A fifth regimental S-400 unit is supposed to be delivered by the end of 2012. By 2015, the plan is for nine regimental S-400 units to be deployed.

In his 2015 remarks on Russia, DIA Director Lieutenant General Vincent R. Stewart stated,¹²⁰

Russia has made significant progress modernizing its nuclear and conventional forces, improving its training and joint operational proficiency, modernizing its military doctrine to integrate new methods of warfare, and developing long range precision strike capabilities. Despite its economic difficulties, Moscow is fully committed to modernizing both nuclear and conventional forces. At the same time, Russian forces have conducted exercises and a record number of out-of-area air and naval operations. We expect these to continue this year to include greater activity in the Caribbean and Mediterranean Seas.

...Russia will continue to place the highest priority on the maintenance of a robust and capable arsenal of strategic nuclear weapons. Priorities for the strategic nuclear forces include the modernization of its road-mobile intercontinental ballistic missiles (ICBMs) and upgrades to strategic forces' command and control facilities. In the next year, Russia will field more road mobile SS-27 Mod-2 ICBMs with multiple independently targetable re-entry vehicles. It also will continue development of the RS-26 ballistic missile, the Dolgorukiy ballistic missile submarine, its SS-N-32 Bulava submarine-launched ballistic missile, and next-generation air and ground-launched cruise missiles.

Chinese Biological and Chemical Weapons Programs

While China is a party to many of the international agreements regulating biological weapons, past U.S. government reports have alleged that China maintains a small offensive weapons program and has engaged in proliferation of related items to countries such as Iran. There have also historically been concerns in the United States about Chinese will to enforce export controls on dual use items, but the State Department concluded in 2011 that there were no compliance issues raised between the two.

In ratifying the Chemical Weapons Convention in 1997, China declared three former production facilities. While the U.S. has doubted that China was fully declaring its previous and current activities in this area, the U.S. reported most of its concerns resolved in 2011.¹²¹

¹ John W. Lewis and Xue Litai, *China Builds the Bomb* (Stanford: Stanford University Press, 1991), 242.

² Gregory Kulacki. "The Chinese Military Updates China's Nuclear Strategy," *Union of Concerned Scientists*, March 2015.

³ Gregory Kulacki. "The Chinese Military Updates China's Nuclear Strategy," *Union of Concerned Scientists*, March 2015.

⁴ Gregory Kulacki. "The Chinese Military Updates China's Nuclear Strategy," *Union of Concerned Scientists*, March 2015.

⁵ M. Taylor Fravel and Evan S. Medeiros. "China's Search for Assured Retaliation: The Evolution of Chinese Nuclear Strategy and Force Structure." *International Security* 35, no. 2 (2010): 79-81.

⁶ Wu Riqiang. "Certainty of Uncertainty: Nuclear Strategy with Chinese Characteristics." *Journal of Strategic Studies* 36, no. 4 (2013): 587-588.

⁷ Gregory Kulacki. "The Chinese Military Updates China's Nuclear Strategy," *Union of Concerned Scientists*, March 2015.

⁸ Wu Riqiang. "Certainty of Uncertainty: Nuclear Strategy with Chinese Characteristics." *Journal of Strategic Studies* 36, no. 4 (2013): 587; Philip A. Karber, "China's Underground Great Wall Challenge for Arms Control," (lecture, Washington DC, December 7, 2011)/

⁹ Gregory Kulacki. "The Chinese Military Updates China's Nuclear Strategy," *Union of Concerned Scientists*, March 2015.

¹⁰ Gregory Kulacki. "The Chinese Military Updates China's Nuclear Strategy," *Union of Concerned Scientists*, March 2015.

¹¹ Lora Saalman, "Prompt Global Strike: China and the Spear," *Asia Pacific Center for Security Studies*, http://www.apcss.org/wp-content/uploads/2014/04/APCSS_Saalman_PGS_China_Apr2014.pdf, 7.

¹² Philip A. Karber, "Strategic Implications of China's Underground Great Wall," *Georgetown University Asian Arms Control Project*, September 11, 2011.

¹³ M. Taylor Fravel and Evan S. Medeiros. "China's Search for Assured Retaliation: The Evolution of Chinese Nuclear Strategy and Force Structure." *International Security* 35, no. 2 (2010): 79.

¹⁴ "China," *Nuclear Threat Initiative*, updated January 2013. <http://www.nti.org/country-profiles/china/>.

¹⁵ Chinese State Council Information Office, *China's National Defense in 2008*, http://www.china.org.cn/government/central_government/2009-01/20/content_17155577_9.html.

¹⁶ People's Republic of China Information Office of the State Council, *China's National Defense in 2010*, March 31, 2011, p. 35.

¹⁷ People's Republic of China Information Office of the State Council, "China's Military Strategy," *Xinhu*, May 26, 2015, Strategic Guideline for Active Defense, http://eng.mod.gov.cn/DefenseNews/2015-05/26/content_4586748.htm.

¹⁸ DoD Report to Congress, *Military and Security Developments Involving the People's Republic of China 2016*, April 2016, p. 57, 58.

¹⁹ DoD Report to Congress, *Military and Security Developments Involving the People's Republic of China 2016*, April 2016, p. 58, 59.

²⁰ *The Ballistic Missile Threat to the United States*, Statement to the Senate Subcommittee on International Security, Proliferation, and Federal Services on the Ballistic Missile Threat to the United States, statement by Robert D Walpole, National Intelligence Officer for Strategic and Nuclear Programs, February 9, 2000.

²¹ David E. Sanger and William J. Broad, "China Making Some Missiles More Powerful", *The New York Times*, May 16, 2015, http://www.nytimes.com/2015/05/17/world/asia/china-making-some-missiles-more-powerful.html?_r=1.

²² National Intelligence Council, "Foreign Missile Developments and the Ballistic Missile Threat to the United States Through 2015", September 1999, <http://fas.org/irp/threat/missile/nie99msl.htm#rtoc12>.

²³ Department of Defense, *Report to Congress on Military and Security Developments Involving the People's Republic of China 2015*, April 2015.

²⁴ Department of Defense, *Report to Congress on Military and Security Developments Involving the People's Republic of China 2016*, April 2016.

²⁵ Hans M. Kristensen and Robert S. Norris, "Chinese nuclear forces, 2016", *Bulletin of the Atomic Scientists*, June 13, 2016. <http://www.tandfonline.com/doi/pdf/10.1080/00963402.2016.1194054>

²⁶ Jeffrey G. Lewis, *The Lures and Pitfalls of MIRVs: From the First to the Second Nuclear Age* ed. Michael Krepon, Shane Mason, and Travis Wheeler (Stimson Center: DC, 2016), 96.

²⁷ *Military and Security Developments Involving the People's Republic of China 2011*, Office of the Secretary of Defense, Annual Report to Congress, p. 36.

²⁸ *Military and Security Developments Involving the People's Republic of China 2011*, Office of the Secretary of Defense, Annual Report to Congress, p. 36.

²⁹ Department of Defense, *Military and Security Developments Involving the People's Republic of China 2015*, April 2015.

³⁰ *Annual Threat Assessment*, Senate Armed Services Committee, 113th Congress 15 (2014) (statement of Lieutenant General Michael T. Flynn, U.S. Army, Director of the DIA)

³¹ FAS, Status of World Nuclear forces, May 26, 2016. <https://fas.org/issues/nuclear-weapons/status-world-nuclear-forces/>; Prepared by Lesley McNiesh, Updated by Justin Bresolin; *Fact Sheet: Global Nuclear Weapons Inventories in 2013*, Center for Arms Control and Non-Proliferation March 2013, http://armscontrolcenter.org/issues/nuclearweapons/articles/fact_sheet_global_nuclear_weapons_inventories_in_2012/.

³² Center for Arms Control and Non-Proliferation Notes and Sources

Note: U.S. (2013), Russia (2012), UK (2011), France (2011-2012), China (2013), India (2013), Pakistan (2013), Israel (2013), DPRK (2013)

Note: Nuclear weapons programs are generally shrouded in secrecy and all of the totals listed above should be considered estimates. The numbers in the chart above are based on the most recent available estimates from the Bulletin of the Atomic Scientists Nuclear Notebook series by Robert S. Norris and Hans M. Kristensen. The specific sources include 2013 data on "Non-P5 Nuclear-Armed States" and "U.S. Nuclear Forces," 2012 data on "Indian Nuclear Forces," and 2011 data on "British Nuclear Forces".

According to State Department figures from the latest New START data exchange, as of September 1, 2012 the United States had 1,722 deployed strategic warheads and Russia had 1,499 deployed strategic warheads. This is a respective drop of 15 and increase of 9 warheads since the data exchange six months previously. U.S. totals are lower than the estimates in the chart primarily because New START counts bombers as having one warhead each, even though up to 20 warheads can be assigned to each bomber. In Russia's case, the number of warheads assigned to delivery systems in the chart also includes warheads assigned to submarines in overhaul, which are also not counted as deployed by the treaty. Under New START, both the United States and Russia must reduce their

stockpiles of deployed strategic warheads to less than 1,550 warheads by 2018. According to the December 2012 State Department report, operations to reduce U.S. missile launchers will begin in 2015.

The U.S. government disclosed in April 2010 that as of September 30, 2009, the total U.S. stockpile had 5,113 warheads. On March 1st, 2013, Drs. Hans Kristensen and Robert S. Norris revised that total to an estimated 4,650 warheads. This number excludes approximately 3,000 thousand warheads awaiting dismantlement, whereas the totals in the chart above include weapons awaiting dismantlement.

³³ Note: According to Henry Sokolski's report, The numbers used to generate this chart came from U.S. Department of State, "New START Treaty Aggregate Numbers" Fact Sheet; Robert S. Norris and Hans M. Kristensen, "U.S. Tactical Nuclear Weapons in Europe, 2011," *The Bulletin of Atomic Scientists* Vol. 67, No. 1, January/February 2011, pp. 64-73, available from www.bos.sagepub.com/content/67/1/64.full; Zia Mian, A.H. Mayyar, R. Rajaraman, and M.V. Ramana, "Fissile Materials in South Asia and the Implications of the U.S.-India Nuclear Deal," in Henry Sokolski, ed., *Pakistan's Nuclear Future: Worries Beyond War*, Carlisle, PA: Strategic Studies Institute, 2008, pp. 167-218; Shannon N. Kile, Vitaly Fedchenko, Bharath Gopalaswamy, and Hans M. Kristensen, "World Nuclear Forces," *SIPRI Yearbook 2011*, available from www.sipri.org/yearbook/2011/07; "Nuclear Weapons: Who has What at a Glance," *Arms Control Association*, available from www.armscontrol.org/factsheets/Nuclearweaponswhohaswhat; "Status of World Nuclear Forces," *Federation of American Scientists*, available from www.fas.org/programs/ssp/nukes/nuclearweapons/nukestatus.html; Alexander Glaser and Zia Mian, "Fissile Material Stockpiles and Production, 2008," *Science and Global Security*, Vol. 16, Issue 3, 2008, pp. 55-73, available from www.tandfonline.com/doi/abs/10.1080/08929880802565131; Warner D. Farr, "The Third Temple's Holy of Holies: Israel's Nuclear Weapons," *USAF Counterproliferation Center*, Counterproliferation Paper No. 2, September 1999, available from www.au.af.mil/au/awc/awcgate/cpc-pubs/farr.htm; and Kenneth S. Brower, "A Propensity for Conflict: Potential Scenarios and Outcomes of War in the Middle East," *Jane's Intelligence Review*, Special Report No. 14, February 1997, pp. 14-15; Robert S. Norris and Hans M. Kristensen, "U.S. Nuclear Forces, 2011," *Bulletin of the Atomic Scientists* Vol. 67, No. 2, March/April 2011, pp. 66-76, available from www.bos.sagepub.com/content/67/2/66.full; Robert S. Norris and Hans M. Kristensen, "Russian Nuclear Forces, 2011," *Bulletin of the Atomic Scientists* Vol. 67, No. 3, May/June 2011, pp. 67-74, available from www.bos.sagepub.com/content/67/2/66.full; Robert S. Norris and Hans M. Kristensen, "Global Nuclear Weapons Inventories, 1945-2010," *Bulletin of the Atomic Scientists*, Vol. 66, No. 4, July 2010, pp. 77-83; William Wan, "Georgetown Students Shed Light on China's Underground Missile System for Nuclear Weapons," *The Washington Post*, November 29, 2011; Hans Kristensen, "No, China Does Not Have 3,000 Nuclear Weapons"; and Robert Burns, "U.S. Weighing Steep Nuclear Arms Cuts," *Associated Press*, February 14, 2012, available from

www.boston.com/news/nation/washington/articles/2012/02/14/ap_newsbreak_us_weighing_steep_nuclear_arms_cuts/

³⁴ "China: Overview," *Nuclear Threat Initiative*, <http://www.nti.org/country-profiles/china/>, updated July 2015.

³⁵ "Nuclear," *Nuclear Threat Initiative*, <http://www.nti.org/country-profiles/china/nuclear/>, updated July 2015.

³⁶ "Nuclear," *Nuclear Threat Initiative*, <http://www.nti.org/country-profiles/china/nuclear/>, updated July 2015.

³⁷ "Nuclear," *Nuclear Threat Initiative*, <http://www.nti.org/country-profiles/china/nuclear/>, updated July 2015.

³⁸ Hans M. Kristensen and Robert S. Norris, "Chinese nuclear forces, 2016," *Bulletin of the Atomic Scientists*, June 13, 2016, 1-5.

³⁹ Global Security, "China, Weapons of Mass Destruction,"

<http://www.globalsecurity.org/wmd/world/china/nuke.htm>, accessed July 29, 2015.

⁴⁰ Excerpted from Gregory Kulacki, "China's Nuclear Arsenal: Status and Evolution," Union of Concern Scientists, October 2011 <http://www.ucsusa.org/assets/documents/nwgs/UCS-Chinese-nuclear-modernization.pdf>.

⁴¹ Federation of American Scientists (FAS), China: Nuclear Weapons,"

<http://www.fas.org/nuke/guide/china/nuke/index.html>.

⁴² Hans M. Kristensen and Robert S. Norris, "U.S. Nuclear Forces 2015," *Bulletin of the Atomic Scientists*, February 27, 2015. <http://bos.sagepub.com/content/71/2/107.full.pdf+html>.

⁴³ Department of Defense, Office of the Undersecretary of Defense (Comptroller), *FY2017 Budget Overview*, February 2016, 8-22.

⁴⁴ "United States," *Nuclear Threat Initiative*, updated October 2012. <http://www.nti.org/country-profiles/united-states/>.

⁴⁵ Amy F. Woolf, *Nonstrategic Nuclear Weapons*, Congressional Research Service, RL32572, February 23, 2015, p. 16-19.

-
- ⁴⁶ Office of the Secretary of Defense, *U.S. Department of Defense Fiscal Year 2017 Budget Request*, Department of Defense February 2016, p. 5-4
- ⁴⁷ "United States," *Nuclear Threat Initiative*, updated June 2015. <http://www.nti.org/country-profiles/united-states/>.
- ⁴⁸ Office of the Press Secretary, U.S. White House, "FACT SHEET: Nuclear Weapons Employment Strategy of the United States," June 19, 2013. <http://www.whitehouse.gov/the-press-office/2013/06/19/fact-sheet-nuclear-weapons-employment-strategy-united-states>.
- ⁴⁹ Department of Defense, *Report on Nuclear Employment Strategy of the United States Specified in Section 491 of 10 U.S.C.*, June 12, 2013.
- ⁵⁰ Hans Nichols and Mike Dorning, "Obama Calls for Russia to Join U.S. in Nuclear Arms Cuts," *Bloomberg*, June 19, 2013, <http://www.bloomberg.com/news/2013-06-19/obama-said-to-call-for-russia-to-join-u-s-in-arms-cuts.html>.
- ⁵¹ United Nations Security Council, "Report of the Panel of Experts established pursuant to resolution 1874 (2009)," S/2010/571, November 5, 2010, <http://www.securitycouncilreport.org>.
- ⁵² Simon Martin, "N. Korea vows to bolster nuclear deterrent," *Agence France Presse*, June 27, 2010; see also KCNA, June 28, 2010.
- ⁵³ James R. Clapper, Director of National Intelligence, *Statement for the Record on the Worldwide Threat Assessment of the U.S. Intelligence Community*, House Permanent Select Committee on Intelligence, February 10, 2011.
- ⁵⁴ "GFTUK Spokesman Supports New Strategic Line," *Korean Central News Agency*, April 4, 2013.
- ⁵⁵ Markus Schiller, *Characterizing the North Korean Nuclear Missile Threat*, RAND, 2012, p. 65.
- ⁵⁶ Mary Beth Nikitin, *North Korea's Nuclear Weapons: Technical Issues*, Congressional Research Service, February 12, 2013, p. 17.
- ⁵⁷ "U.S. Talk about 'Threat' from DPRK Censured by Minju Joson," *Korean Central News Agency*, March 2, 2013.
- ⁵⁸ Chuck Jones, former DoD and NSC official in Asian/Korean affairs, interview on February 14, 2013.
- ⁵⁹ Rick Gladstone and Gerry Mullany, "Study Suggests North Korea Is Doubling Area Devoted to Uranium Enrichment," *International New York Times*, August 7, 2013, <http://www.nytimes.com/2013/08/08/world/asia/north-korea-uranium-enrichment.html>; David Albright and Robert Avagyan, "Recent Doubling of Floor Space at North Korean Gas Centrifuge Plant: Is North Korea doubling its enrichment capacity at Yongbyon?," *ISIS*, August 7, 2013, [sis-online.org/uploads/isis-reports/documents/Yongbyon_fuel_facility_7Aug2013.pdf](http://isis-online.org/uploads/isis-reports/documents/Yongbyon_fuel_facility_7Aug2013.pdf).
- ⁶⁰ Jethro Mullen and Stella Kim, "North Korea steps up activity at its nuclear site, South says," *CNN*, April 22, 2014, Updated 3:33 PM ET, <http://www.cnn.com/2014/04/21/world/asia/north-korea-nuclear-activity/>; BBC, "More activity' at North Korea nuclear test site," April 22, 2014, Last updated at 03:22 ET, <http://www.bbc.com/news/world-asia-27107273>; "Timeline on North Korea's Nuclear Program," *New York Times*, November 19, 2014, http://www.nytimes.com/interactive/2014/11/20/world/asia/northkorea-timeline.html?_r=0.
- ⁶¹ David E. Sanger, "U.S. Commander Sees Key Nuclear Step by North Korea," *International New York Times*, October 24, 2014, <http://www.nytimes.com/2014/10/25/world/asia/us-commander-sees-key-nuclear-step-by-north-korea.html>.
- ⁶² Thom Shanker, David E. Sanger, Eric Schmitt, "Pentagon Finds Nuclear Strides by North Korea," *International New York Times*, April 11, 2013, <http://www.nytimes.com/2013/04/12/world/asia/north-korea-may-have-nuclear-missile-capability-us-agency-says.html>.
- ⁶³ Choe Sang-Hun, "North Korea Threatens to Conduct Nuclear Test," *International New York Times*, November 20, 2014, <http://www.nytimes.com/2014/11/21/world/asia/north-korea-threatens-to-conduct-nuclear-test.html>.
- ⁶⁴ See Thom Shanker, Eric Schmitt, and David E. Sanger, "Pentagon Finds Nuclear Strides by North Korea," *New York Times*, April 11, 2013; David E. Sanger and Choe Sang-Hun, "Intelligence on North Korea, and Its New Leader, Remains Elusive," *New York Times*, April 11, 2013.
- ⁶⁵ David Chance and Phil Stewart, "North Korea readies rockets after U.S. show of force," *Reuters*, March 29, 2013.
- ⁶⁶ Choe Sang-hun, "North Korea Vows to Keep Nuclear Arms and Fix Economy," *The New York Times*, March 31, 2013.
- ⁶⁷ Ham, Hyeong-pil. "Changes in North Korea's Strategic Line and Efforts for Strengthened Nuclear Capabilities," *ROK Angle*, Korea Institute for Defense Analyses, April 22, 2013.
- ⁶⁸ Mary Beth Nikitin, *North Korea's Nuclear Weapons: Technical Issues*, Congressional Research Service, February 12, 2013, p. 20-1.
- ⁶⁹ "North Korea 'to restart Yongbyon nuclear reactor,'" *BBC News*, April 2, 2013; Choe Sang-hun and Mark Landler, "North Korea Threatens to Restart Nuclear Reactor," *The New York Times*, April 2, 2013; Alastair Gale, "Pyongyang to Restart Nuclear Plant," *The Wall Street Journal*, April 2, 2013.; "North Korea Will Never be Recognized as a Nuclear State, Kerry Says," *Nuclear Threat Initiative*, April 3, 2013.

-
- ⁷⁰ “North Korea Is Said to Move Missiles,” *Reuters*, April 21, 2013; David E. Sanger and Choe Sang-hun, “Intelligence on North Korea, and Its New Leader, Remains Elusive,” *The New York Times*, May 6, 2013.
- ⁷¹ Christine Kim, “North Korea suspends last project with South, Putin cites Chernobyl,” *Yahoo! News*, April 8, 2013.
- ⁷² Thom Shanker, “U.S. to Bolster Missile Defense to Deter Attack by North Korea,” *The New York Times*, March 15, 2013.
- ⁷³ “North Korea Will Never be Recognized as a Nuclear State, Kerry Says,” Nuclear Threat Initiative, April 3, 2013.
- ⁷⁴ “South Korea pledges strong response against North,” *BBC*, April 2, 2013.
- ⁷⁵ “South Korea raises alert with North to ‘vital threat,’” *BBC*, April 10, 2013.
- ⁷⁶ Thom Shanker, “U.S. to Bolster Missile Defense to Deter Attack by North Korea,” *The New York Times*, March 15, 2013; Thom Shanker, David E. Sanger, and Martin Fackler, “U.S. Is Bolstering Missile Defense to Deter North Korea,” *The New York Times*, March 15, 2013.
- ⁷⁷ “Pentagon Delays Missile Test to Avoid Misperception by N. Korea,” *ABCTV Foreign News*, April 6, 2013.
- ⁷⁸ Choe Sang-hun, “North Korea Moves Missile to Coast, but Little Threat Is Seen,” *The New York Times*, April 4, 2013.
- ⁷⁹ Choe Sang-hun, “Tensions with North Korea Unsettle South’s Economy,” *The New York Times*, April 5, 2013.
- ⁸⁰ Max Fisher, “Can the U.S. widen the gap between China and North Korea?” *The Washington Post*, April 15, 2013.
- ⁸¹ Choe Sang-Hun, “South Korea tells China not to meddle in decision over missile system,” *The New York Times*, March 17, 2015.
- ⁸² David E. Sanger and Choe Sang-Hun, “North Korea Says It Has Detonated Its First Hydrogen Bomb” *The New York Times*, January 5, 2016.
- ⁸³ Kelsey Davenport, “Chronology of U.S.-North Korean Nuclear and Missile Diplomacy”, updated March 2016, <https://www.armscontrol.org/factsheets/dprkchron>.
- ⁸⁴ Thomas Karako, “North Korea’s February 2016 Satellite Launch”, *Center for Strategic and International Studies*, February 8, 2016, <https://www.csis.org/analysis/north-korea%E2%80%99s-february-2016-satellite-launch>.
- ⁸⁵ John Kerry, *D.P.R.K. Missile Launch*, U.S. Department of State, February 6, 2016.
- ⁸⁶ “North Korea ‘has miniature nuclear warhead’, says Kim Jong-un”, *BBC*, March 9, 2016, <http://www.bbc.com/news/world-asia-35760797>
- ⁸⁷ Jack Kim and Ju-Min Park, “North Korea fires missiles, to ‘liquidate’ South Korean assets”, *Reuters*, March 10, 2016 <http://www.reuters.com/article/northkorea-missiles-idUSKCN0WB2SN>.
- ⁸⁸ Jeffrey Lewis, “New DPRK ICBM Engine”, *Arms Control Wonk*, April 9, 2016, <http://www.armscontrolwonk.com/archive/1201278/north-korea-tests-a-fancy-new-rocket-engine/>.
- ⁸⁹ Don Melvin, Jim Sciutto and Will Ripley, “North Korea launches missile from submarine”, *CNN*, April 23rd, 2016 <http://www.cnn.com/2016/04/23/asia/north-korea-launches-missile-from-submarine/>
- ⁹⁰ Choe Sang-Hun, “North Korea’s Successful Missile Test Shows Program’s Progress, Analysts Say”, *The New York Times*, June 22, 2016, <http://www.nytimes.com/2016/06/23/world/asia/north-korea-missile-test.html>.
- ⁹¹ WikiLeaks, “Missile Technology Control Regime (MTCR): North Korea’s Missile Program”, October 6, 2009, https://wikileaks.org/plusd/cables/09STATE103755_a.html
- ⁹² Justin McCurry, “North Korea: UN security council ‘to meet’ after missile tests”, *The Guardian*, June 22, 2016, <https://www.theguardian.com/world/2016/jun/21/north-korea-launches-missile-but-test-appears-to-have-failed>
- ⁹³ Choe Sang-Hun, “North Korea’s Successful Missile Test Shows Program’s Progress, Analysts Say”, *The New York Times*, June 22, 2016, <http://www.nytimes.com/2016/06/23/world/asia/north-korea-missile-test.html>.
- ⁹⁴ International Crisis Group, *North Korea’s Nuclear and Missile Programs—Asia Report No. 168*, June 18, 2009, p. 9.
- ⁹⁵ International Crisis Group, *North Korea’s Nuclear and Missile Programs—Asia Report No. 168*, June 18 2009, p. 10; “N. Korea can make nuke-tipped missiles able to hit S. Korea: expert,” *Yonhap News Agency*, April 24, 2013.

-
- ⁹⁶ January 7, 2009, interview, in International Crisis Group, *North Korea's Nuclear and Missile Programs—Asia Report No. 168*, June 18, 2009), p. 11.
- ⁹⁷ “South Korea,” *Nuclear Threat Initiative*, updated January 2013. nti.org/country-profiles/south-korea; “Tensions Remain High as South Korea Performs Military Drills,” *NKNews.org*, February 14, 2013; Mark Hibbs, “Will South Korea Go Nuclear?” *Foreign Policy*, March 15, 2013.
- ⁹⁸ In-Soo nam, “North’s Test Re-ignites Debate in South on Nuclear Weapons,” *The Wall Street Journal*, February 15, 2013; “Pres. Lee: U.S. troops to stay if NK event causes reunification,” *The Dong-A Ilbo*, February 15, 2013.
- ⁹⁹ Martin Fackler and Choe Sang-hun, “As North Korea Blusters, South Flirts With Talk of Nuclear Arms,” *The New York Times*, March 10, 2013.
- ¹⁰⁰ Martin Fackler and Choe Sang-hun, “As North Korea Blusters, South Flirts With Talk of Nuclear Arms,” *The New York Times*, March 10, 2013.
- ¹⁰¹ Mark Hibbs, “Chung Mong-joon, the 123, and the State-Level Approach,” Carnegie Endowment for International Peace, April 14, 2013.
- ¹⁰² Toby Dalton, Byun Sunggee, and Lee Sang Tae, “South Korea Debates Nuclear Options”, *Carnegie Endowment for International Peace*, April 27, 2016, <http://carnegieendowment.org/2016/04/27/south-korea-debates-nuclear-options-pub-63455>.
- ¹⁰³ Mark Hibbs, “Will South Korea Go Nuclear?” *Foreign Policy*, March 15, 2013.
- ¹⁰⁴ World Nuclear Association, “Nuclear Power in South Korea,” <http://www.world-nuclear.org/info/inf81.html>.
- ¹⁰⁵ Miles A Pomper, “Concerns Raised as South Korea Joins GNEP,” *Arms Control Today* (January/February 2008).
- ¹⁰⁶ Miles A Pomper, “Concerns Raised as South Korea Joins GNEP,” *Arms Control Today* (January/February 2008).
- ¹⁰⁷ Ser Myo-ja, “Gates, Par discuss future nuclear energy options,” *Korean JoongAng Daily*, April 23, 2013.
- ¹⁰⁸ David E. Sanger and Thom Shanker, “U.S. Designs a Korea Response Proportional to the Provocation,” *The New York Times*, April 7, 2013.
- ¹⁰⁹ Jane Perlez, “U.S. General Sees Hope for Chinese Help on Korea,” *The New York Times*, April 24, 2013.
- ¹¹⁰ “China says new North Korea nuclear test possible,” *Associated Press*, April 22, 2013.
- ¹¹¹ Somini Sengupta and Choe Sang-Hun, “U.N. Toughens Sanctions on North Korea in Response to Its Nuclear Program”, *The New York Times*, March 2, 2016.
- ¹¹² “Images Suggest Decrease In Sino-NK Border Trade”, *Beyond Parallel*, Center for Strategic and International Studies, <http://beyondparallel.csis.org/decrease-in-trade-after-nuclear-test/>
- ¹¹³ Christine Kim, “North Korea suspends last project with South, Putin cites Chernobyl,” *Yahoo! News*, April 8, 2013.
- ¹¹⁴ Hans M. Kristensen and Robert S. Norris, “Indian nuclear forces, 2015,” *Bulletin of the Atomic Scientists*, November 27, 2015, <http://www.tandfonline.com/doi/pdf/10.1177/0096340215599788>.
- ¹¹⁵ Hans M. Kristensen and Robert S. Norris, “Pakistan nuclear forces, 2015,” *Bulletin of the Atomic Scientists*, November 27, 2015, <http://www.tandfonline.com/doi/pdf/10.1177/0096340215611090>.
- ¹¹⁶ “Russia,” *Nuclear Threat Initiative*, updated October 2012. <http://www.nti.org/country-profiles/russia/>; IISS, *Military Balance 2013*, p. 204.
- ¹¹⁷ “Russia,” *Nuclear Threat Initiative*, updated October 2012. <http://www.nti.org/country-profiles/russia/>; IISS, *Military Balance 2013*, p. 204.
- ¹¹⁸ “Russia,” *Nuclear Threat Initiative*, updated October 2012. <http://www.nti.org/country-profiles/russia/>.
- ¹¹⁹ IISS, *Military Balance 2013*, p. 204-5.
- ¹²⁰ Lt General Vincent R. Stewart., *Annual Worldwide Threat Assessment*, Senate Armed Services Committee, February 20, 2015.
- ¹²¹ “China,” *Nuclear Threat Initiative*, updated January 2013. <http://www.nti.org/country-profiles/china/>.