NUCLEAR COMMAND, CONTROL, AND COMMUNICATIONS SYSTEMS OF THE PEOPLE'S REPUBLIC OF CHINA



Recommended Citation

Fiona Cunningham, "NUCLEAR COMMAND, CONTROL, AND COMMUNICATIONS SYSTEMS OF THE PEOPLE'S REPUBLIC OF CHINA", NAPSNet Special Reports, July 18, 2019, https://nautilus.org/napsnet/napsnet-special-reports/nuclear-command-contro--and-communications-systems-of-the-peoples-republic-of-china/

FIONA S. CUNNINGHAM

JULY 18 2019

I. INTRODUCTION

In this essay, Fiona Cunningham describes the origins of China's NC3 system and its primary role in supporting China's land-based missile force. She outlines recent developments including mobility, "informatization" and automation of parts of the NC3 system, pending deployment of nuclear missile submarines, early warning systems, evolving organizational structure, and cultural factors that shape China's NC3 system and its orientation towards negative versus positive control.

Fiona Cunningham is CISAC Post-Doctoral Fellow, Center for International Security and Cooperation, Stanford University

Acknowledgments: The workshop was funded by the John D. and Catherine T. MacArthur Foundation.

This report is published simultaneously here by Technology for Global Security and here by Nautilus Institute and is published under a 4.0 International Creative Commons License the terms of which are found here.

The views expressed in this report do not necessarily reflect the official policy or position of the Nautilus Institute. Readers should note that Nautilus seeks a diversity of views and opinions on significant topics in order to identify common ground.

A podcast with Fiona Cunningham, Peter Hayes, and Philip Reiner on NC3 in a multipolar world is found **here**.

The views expressed in this report do not necessarily reflect the official policy or position of the Nautilus Institute. Readers should note that Nautilus seeks a diversity of views and opinions on significant topics in order to identify common ground.

Banner image is by Lauren Hostetter of Heyhoss Design.

II. NAPSNET SPECIAL REPORT BY FIONA S. CUNNINGHAM

NUCLEAR COMMAND, CONTROL, AND COMMUNICATIONS SYSTEMS OF THE PEOPLE'S REPUBLIC OF CHINA

JULY 18 2019

Summary

Since 1964, China has developed nuclear command, control, and communications (NC3) systems optimized for a retaliatory nuclear strike using a land-based missile force. China's first priority in its NC3 arrangements is strict control over the alerting and use of nuclear weapons by its top leaders, while its second priority is the survivability of NC3 systems. Technical systems include multiple, redundant means of communicating with mobile, land-based missiles, an automated command and control network allowing top leaders to skip levels in the chain of command, and likely technical use-controls. China's current nuclear attack early warning capabilities are limited to ground-based radars on Chinese territory, but those systems are likely to become more sophisticated in the next decade, perhaps with the addition of space-based early warning systems. China separates its warheads and missiles in peacetime to ensure negative control. Little is known about NC3

arrangements for China's nascent sea-based nuclear deterrent, but Chinese experts point out that China's NC3 arrangements for land-based missiles cannot be easily replicated at sea. Chinese leaders may be forced to confront difficult trade-offs between strict control and the survivability of its undersea nuclear weapons. The only known incident involving China's NC3 system was the alerting of China's first nuclear units during the 1969 Sino-Soviet border conflict.

Introduction

The People's Republic of China (PRC) has maintained a retaliatory nuclear posture since it tested its first nuclear device in 1964 and adopted a No First-Use Policy for its nuclear weapons. The PRC relies primarily on land-based missiles to carry out its only campaign for the use of nuclear weapons, a nuclear counterstrike campaign. This profile focuses on China's land-based missile force nuclear command, control, and communications arrangements (NC3), which is the most mature and transparent leg of China's nuclear deterrent. Where possible, it also speculates about possible arrangements for China's ballistic missile submarine NC3.

China's NC3 arrangements are optimized for a small, land-based missile force because its nuclear force has until recently been a strategic monad made up of land-based missiles. China is slowly taking steps to develop a sea leg to its nuclear deterrent and is likely to develop an air leg in the future, with a view to establishing a triad of delivery systems. The People's Liberation Army (PLA) Second Artillery Force, established in 1966, operated China's land-based missile force until it was renamed the PLA Rocket Force (PLARF) on January 1, 2016 as part of sweeping PLA organizational reforms implemented that year. Although Chinese leaders decided to develop a sea-based nuclear deterrent in 1958, China only began to seriously develop an operational ballistic missile submarine (SSBN) capability in the 1990s when its leaders decided to develop a second-generation SSBN. The PRC could have used aircraft to deliver nuclear weapons, but its early bombers lacked the range and survivability to deliver a retaliatory strike against the Soviet Union or United States. The PLA Air Force (PLAAF) may, however, gain a nuclear mission for a dual-capable strategic bomber in the future.[1]

This profile employs best-practice methods for using open sources to describe China's nuclear and military capabilities, organization, doctrine, and history. It draws on authoritative Chinese-language materials such as textbooks for PLA officers, historical texts authored by PLA officers and decision-makers, military newspapers, and selected secondary sources.

Historical Origins

Two key aspects of China's nuclear strategy have shaped its NC3 system since the 1960s. First, authority to use China's nuclear weapons is reserved for its top civilian and military leaders only. As a result, China has prioritized negative control over positive control for its nuclear weapons. Second, China intends to use its nuclear weapons for retaliation only. To implement a retaliatory posture, China needed to be able to determine whether it had been attacked with nuclear weapons and an NC3 system that could transmit orders to use nuclear weapons from top leaders to missile launch battalions after the PRC had absorbed a nuclear attack. Where Chinese leaders have faced trade-offs between the requirements of strict control and survivability of the missile force in the past, they have prioritized strict control.

The priorities of China's NC3 system, to enable strict command and control arrangements and the ability to ride out a nuclear attack, were established in 1967. China's top military decision-making body, the Central Military Commission (CMC), promulgated a set of regulations that placed the force's development, deployments, maneuvers and operations under its direct control.[2] Since 1967, the CMC has directly commanded China's missile forces. By contrast, other PLA services are

commanded by the CMC through the PLA's geographical combatant commands, the Military Regions, which were re-structured into peacetime Theater Commands during the 2015-6 PLA reforms. The 1967 regulations established a three-tier chain of command from the CMC to the Second Artillery Headquarters, to the missile combat base, to the missile battalion.[3] By 2004, a fourth tier was added to the bottom of the chain of command, the launch company.[4]

The development of an NC3 system to fully implement the 1967 regulations was hampered by the domestic political turmoil within the PRC during the Cultural Revolution between 1966 and 1976. Chinese strategists and missile force officers generally agree that the Second Artillery achieved the ability to launch nuclear weapons independent of other units of the PLA in 1984.[5] After 1973, the CMC and the PLA General Staff Department decided that the Second Artillery would develop an automated command system that would eventually be rolled out to the rest of the PLA.[6] By the end of the 1970s, a research institute established within the Second Artillery surmounted two early obstacles to that command system – unreliable computers and Chinese-language data entry. During a missile test launch in October 1985, the Second Artillery tested a Chinese character microcomputer (*Hanzi weiji*), which transmitted the oral instructions of the commander to their recipients. The microcomputer was certified following the test and those computers formed the nodes of a "distributed command network reporting transmission network."[7] In the mid-1980s as the Second Artillery linked multiple computer types to its network, borrowing standards from the U.S. Alpha computer network system.[8]

After the Gulf War the Second Artillery began to develop a command automation system with operational support as its main goal. That system combined command and control, communications, intelligence, electronic warfare, and operational support functions.[9] Command automation was a major priority for the Second Artillery under the 9th Five Year Plan (1995-2000). In that period, the missile force rolled out the automated command system at scale and began to establish a system that was interoperable with automated command systems for other PLA services. In the words of one Second Artillery leader, the Force "started to form a mutually supporting technological system that included the special characteristics of the Second Artillery but was fundamentally identical to the overall PLA [system]."[10] During the 2000s, the Second Artillery addressed inadequacies in its automated command system and established a mobile combat system structure to provide C3I to its road-mobile missile force. The Force settled on a model for that mobile combat system structure after more than two years of deliberation and testing in different environments.[11]

Technical Systems

China's early NC3 relied heavily on radio-frequency communications equipment, but has increasingly diversified its means of communication to include fiber-optic cables and satellites. The Second Artillery reportedly has a dedicated fiber-optic communications network.[12] That network likely became operational in 1999. The Second Artillery also likely uses fiber-optic cables laid for both civilian and military use during the 1990s and early 2000s.[13] In 1994 top military leaders recognized that the PLA needed to update its military communications network but proposed that the civilian government could take the lead in updating that system using state-of-the-art technology. The communications system could be used by civilians in peacetime and the military during wartime, an example of civil-military integration (*junmin ronghe*).[14] The 2004 *Science of Second Artillery Campaigns*, a textbook for China's missile forces, refers to a reliable and redundant communications system relying on radio, cables, fiber-optic cables, and satellites. If a missile unit's communications links are severed, officer liaison units may personally deliver orders to missile units.[15]

By the early 2000s, the Second Artillery used an automated command and control system for its missile units. That system enabled command and control over mobile missile brigades from either

missile bases or the missile force headquarters in Beijing. The functions of the system include transmitting commands, fusing intelligence, and monitoring launches in real-time.[16] Commanders in distant locations are therefore able to monitor preparations for a missile launch using real-time video and audio, issue orders, and use a variety of information sources to support their decision-making, such as intelligence, mapping, and weather data. The system was rolled out across all Second Artillery units in approximately 1998. Media reports from 2014 suggest that the command and control network for missile brigades is separated from other computer networks serving the brigade. Missile force newspaper reports indicate that brigade headquarters are equipped with four separate computer networks, one of which is the dedicated command network (*zhihui zhuanwang*) that is separate from a comprehensive military information network, office local network, and the worldwide internet.[17]

Little information about China's SSBN communications systems is available in open sources. Analysts expect that if the PLA Navy (PLAN) keeps its SSBNs on continuous at-sea deterrent patrols in future, it will initially conduct those patrols close to Chinese shores and protect its submarines using conventional naval capabilities. Once China develops a next-generation SSBN that is quieter than its current-generation Type-094 boat, it may shift from a bastion to an open ocean mode of deployment.[18] Wu suggests that China uses the same two super low-frequency (SLF) communications towers, located in northern Shaanxi province and Henan province, for both SSBNs and attack submarines.[19] Zhao points to Chinese publications that suggest the PLA is researching extremely low-frequency radio communications, an airborne communications system, and satellite communications to add redundancy to its SSBN NC3I.[20] Nevertheless, Wu points out that the PLA Navy cannot replicate the Second Artillery's NC3I and warhead handling practices on land. For example, China's ballistic missile submarines cannot make use of the last-resort option of dispatching orders using a liaison unit if their communications with superiors are severed,[21] which may lead Chinese leaders to consider pre-delegating authority to use nuclear weapons.

The practices of land-based missile communications regiments offer some insights into how China employs technical systems to ensure reliable communications with nuclear missile units. Each nuclear missile brigade relies on a communications regiment to enable communications between the missile force headquarters and launch battalions. Communications regiments likely rely on fiber-optic and satellite means to communicate with superiors, and "tactical line-of-sight communications" to communicate with other elements of the brigade.[22] Until the past few years, all Chinese mobile ballistic missiles could only be launched from a pre-surveyed launch. At least two of China's newest mobile ballistic missiles, the nuclear-variant of the DF-26 and the DF-31AG, are believed to be able to launch without a pre-surveyed site. It is not clear whether and, if so, how this flexibility in launch site location affects a unit's arrangements for communicating up the chain of command. Media reports from 2014 indicate that communications units have been training to rapidly establish field combat operations communications networks, including telephone, videoconferencing, and a command networks, within 30 minutes.[23] Communications regiments are also reported to train to overcome background and enemy interference with communications links by switching between wireless and satellite to wired communications, and frequency hopping.[24]

China's missile attack early warning system at present relies primarily on ground-based radars, but that system is likely to become much more sophisticated in coming years. Chinese texts state that its land-based missile force would be alerted if China received warning of an imminent missile attack to ensure the survivability of the force,[25] but its existing early warning radars would not provide a long period of warning. China has three phased array ground-based radars, similar to U.S. PAVE PAWS radars, located in Heilongjiang province in the country's northeast, Fujian province in its southeast, and Xinjiang in its northwest.[26] Improving China's strategic warning capabilities was an explicit priority for the PLA in China's most recent 2015 defense white paper.[27] China has no

space-based missile attack early warning system but is likely to be developing one. A space-based early warning system would enable China to shift to a launch-under-attack alert status if it chose to do so in the future.[28] A Chinese space-based early warning system is, however, unlikely to be operational for approximately another decade.[29]

To implement a retaliatory nuclear posture, China also needed to establish a means of detecting a nuclear attack on its territory. The PLA began to build a nuclear blast detection system in 1974--and linked reporting centers with the military regions and CMC throughout the 1980s.[30] It established a ground-based nuclear detonation detection network in the late 1980s.[31] The PLA's official glossary of military terms, the *Junyu*, lists nuclear explosion, infrasonic wave, seismic wave, electromagnetic pulse, hydroacoustic wave, and radiation means of detecting a nuclear blast.[32]

Positive and Negative Controls

China's missile forces prioritize negative control over positive control of nuclear weapons to implement the strict control of the CMC and Politburo over the alerting and use of nuclear weapons. Until the 1990s, the Second Artillery relied primarily on the physical separation of warheads in a central storage base from delivery systems during peacetime to avoid accidental, mistaken or unauthorized launches. Although today the PLA Rocket Force likely has technical use-controls for its nuclear weapons, it retains the practice of separating warheads and delivery systems in peacetime. Warheads are stored in a central depot tunneled into a mountain in Shaanxi province. They may only be dispatched to missile units to be mated with their delivery systems when the CMC and Politburo orders an increase in the alert status of the nuclear force.[33] Equipment inspection support units attached to each missile unit likely have responsibility for handling nuclear warheads once they are received from the central nuclear warhead storage depot.[34] The PLA Navy commands China's SSBN force, but the navy's role in warhead handling for China's submarine launched ballistic missiles (SLBMs) is unknown and it is not clear whether China's SSBNs will carry SLBMs in peacetime.[35] Chinese experts acknowledge the pros and cons of replicating the land-based missile force's practice of separating warheads and delivery systems in peacetime for its sea-based deterrent.[36]

China likely has technical use-controls for its nuclear weapons, although very little is known about its technical and personnel systems for ensuring negative control of its nuclear weapons. In the 1990s, scientists from China's Academy of Engineering Physics requested U.S. assistance with technical use-controls for its nuclear weapons as an additional mechanism of ensuring negative control. The United States did not provide any assistance with permissive action lock (PAL)-style use-control devices. Instead, China likely developed its own technical use-controls, and/or received assistance from Russia.[37]

Chinese missile forces have a three-tier alert system to ensure that the force is able to ride out an enemy nuclear attack, but it does not maintain a launch-on-warning alert status in peacetime. China's missiles and warheads remain separated when the force is at peacetime alert status, the first-tier alert. When the missile forces enter second-tier alert status, they are preparing to carry out launch orders. Once the missile forces enter third-tier alert status they are ready to carry out launch orders.[38] In recent years, some PLA publications have indicated that China could adopt a launch-on-warning alert status for its nuclear missiles.[39] But some Chinese nuclear strategists dispute whether such a change to the operational doctrine of the missile force would be consistent with China's No First-Use policy.[40] Others question the prudence of a launch-on-warning posture given the thin margin for error in the event of a false alarm. In any case, China is still likely a decade away from even being able to adopt a launch-on-warning alert status, given its need to invest in space-based early warning systems to provide a longer period of warning.

Organizational Structure

China's top military leaders on the Central Military Commission (CMC) and top political leaders on the Politburo Standing Committee must authorize the alerting and use of nuclear weapons.[41] Unlike other PLA services, the Second Artillery and its successor organization, the PLARF, are commanded directly by the CMC, rather than indirectly through the geographical Theater Commands responsible for the operations of the navy, air force, and army.

The PLA Rocket Force headquarters are located in Beijing's northwest. China's land-based missile forces are organized into six missile bases located in Liaoning province in China's northeast, Anhui province in the east, Yunnan province in the southwest, Henan and Hunan provinces in the center of the country, and Gansu province in the northwest. Conventional and nuclear missile brigades are subordinated to each base and garrisoned in different locations. Each missile brigade is composed of subordinate missile battalions, which are further divided into launch companies and then launch platoons. China's central warhead depot, located in the center of the country in Shaanxi province, has an equivalent military rank to a missile base.[42]

CMC orders to alert or use nuclear weapons are likely transmitted to the CMC Joint Operations Command Center, then to the Rocket Force Headquarters, then to missile bases and down the chain of command to launch companies. Alternatively, orders may be transmitted directly from the Rocket Force Headquarters to missile brigades, battalions or launch companies, making use of the skip-echelon function of the automated command system.

To ensure the survivability of command over nuclear missile units, command of those units is organized into basic (*jiben*), reserve (*yubei*), and rear (*houfang*) command posts. As appropriate, the missile force may also establish forward (*qianjin*) and directional; (*fangxiang*) command posts. Reserve and rear command posts are only staffed at the second and third tiers of China's alert levels, when missile units are preparing and actually ready to carry out launch orders.[43]

Cultural Imperatives

China's N3CI arrangements are influenced by a tendency among China's top leaders over the years to retain strict control over the use of strategic weapons, both nuclear and non-nuclear.[44] Those preferences led to China's prioritization of negative over positive control of its nuclear weapons, and prioritization of strict control over the survivability of the nuclear force. For example, China's practice of separating warheads and delivery systems for its land-based missile force would have been redundant once China established technical use-controls for its nuclear weapons. Warhead and delivery system separation increases the challenges of ensuring that the nuclear force can survive an adversary's attempt at a disarming first-strike. Similarly, there is no evidence that Chinese leaders have pre-delegated authority to use nuclear weapons down the chain of command in the event that its leadership is decapitated.

In the past decade or so, Chinese leaders have emphasized the need for the PLA to train under more realistic conditions. Media reports suggest that missile force training has become more rigorous and realistic to properly prepare the force for actual combat. For example, missile units train to live and operate their equipment in underground shelters for extended periods of time, presumably to simulate riding out a nuclear attack. Underground training exercises now use real weapons, and ration water and food, to better simulate the conditions of actual combat.[45] Media reports also indicate, however, that some units trained to satisfy the training evaluation standards rather than to ensure combat effectiveness, for example by postponing exercises until their best personnel or ideal weather conditions were available.[46]

Formal Definitions and Legal Framework

Legal definitions for China's NC3 system are not available in open source materials, while definitions of nuclear command, control, communications and intelligence (C3I) systems in PLA reference texts are general rather than specific to China. The 2012 edition of PLA's official military glossary of terms, the *Junyu*, refers to a "command information system of the Second Artillery." That system is defined as "a command information system for the exclusive (*zhuanmen*) use of the Second Artillery to ensure that each level of command structure commands subordinate units and sub-unit maneuvers and missile use. It is an important part of the military command information system."[47] A missile force reference text describes a C3I system in general terms, rather than describing China's NC3I system. A C3I system (C3I *xitong*) is "a system used for command, control, communications, and intelligence. It is also referred to as military command automation system (*jundui zhihui zidonghua xitong*) or military command information system (*jundui zhihui xinxi xitong*). Made up of personnel informationization technology equipment and computer software, it has the characteristics of human-machine interaction and distributed network links and 1995functions of initiating command and control of the use of armed force."[48] The same text defines a strategic C3I system as "the C3I system at a country's highest-level military command structure that implements uninterrupted command and control of armed force. It is primarily made up of intelligence gathering systems (or intelligence and surveillance systems), strategic warning systems, communications network systems, and all levels of command center computer automated data management, display, and command monitoring and control systems." Strategic C3I systems are not exclusively nuclear.[49]

The legal framework for China's NC3 system is unknown.

Interactions with Other Systems

The degree of overlap in the C3I systems of China's conventional and nuclear missile units has garnered much attention in recent years, largely because of the growth of China's conventional missile force. China's conventional missile units, the first of which was established in 1993, are also commanded by the Second Artillery/PLARF. Western experts worried that U.S. efforts to destroy sensors, infrastructure, or launchers associated with China's conventional missile force could inadvertently damage China's nuclear missile force and provoke Chinese nuclear retaliation.[50] Chief among those concerns were U.S. efforts to target China's dual-capable DF-21 nuclear and conventional medium-range ballistic missile, which includes an anti-ship variant and, more recently, its dual-capable DF-26 intermediate-range ballistic missile. Analysts have also worried about inadvertent escalation risks from the United States attacking SLF communications stations supporting both China's attack submarines as well as its SSBNs.[51]

Although China's conventional and nuclear missiles share infrastructure, including command and control systems, for bureaucratic reasons, the overlap in C3I systems has diminished over time. At least until the Taiwan Straits Crisis in 1995-96, China's conventional missile units likely shared the same C3I system as its nuclear units. All PLA Rocket Force Bases command both conventional and nuclear missile brigades, such that both types of units share common infrastructure at the base level.[52] If PLA Rocket Force bases were attacked, the skip-echelon command system, enabled by the automated command and control system, would ensure continuity of command of nuclear (and conventional) units if the unit was no longer able to communicate with its immediate superiors at the appropriate missile base.[53]

Conventional missile units could be commanded through Theater Commands as well as directly by the CMC, while nuclear missile units can only be commanded by the CMC, which appears to have led to some divergence in C3I systems for nuclear and conventional missile units. The option of

assigning conventional missile units to joint theater commands ensures coordination of conventional missile strikes with naval, air and ground forces in a joint campaign. The command network for some conventional missile brigades is connected to the PLA's command platform for joint conventional operations.[54]

Incidents

Few incidents involving China's NC3 system are reported in open-source literature. One incident involved the alerting of China's first nuclear missile units during a PLA-wide alerting during the 1969 Sino-Soviet border crisis. Very little reliable information is available about the role of the nuclear force in that crisis and the intentions of the Chinese leader who ordered the alert, Marshall Lin Biao, in the midst of during the Cultural Revolution.

The Sino-Soviet border dispute flared in early 1969 when PLA units attacked their Soviet counterparts along the disputed Sino-Soviet border early that year. The Soviet Union counterattacked, massed troops along the border and, in August 1969, issued nuclear threats against China.[55] Mao's chosen successor, Marshall Lin Biao, who was directing the PLA's affairs at the time, alerted the PLA on October 17, 1969, and dispersed Chinese leaders throughout the country. Marshall Lin's "No. 1 Order" to alert the PLA placed China's nascent nuclear missile force on alert for the first and only time. Lewis and Xue claim that the missile force was explicitly alerted as part of the No. 1 order.[56] Wu points out, however, that China's nuclear force was too weak and the range of the DF-2 was too short to strike a Soviet city in 1969.[57] Accounts of the crisis in secondary sources also suggest that Soviet jamming interrupted communications between PLA units in the front lines and their superiors in 1969, although it is unknown whether (and unlikely that) these communications interruptions affected the nuclear units. The crisis allegedly served as a lesson in the wartime vulnerability of China's overall military C3I system.[58]

Future Directions of China's NC3 Systems

China's NC3 systems are likely to become more robust in future, although the addition of new capabilities such as space-based early warning and the SSBN leg are likely to create additional vulnerabilities. Longstanding concerns among Chinese analysts about a U.S. disarming attack on its nuclear arsenal, as well as more recent concerns about cyber attacks on its NC3 systems, are likely to drive investments in redundant communications and early warning systems to ensure close protection of the nuclear force. Nevertheless, the preference among Chinese leaders for strict control over strategic weaponry shows no signs of abating, such that China's preference for negative over positive control in the use of nuclear weapons is also likely to continue. Concerns about NC3 vulnerability and negative control are, however, likely to pose difficult trade-offs as new capabilities come online. For example, leaders must decide whether to arm China's SSBN force in peacetime and the instructions for SSBN crews if communications with the CMC are severed. As China's strategic warning capabilities improve, whether China adopts a launch-on-warning alert status will also depend on whether the leadership alters its current order of priorities of strict control ahead of survivability. At present, nuclear and conventional missiles appear to be increasingly separate rather than entangled, increasing the robustness of China's NC3. That trend is, however, difficult to confirm with open sources and may be reversed at any time.

III. ENDNOTES

[1] Office of the Secretary of Defense, "Annual Report to Congress on the Military Power of the People's Republic of China" (Washington, D.C., 2018), 55.

[2] Gao Tongsheng, *Dongfeng Qiwu: Zhongguo Zhanlue Daodan Budui Chuchuang Jishi [The First Dance of the East Wind: A Record of the Establishment of China's Strategic Missile Forces]* (Beijing: Guofang Gongye Chubanshe, 2016), 380.

[3] Fiona S. Cunningham, "Maximizing Leverage: Explaining China's Strategic Force Posture Choices in Limited Wars" (Ph.D. Dissertation, Political Science Department, Massachusetts Institute of Technology, 2018), 128.

[4] Yu Jixun, *Di'er Paobing Zhanyi Xue [The Science of Second Artillery Campaigns]* (Beijing: Jiefangjun Chubanshe, 2004), 161.

[5] Wu Riqiang, "Certainty of Uncertainty: Nuclear Strategy with Chinese Characteristics," *Journal of Strategic Studies* 36, no. 4 (2013): 579–614.

[6] Di'er Paobing Zhengzhi Bu [Second Artillery Political Department], *Huihuang Niandai: Huigu Zai Gaige Kaifang Zhong Fazhan Qianjin de Di'er Paobing [Golden Age: A Review of the Development and Progress of the Second Artillery in the Reform and Opening Period]* (Beijing: Zhongyang Wenxian Chubanshe, 2008), 529.

[7] Di'er Paobing Zhengzhi Bu, 531.

[8] Di'er Paobing Zhengzhi Bu, 533.

[9] Di'er Paobing Zhengzhi Bu, 534.

[10] Di'er Paobing Zhengzhi Bu, 536.

[11] Di'er Paobing Zhengzhi Bu, 537.

[12] Michael S. Chase, Daniel Yoon, and Mark A. Stokes, "The People's Liberation Army Second Artillery Force (PLASAF) as an Organization," in *The PLA as Organization v2.0*, ed. Kevin Pollpeter and Kenneth W. Allen (Vienna, V.A.: Defense Group, Inc., 2015), 409.

[13] Jiang Zemin, *Lun Guofang He Jundui Jianshe [On National Defense and Army Building]* (Beijing: Jiefangjun Chubanshe, 2002), 358, 434; Di'er Paobing Zhengzhi Bu, *Huihuang Niandai*, 545; James Mulvenon, "Chinese C4I Modernization: An Experiment in Open-Source Analysis," in *A Poverty of Riches: New Challenges and Opportunities in PLA Research*, ed. James Mulvenon and Andrew N.D. Yang (Santa Monica, C.A.: RAND Corporation, 2003), 193–208.

[14] Jiang Weimin, ed., *Liu Huaqing Nianpu [Chronology of Liu Huaqing]*, vol. 2 (Beijing: Jiefangiun Chubanshe, 2016), 1093. CMC leaders' decision to build a dual-use military communications system was very likely influenced by cuts to the military budget after 1985 as top leaders prioritized economic development over national defense.

[15] Fiona S. Cunningham and M. Taylor Fravel, "Assuring Assured Retaliation: China's Nuclear Strategy and U.S.-China Strategic Stability," *International Security* 40, no. 2 (Fall 2015): 45; Yu, *Di'er Paobing Zhanyi Xue*, 349.

[16] Yu, *Di'er Paobing Zhanyi Xue*, 168.

[17] Shi Yijie, "Wei Daying Xinxi Hua Zhanzheng Chashang Tengfei [Plugging into Rapid Advances in Capabilities for Winning Informationized Wars]," *Huojian Bingbao [Rocket Force Daily]*, December 2, 2014.

[18] Tong Zhao, “Tides of Change: China’s Nuclear Ballistic Missile Submarines and Strategic Stability” (Washington, D.C.: Carnegie Endowment for International Peace, 2018).

[19] Wu Riqiang, “Zhongguo Zhanlue He Qianting Kaishi Zhanbei Xunhang Le Ma? [Have China’s Strategic Nuclear Submarines Already Commenced Operational Patrols?],” *Dangdai Jianchuan [Modern Ships* 1 (2016): 34.

[20] Zhao, “Tides of Change,” 37.

[21] Wu, “Zhongguo Zhanlue He Qianting Kaishi Zhanbei Xunhang Le Ma?" 34–35.

[22] Chase, Yoon, and Stokes, “The People’s Liberation Army Second Artillery Force (PLASAF) as an Organization,” 423.

[23] Kenneth W. Allen and Jana Allen, “Building a Strong Informatized Strategic Missile Force: An Overview of the Second Artillery Force with a Focus on Training in 2014” (Washington, D.C.: Jamestown Foundation, 2015), 35.

[24] Allen and Allen, 22, 23.

[25] Xue Xinglin, *Zhanyi Lilun Xuexi Zhinan [Campaign Theory Study Guide]* (Beijing: Guofang Daxue Chubanshe [NDU Press], 2001), 389.

[26] “New Long-Range Early-Warning Radar System Revealed in China,” Army Recognition, August 11, 2015, https://www.armyrecognition.com/august_2015_global_defense_security_news_uk/new_long-range_early-warning_radar_system_revealed_in_china_21108153.html.

[27] State Council Information Office of the People’s Republic of China, *China’s Military Strategy* (Beijing: Renmin Chubanshe, 2015).

[28] Xiao Tianliang, ed., *Zhanlue Xue [The Science of Military Strategy]* (Beijing: Guofang Daxue Chubanshe, 2015), 368.

[29] Eric Heginbotham et al., “The U.S.-China Military Scorecard” (Santa Monica, C.A.: RAND Corporation, 2015), 143.

[30] Alastair Iain Johnston, “China’s New ‘Old Thinking’: The Concept of Limited Deterrence,” *International Security* 20, no. 3 (Winter 1995/96): 31–32.

[31] M. Taylor Fravel and Evan S. Medeiros, “China’s Search for Assured Retaliation: The Evolution of Chinese Nuclear Strategy and Force Posture,” *International Security* 35, no. 2 (Fall 2010): 55.

[32] Junshi Kexue Yuan [Academy of Military Science], *Zhongguo Renmin Jiefang Jun Junyu [PLA Military Terminology]* (Beijing: Junshi Kexue Yuan Chubanshe, 2011), 1058.

[33] Mark A. Stokes, “China’s Nuclear Warhead Storage and Handling System” (Washington, D.C.: Project 2049 Institute, March 12, 2010).

[34] Yu, *Di’er Paobing Zhanyi Xue*, 162.

[35] There is little evidence to support speculation that the PLA Rocket Force would assume command of China’s nuclear submarine force after the 2015-6 PLA military reforms. David C. Logan, “China’s Future SSBN Command and Control Structure,” INSS Strategic Forum (National Defense

University, November 2016), 3.

[36] Wu, “Zhongguo Zhanlue He Qianting Kaishi Zhanbei Xunhang Le Ma?” 34.

[37] Steve Coll, “The Man Inside China’s Bomb Labs,” *The Washington Post*, May 16, 2001, https://www.washingtonpost.com/archive/politics/2001/05/16/the-man-inside-chinas--omb-labs/7d5a0209-fe13-4394-9ff5-6bbd16538f2e/?utm_term=.3f2e38f8f267.

[38] Cunningham and Fravel, “Assuring Assured Retaliation,” 44–45.

[39] Shou Xiaosong, ed., *Zhanlue Xue [The Science of Military Strategy]* (Beijing: Junshi Kexue Yuan Chubanshe, 2013); Xiao, *Zhanlue Xue*, 363; Gregory Kulacki, “China’s Military Calls for Putting Its Nuclear Forces on Alert” (Cambridge, M.A.: Union of Concerned Scientists, 2016).

[40] Cunningham and Fravel, “Assuring Assured Retaliation.”

[41] Jiang Tiejun, *Dang de Guofang He Jundui Gaige Sixiang Yanjiu [Research on Party Defense and Military Reform Thought]*, (Beijing: Junshi Kexue Yuan Chubanshe, 2015), 79.

[42] Cunningham and Fravel, “Assuring Assured Retaliation,” 43.

[43] Cunningham and Fravel, “Assuring Assured Retaliation,” 44–45.

[44] Fravel and Medeiros, “China’s Search for Assured Retaliation”; M. Taylor Fravel, *Active Defense: China’s Military Strategy Since 1949* (Princeton, N.J., 2019); Cunningham, *Maximizing Leverage*.

[45] Allen and Allen, “Building a Strong Informatized Strategic Missile Force,” 20–21.

[46] Allen and Allen, 16–18.

[47] Junshi Kexue Yuan, *Zhongguo Renmin Jiefang Jun Junyu*, 1026.

[48] Jing Zhiyuan, ed., *Zhongguo Zhanlue Daodan Budui Baike Quanshu [China Strategic Missile Force Encyclopedia]* (Beijing: Zhongguo da Baike Quanshu Chubanshe, 2012), 739.

[49] Jing, 741.

[50] Thomas J. Christensen, “The Meaning of the Nuclear Evolution: China’s Strategic Modernization and US-China Security Relations,” *Journal of Strategic Studies* 35, no. 4 (2012): 468; Avery Goldstein, “First Things First: The Pressing Danger of Crisis Instability in U.S.-China Relations,” *International Security* 37, no. 4 (Spring 2013): 71; Joshua Rovner, “Two Kinds of Catastrophe: Nuclear Escalation and Protracted War in Asia,” *Journal of Strategic Studies* 40, no. 5 (2017): 696–730; Caitlin Talmadge, “Would China Go Nuclear? Assessing the Risk of Chinese Nuclear Escalation in a Conventional War with the United States,” *International Security* 41, no. 4 (Spring 2017): 50–92; Tong Zhao and Li Bin, “The Underappreciated Risks of Entanglement: A Chinese Perspective,” in *Entanglement: Russian and Chinese Perspectives on Non-Nuclear Weapons and Nuclear Risks*, ed. James M. Acton (Washington, D.C.: Carnegie Endowment for International Peace, 2017).

[51] Wu Riqiang, “Sino-U.S. Inadvertent Nuclear Escalation,” cited in Talmadge, “Would China Go Nuclear?,” 55.

[52] Cunningham and Fravel, “Assuring Assured Retaliation,” 42–45.

[53] Yu, *Di'er Paobing Zhanyi Xue*, 336.

[54] See Kevin Pollpeter et al., "Enabling Information-Based System of System Operations: The Research, Development, and Acquisition Process for the Integrated Command Platform," Policy Brief (UC Institute on Global Conflict and Cooperation, January 9, 2014).

[55] M. Taylor Fravel, *Strong Borders, Secure Nation: Cooperation and Conflict in China's Territorial Disputes* (Princeton, N.J.: Princeton University Press, 2008), 201–3, 213.

[56] John Wilson Lewis and Litai Xue, *Imagined Enemies: China Prepares for Uncertain War* (Palo Alto, C.A.: Stanford University Press, 2006), 63–74.

[57] Wu, "Certainty of Uncertainty," 21–25.

[58] Mulvenon, "Chinese C4I Modernization: An Experiment in Open-Source Analysis."

IV. NAUTILUS INVITES YOUR RESPONSE

The Nautilus Asia Peace and Security Network invites your responses to this report. Please send responses to: nautilus@nautilus.org. Responses will be considered for redistribution to the network only if they include the author's name, affiliation, and explicit consent.

View this online at: https://nautilus.org/napsnet/napsnet-special-reports/nuclear-command-control-and-communications-systems-of-the-peoples-republic-of-china/

Nautilus Institute
608 San Miguel Ave., Berkeley, CA 94707-1535 | Phone: (510) 423-0372 | Email: nautilus@nautilus.org