

China's Nuclear Warhead Storage and Handling System

Mark A. Stokes

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Cover image and below: Chinese nuclear test. Source: CCTV.



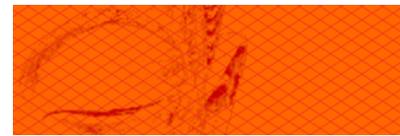
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The Project 2049 Institute seeks to guide decision makers toward a more secure Asia by the century's mid-point. The organization fills a gap in the public policy realm through forward-looking, region-specific research on alternative security and policy solutions. Its interdisciplinary approach draws on rigorous analysis of socioeconomic, governance, military, environmental, technological and political trends, and input from key players in the region, with an eye toward educating the public and informing policy debate.

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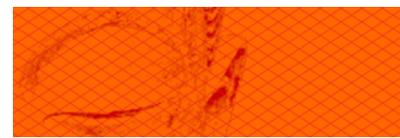
Introduction

Transparency and accountability are fundamental enablers for arms control and nuclear weapon safety and security. As noted in a United Nations-supported Weapons of Mass Destruction Commission report, “increased transparency of nuclear-weapons-related information is an indispensable prerequisite for more progress in nuclear disarmament and its verification.”¹ Among the least understood elements of the world’s nuclear weapon arsenal is the People’s Republic of China’s (PRC) system for storing and maintaining its nuclear warhead stockpile. The dearth of information is in part purposeful – its nuclear warhead stockpile naturally is among China’s most closely guarded secrets.²

The Chinese Communist Party’s Central Military Commission (CMC) maintains strict control over China’s operational nuclear warheads through a centralized storage and handling system managed by the People’s Liberation Army (PLA) Second Artillery. Nuclear warheads are granted special consideration due to their political significance and potential consequences of an accident, incident, or unauthorized use.³ As a result, warheads are managed in peacetime through a system that is separate and distinct from Second Artillery missile bases and subordinate launch brigades.⁴ Second Artillery nuclear warheads also appear to be managed separately from China’s civilian fissile material protection, control and accounting (MPC&A) system.⁵ In addition, the Second Artillery appears to control and manage nuclear warheads that could be delivered by other services, such as the PLA Air Force and Navy.⁶

A preliminary examination of China’s nuclear warhead storage and handling system indicates that Beijing adopts a responsible and serious attitude with regards to nuclear security and safety. A centralized warhead management system has clear benefits. However, assuming China’s nuclear strategy remains one of minimal deterrence and retaliation, it also can be vulnerable to a disarming first strike. As a result, China’s warhead storage and handling system is designed to survive a first strike and retain sufficient operational capability for retaliation.

The size of the PRC’s nuclear weapon arsenal is less important than how warheads are managed or employed. As New America Foundation’s Jeffrey Lewis adroitly observed, “China’s nuclear deployment and arms control patterns stem from the belief that deterrence is relatively unaffected by changes in the size, configuration, and readiness of nuclear forces.”⁷ Consistent with this observation, an initial review of its storage and handling infrastructure does not indicate obvious or significant expansion of China’s nuclear warhead stockpile. However, a ballistic missile infrastructure that is expanding without a significant growth in its nuclear warhead stockpile could indicate an extension of Second Artillery’s



conventional strike mission. In general, the distinction between ballistic missiles equipped with nuclear and conventional payloads is becoming increasingly blurred.

Under a declaratory no-first-use policy, the PRC's nuclear deterrent has relied upon quantitative and geographic ambiguity.⁸ Yet after more than 40 years, it appears that Chinese censorship is relaxing to the point that sufficient information can be pieced together to form an initial mosaic of how the PRC may store and maintain its most powerful and destructive weapons. This image is tiled together through a mix of authoritative sources, correlation of reliable data, and analysis.

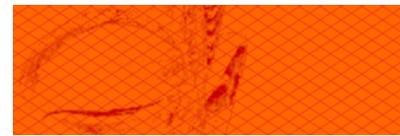
The 22 Base & Warhead Stockpile Management

Situated deep in the Qinling [秦岭] mountain range about 140 kilometers west of the historical city of Xian, an independent organization known as the 22 Base is responsible for storing and managing most of the Second Artillery's nuclear warhead stockpile. As primary custodians of China's nuclear warhead stockpile, the 22 Base inspects warheads for reliability and safety, stores and transports warhead components, trains missile base personnel in warhead storage, maintenance, assembly, and mating, maintains a support infrastructure for warhead management, and operates a communications system that supports its mission. Each of Second Artillery's six army-level missile bases replicates 22 Base functions on a smaller and perhaps modified scale. Each missile base also has regiments responsible for training, transportation, warhead storage and inspection, repair and maintenance, and communications.⁹ A specialized 13-member warhead expert working group [二炮兵弹头专家组] assists Second Artillery's leadership in stockpile management policy.¹⁰

The Second Artillery's nuclear weapons management function begins with its central warhead storage and handling complex. Known as the 22 Base [96401 Unit], the complex has been located in Taibai County [太白县] deep in the Qinling mountain range for over 40 years.¹¹ However, its original location, dating back to the origins of China's nuclear weapon development program, was near Xining in Qinghai Province.¹²



Taibai County township nestled in the Qinling Mountains. (Source: www.163.com)

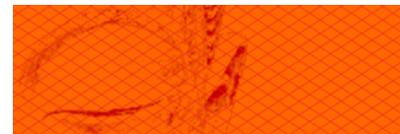


In 1958, Mao Zedong commissioned a little known infantry school based in Shangqiu, Henan Province, to survey sites for missile and nuclear warhead testing and storage. The Shangqiu Infantry School commandant Major General Jia Qianrui [贾乾瑞] and student affairs director Hong Youdao [洪有道] were responsible for the warhead storage site survey, with the former eventually becoming the father of China's warhead security. The first storage tunnel reportedly was completed in 1964, the same year as China's first nuclear test, and subordinated to the National Defense Science Commission in 1965.¹³ Declassified U.S. intelligence community reporting from 1971 indicates that a central storage facility for warheads was located "in a ridge about 12nm from the Koko Nor weapons fabrication complex."¹⁴

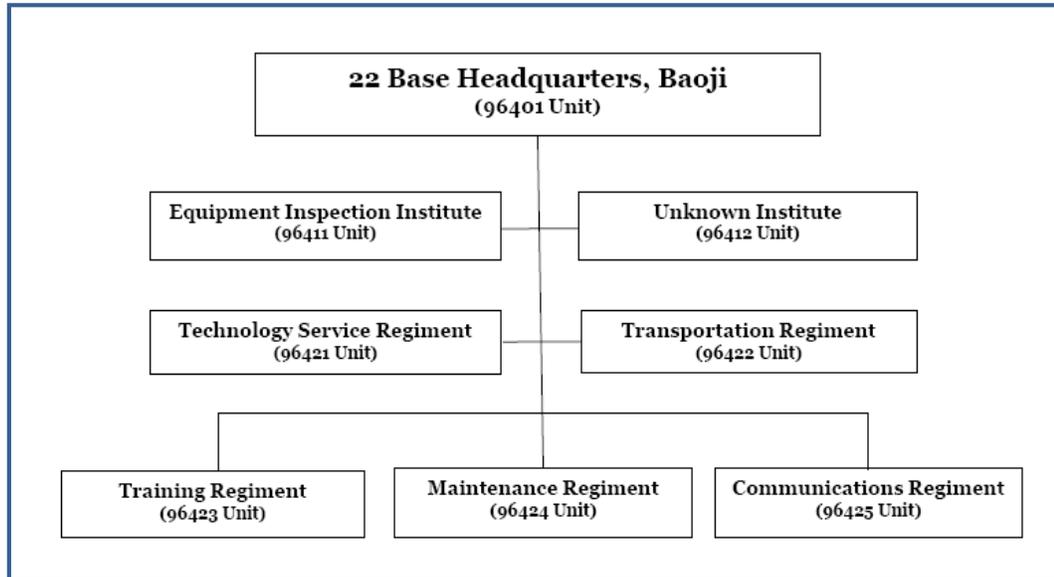
The Move from Qinghai to Taibai. In 1969, China's political and military leadership began preparations for relocating the primary warhead storage and handling function to Taibai County in the Qinling mountain range.¹⁵ Taibai County is said to have been identified as a candidate storage site in the 1958 survey and may have been a factor in the establishment of Taibai County in early 1960s. However, the final decision to relocate to Taibai appears to have resulted from a number of factors. First, military leaders may have opted for a more defensible location in the wake of the deterioration in relations with the Soviet Union in 1969. In addition, a larger facility may have been required to facilitate the growth in delivery platforms and initial operational capability of the DF-2 (CSS-1).¹⁶

Another security consideration may have led to the move. During 1967, the nuclear weapons program in Qinghai became subject to Cultural Revolution strife, including attempts by rival factions to seize nuclear-related facilities in both Qinghai and Xinjiang. On March 5, 1967, Premier Zhou Enlai, at the urging of CMC Vice Chairman Gen Nie Rongzhen, declared martial law and placed Jia Qianrui in charge of enforcement. Along with Hong Youdao, Jia oversaw the relocation from Qinghai to Taibai County in 1969 and 22 Base operations until the unit's subordination to Second Artillery in January 1979.¹⁷

Details regarding construction of the Taibai tunnel complex are unavailable at the current time. Taibai Mountain is the highest peak in China, east of its three western-most provinces of Tibet, Qinghai, and Xinjiang. Taibai Mountain reaches 3767 meters (12,358 feet) in height and is formed of large granite rock. Perhaps to facilitate logistics, the PLA Rail Corps initiated construction of a rail line connecting Baoji and Chengdu and third line nuclear production facilities near Mianyang in the 1960s. The Baoji-Chengdu line was considered a major feat, not only because it was China's first electric rail, but due to tunnels that sliced through mountains south of Baoji. Of most significance was a 2.3 kilometer tunnel passing through Qinling Mountain and a series of spiral tunnels just southwest of Baoji.¹⁸ The rail also supported a major ballistic missile engine and component research and development and production complex, known as the 067 Base, in the mountainous county adjacent to Taibai that was established in 1965.¹⁹



22 Base Headquarters. As custodians of China's nuclear warheads, the 22 Base headquarters is located in the city of Baoji. The 22 Base mirrors the Second Artillery's six missile bases in stature and organization.

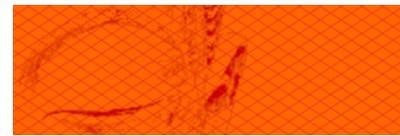


Due to the nature of their work, 22 Base personnel have some distinguishing characteristics. The role of the political commissar is likely more pronounced than in other bases, due to the heavy emphasis on personnel reliability, security, and local civil-military relations.²⁰ Similarly, position of senior engineer [*zong gongchengshi*; 总工程师] and staff in the Equipment Department are likely more prestigious than counterparts in other bases as they are responsible for the technical aspects of nuclear warhead safety and reliability.²¹ Base engineers have been reported to have developed a close working relationship with defense industry and academia, including the China Academy of Engineering Physics (CAEP).²²

The 22 Base nuclear warhead storage and handling system includes five key functions: 1) storage; 2) transportation; 3) training; 4) communications; and 5) warhead/special vehicle maintenance and repair.

Taibai Underground Nuclear Weapons Storage Depot

With missile bases possessing only a limited number of warheads at any given time, China's central nuclear weapons storage complex is situated in Taibai County.²³ Euphemistically referred to as the 22 Base "technical service regiment" [*jishu qinwu tuan*; 技术勤务团], the Taibai underground complex is said to be equipped with an advanced physical protection system. Security measures include real time video monitoring, infrared security system, a computerized warhead accounting system, temperature and humidity controls, firefighting



equipment, fingerprint and other access control, and advanced communications linking sites within the complex.²⁴ The Taibai complex appears to consist of at least two specific zones known as Hongchuan [红川] and Hongling [红岭].²⁵ Work also has been carried out to examine the effects of electromagnetic pulse effects on warhead and missile electronics.²⁶ The depot has reportedly experienced to have discipline and morale problems.²⁷

A number of subordinate units support the regiment's warhead storage operations. A depot management battalion [*zhuguan ying*; 贮管营] maintains the facilities, while a technical support battalion oversees the safekeeping of warhead components.²⁸ A dedicated security battalion includes a subordinate horse cavalry company for patrolling a 400 square kilometer security zone in mountainous terrain.²⁹ One 2008 *PLA Daily* article credits the regiment and its six subordinate units for their accident-free record for 40 years.³⁰ However, warhead accidents have been known to happen. The *PLA Daily* reported that one missile base-level storage regiment had an accident 15 years ago due to a vehicle mishap.³¹

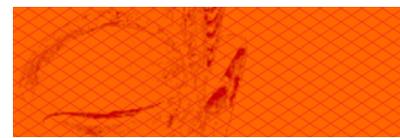
A command center in the area of Taibai appears to serve as the operational hub of the 22 Base's warhead storage and handling system. Known as the Hongling Command Cell (*hongling zhihuizu*; 红岭指挥组), the watch center likely is co-located with a storage facility, and overseen by one of the 22 Base's deputy chiefs of staff.³² One recent *PLA Daily* article indicated that Second Artillery underground storage facilities may double as reserve operational command centers.³³

The storage complex is supported by a Second Artillery civil engineering regiment subordinate to the 308 Engineering Command, based south of Taibai in the city of Hanzhong, and an installation engineering group in Luoyang.³⁴ Although the Taibai nuclear warhead facility has existed for 40 years, Second Artillery engineering units have been engaged in a national engineering project in the Qinling Mountain region between Taibai and western foothills adjacent to Tianshui city (Gansu Province) over the last 10 to 15 years.³⁵ At least one 22 Base study implied a requirement for upgrades to older underground facilities for health reasons.³⁶ Other engineering projects have also been taking place in the area. Construction on a major high speed expressway connecting Baoji and Hanzhong, involving major tunneling work, has been planned to begin in 2010. Second Artillery is allegedly opposing the project as the freeway is planned to pass near Taibai.



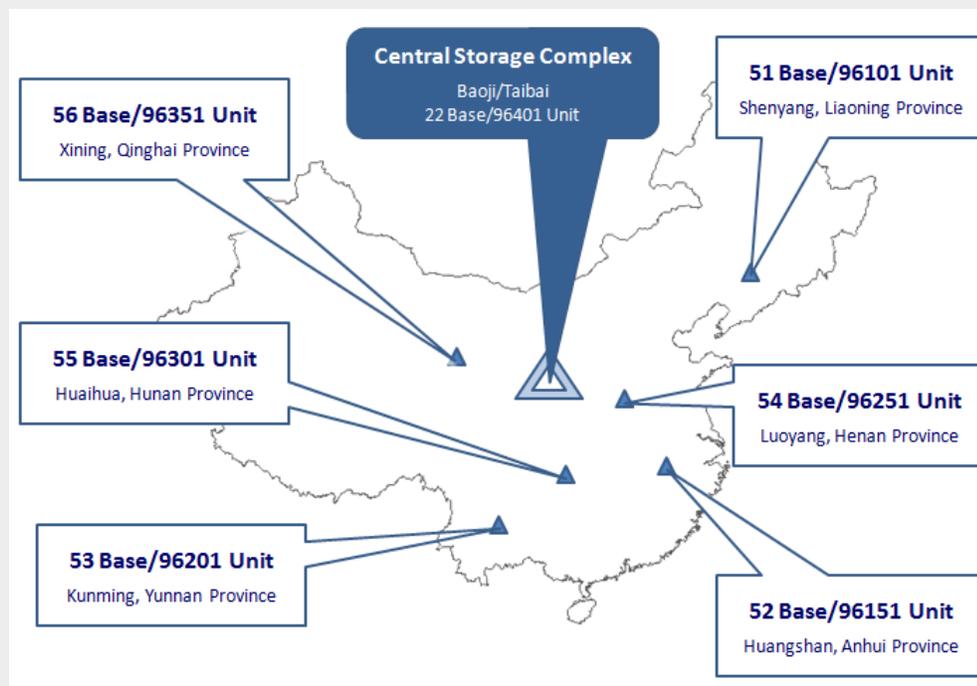
Probable 55 Base Storage Regiment Headquarters, Huaihua, Hecheng District (Source: Google Earth)

Missile Base-Level Storage. Base-level storage facilities for nuclear and probably conventional warheads, missiles, associated sub-systems, components, and fuels are generally referred to as “equipment inspection” regiments [*zhuangjian tuan*; 装检团]. Each regiment oversees at least three battalion-level facilities, known as “equipment



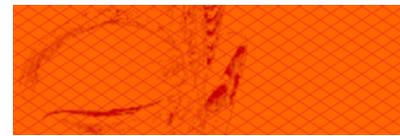
inspection sites” [zhuangjian zhan; 装检站], which conduct testing and diagnostics of warheads in underground facilities, usually in mountainous regions.³⁷ Each site can have as many as seven subordinate sub-units [zhuangjian fenzhan; 装检分站], indicating that a missile base’s warhead inspection and missile depot system could have as many as 21 sites. Warhead regiment engineers appear to deploy to prepared launch sites for final mating and checkout before launch.³⁸ Following is a breakout of the regiments under the six missile bases:

Base	Warhead Regiment (MUCD)	Probable Regimental HQ
51 Base, Shenyang	96123 Unit (901 Regiment)	Tonghua County ³⁹
52 Base, Huangshan	96173 Unit (902 Regiment)	Jingdezhen
53 Base, Kunming	96223 Unit (903 Regiment)	Mi’le County
54 Base, Luoyang	96273 Unit (904 Regiment)	Lushi County ⁴⁰
55 Base, Huaihua	96323 Unit (905 Regiment)	Huaihua, Hecheng District
56 Base, Xining	96373 Unit (906 Regiment)	Huangzhong County



22 Base and the six missile bases

Many of the base-level storage regiments appear to have been relocated over the last 25 years. In 1985, the CMC approved a Second Artillery request to begin redeploying units from remote sites to areas surrounding cities and towns. The initiative was aimed not only at improving the standard of living for Second Artillery troops but also to access more advanced communications networks at the new location.⁴¹



Missiles and fuel appear to be stored separately from warheads. In at least one case, RP-3 turbojet fuel for an unidentified missile (presumably the DH-10), is stored near the brigade's central missile depot area [*zhongxinku daodan chucunqu*; 中心库导弹储存区]. Due to its large inventory of conventional SRBMs, the 52 Base storage functions appear to be somewhat different from the remaining five missile bases. It has a separate regiment (96176 Unit) for storage of missiles located in Shangrao County, known as a "missile component depot" [导弹器材仓库].⁴²

Warhead Mobility

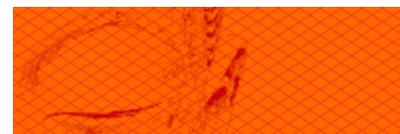
The mobility of nuclear warheads is critical to Second Artillery's nuclear deterrent and warfighting capability. A separate regiment under the 22 Base is responsible for movement of nuclear warheads and components between the Taibai central storage complex and storage regiments under the Second Artillery's six missile bases. The warheads appear to be circulated back and forth between the central storage complex in Taibai and six smaller storage facilities subordinate to each missile base. Only a relatively small handful of warheads appear to be maintained at each base's storage regiment for any extended period of time.⁴³

Second Artillery's warhead storage and handling system relies on rail and road, with air transport only used in extreme circumstances. Also known as the 96422 Unit, the 22 Base special transportation regiment [*tezhuang yunshu tuan*; 特装运输团] relies on the national rail system and operates 24 hours a day, seven days a week to keep the warheads circulating. The 22 Base special transportation regiment headquarters is located in Taibai, while its rail battalion appears to be located in Liangdang County, about 85 kilometers west of the Taibai storage complex.⁴⁴ The regiment's road battalion uses specialized container vehicles to transport warheads by specially designated roads linking Taibai with rail transfer points [*zhuanyun zhan*; 转运站] along the Baoji-Chengdu rail line. These transfers often take place at night and with an effort to avoid public scrutiny.⁴⁵



Second Artillery DF-31 Rail Transport.
(Source: Xinhua)

Given Second Artillery's high degree of reliance on the nation's rail and highway system for its nuclear deterrent, a failure in the transport network is cause for concern. One example of a rail failure that potentially affected warhead logistics occurred during the May 12, 2008 Sichuan earthquake. A train hauling hazardous materials derailed and ignited inside a tunnel in Qinling Mountains in the vicinity of a primary 22 Base warhead rail transfer point. Rail operations on the Baoji-Chengdu line were shut down for 12 days. The Hongling Command Cell commander responded and arrived on the scene in just over two hours.⁴⁶ Another incident on icy roads in the Qinling Mountains resulted in a vehicle pileup that required use of Second Artillery cranes to clear up.⁴⁷



Missile Base Transfer Regiments. Each base has a regiment responsible for transfer of warheads and other systems from rail lines and other sites to missile base operating facilities. Referred to as “technology service” [*jishu qinwu*; 技术勤务] regiments, these units oversee rail transfer facilities [*tielu zhuanyun zhan*; 铁路转运站] and have at least one subordinate rail transport company [铁运连].⁴⁸ Transfer units have an emphasis on armed escort [押运] missions, and rely on dedicated communications and security surveillance networks for security.⁴⁹ Furthermore, a Second Artillery text indicates that missile base technology service regiments are responsible for ensuring availability of materials and spare parts for launch and storage sites.⁵⁰



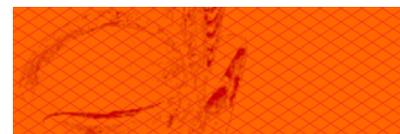
Possible Transportation Regiment rail transfer point. 52 Base 96172 Unit, Yangguangcun, Qimen County, Anhui Province (Source: Google Earth)

Warhead Safety and Reliability

Due to their extremely destructive nature, nuclear warheads require strict safety, reliability, and security measures to guarantee that they are never accidentally or intentionally detonated without the authorization of the most senior political authorities.⁵¹ Along these lines, 22 Base bears the responsibility for engineering analysis and environmental testing to ensure the safety and reliability of China's nuclear weapon stockpile. Reliability and safety of nuclear warheads and materials have been sensitive issues in Chinese politics. Veterans from four units associated with testing, storage, and maintenance of nuclear warheads in the 1960s and 1970s have submitted legal claims to the government related to radiation-linked health problems.⁵²

Until the early 1990s, problems with warhead safety and reliability appeared to have continued. In a 1991 assessment, Second Artillery Equipment Department analysts lamented excess prioritization of missiles over nuclear warhead stockpile management. In addition to inadequate launch battalion training on live warheads, few engineers from the Second Artillery unit tasked with stockpile reliability had hands-on experience in inspecting warheads. Increasing the risk was the lack of follow-on technical support from China's civilian nuclear industry after delivery of new warheads to the Second Artillery. The analysts recommended a major program to improve China's nuclear stockpile management, especially as a new generation of warheads would be entering the operational inventory.⁵³

Today, the specific regimental sized organization under the 22 Base responsible for warhead reliability and safety is the 96411 Unit, also known as the “equipment inspection institute” [*zhuangjian suo*; 装检所]. Since at least 2005, the institute has focused on improving its



warhead surveillance capabilities. Engineers regularly “pulse” components inside the 22 Base storage complex to ensure safety and reliability.⁵⁴ In addition to sending its own engineers for advanced degrees and other training, the institute has contracted with senior warhead designers and specialists from at least 10 nuclear-related institutions throughout China, including CAEP, China Institute of Atomic Energy [中国原子能研究所]; and China Institute of Radiation Protection [CIRP; 中国辐射防护研究院, or中辐院 for short].⁵⁵ The institute also works with the China Aerospace Science and Technology Corporation [CASC; 中国航天科技集团公司]; and PLA General Armaments Department (GAD) warhead-related laboratories [国防科技重点实验室] housed in CAEP facilities.⁵⁶ In the past, 22 Base engineers have worked with CAEP counterparts to extend the service life of warheads associated with DF-2 (CSS-1), DF-4 (CSS-3), and DF-5 (CSS-4) ballistic missiles.⁵⁷ They also have focused on protective clothing for personnel, and ultrasonic testing and acoustic resonance spectroscopy for evaluating the condition of warheads.⁵⁸

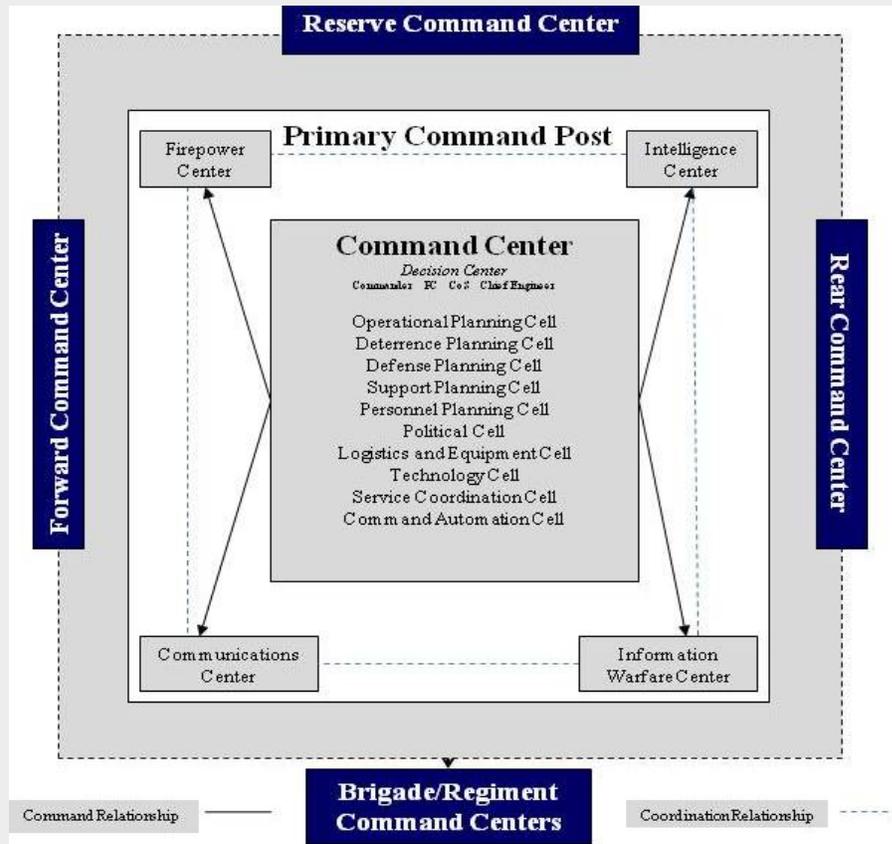
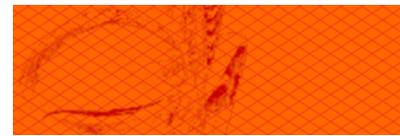
Missile base-level warhead repair and maintenance is conducted in dedicated “factories” [*xiupeichang*; 修配厂], where scheduled and unscheduled maintenance on missile systems and presumably warheads is conducted. Factory personnel have also been known to deploy to the field for emergency repairs.⁵⁹

Warhead Training

Located in Taibai County, the 22 Base’s training regiment [训练团] appears to train not only base personnel, but also the missile base warhead units.⁶⁰ Each missile base has a subordinate regiment with responsibility for operational training of the base’s launch brigades. The operational training regiments appear to be responsible for organizing and evaluating unit performance in mobility and launch exercises. In at least one case, the training regiment manages the training launch sites. Training of enlisted soldiers is conducted in Second Artillery academic institutions and within launch brigade themselves. Despite increasing reliance on simulators, regiments are also training using real warheads.⁶¹

Communications

The Central Military Commission is likely to have a dedicated command, control, and communications network for warhead management and directing nuclear strikes. It is unknown if the 22 Base communications regiment is responsible for only internal communications related to central storage and handling, or whether it plays a role in the overall command and control of China’s nuclear operations. Private contractors recently upgraded the warhead base’s internal fiber optic and wireless communications networks.⁶² Within a missile base, battalion-level entities under communications regiments are responsible for managing a dedicated satellite ground station, microwave communications facility, and fiber optic or other landline communications.

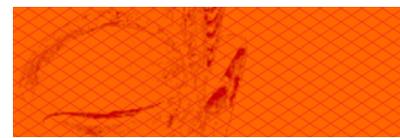


Second Artillery Operational Command and Control. (Source: Second Artillery Campaign Science)

Conclusion

A preliminary examination of China's nuclear warhead storage and handling system indicates that Beijing takes security and safety seriously. With the bulk of its nuclear warhead stockpile nestled deep in secure mountain palaces, the 22 Base's physical protection system appears to be founded upon more than "guns, gates, and guards." In fact, in defending against real and perceived threats, Taibai may be one of the most secure warhead stockpile facilities in the world. However, with warheads most vulnerable to theft or accident during transportation, the system's reliance on mobility creates opportunities for incidents and terrorist action.

While increasingly transparent, future deterrence may continue to rely on ambiguity surrounding precise locations of base-level storage facilities and launch sites and numbers of warheads maintained at any given time. However, while speculative at this point, an added



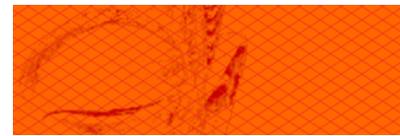
element could be newly constructed underground intercontinental ballistic missile (ICBM) launch garrisons in close proximity to the central warhead storage complex. A shorter logistical tail could reduce vulnerability.⁶³ A brigade headquarters, situated southeast of Gansu Province city of Tianshui, is just over 125 kilometers from Taibai's central storage facility.⁶⁴ Whether or not tunneling has been sufficiently extensive to partially link central storage facilities or possible annexes with launch sites cannot be determined at the current time.⁶⁵

Perhaps related, CASC's China Academy of Launch Technology (CALT), the primary R&D organization in China responsible for strategic ballistic missiles and launch systems, outlined a detailed concept for an underground mobile launch system. The CALT concept integrates a central missile/warhead depot, underground rail and road system, and up to six silos. Assuming a circular error probability (CEP) of 300 meters for a 30 kiloton blast, CALT engineers calculated that the launch silos would need to be separated by at least five kilometers. Therefore, the total area of the launch complex would need to cover 75 square kilometers.⁶⁶

Despite a significant expansion of Second Artillery's missile brigade infrastructure over the last 15 to 20 years, a review of China's nuclear warhead storage and handling system offers no obvious signs of a significant increase in China's nuclear stockpile. Much of the missile infrastructure expansion, beyond short range ballistic missile brigades deployed opposite Taiwan, appears to accommodate new brigades equipped with DF-21 (CSS-5) medium range ballistic missiles, including the terminally-guided DF-21C and perhaps the DF-21D maritime variant in the near future. Some increase in the number of nuclear warheads should be expected with the introduction of new missile systems, such as the DF-31A and DF-31 along with its submarine-launched variant. However, the absence of a clear sign of nuclear warhead growth and expansion of missile infrastructure could indicate an extension of Second Artillery's conventional mission. As a general trend, the distinction between brigades with nuclear and conventional missions is becoming blurred.⁶⁷

Finally, the CMC relies on Second Artillery to manage a highly centralized and tightly controlled nuclear warhead stockpile. Warheads are mated with missiles assigned to brigades only in elevated readiness conditions and perhaps on occasion for training purposes. It remains open to question if China's JIN-class submarines equipped with a new generation JL-2 submarine launched ballistic missile would patrol with armed warheads.⁶⁸

Given nuclear warheads' status as a liability, their safety and security is a common interest of the United States and the PRC, and one of the few practical issues worthy of cooperation between our two defense establishments through the Cooperative Threat Reduction (CTR) or other programs. Most public discussion on nuclear safety and security to date appears limited to the civil nuclear energy sector, despite efforts to place the issue on the defense agenda.⁶⁹



¹ For an outline on nuclear transparency, see Annette Schaper, "Transparency and Secrecy in Nuclear Weapons," *Weapons of Mass Destruction Commission Paper*, No. 34, at <http://www.wmdcommission.org/files/No34.pdf>, accessed on February 2, 2010. For a good overview of U.S. nuclear policy, see Joseph Cirincione, "The Transformation of U.S. Nuclear Policy," in *A World Free of Nuclear Weapons* (Washington DC: U.S. Department of State), pp. 6-8.

² For an initial exploration of China's nuclear material and warhead storage and handling, see Robert S. Norris, Andrew S. Burrows, and Richard Fieldhouse, *Nuclear Weapons Databook, vol. 5, British, French, and Chinese Nuclear Weapons* (Boulder: Westview Press, 1994); Nathan E. Busch, *No End In Sight: The Continuing Menace Of Nuclear Proliferation* (Lexington: University Press of Kentucky, 2004), pp. 132-173; and Robert S. Norris and Hans M. Kristensen, "Nuclear Notebook: Worldwide Deployments of Nuclear Weapons, 2009," *Bulletin of the Atomic Scientists*, November/December 2009, pp. 88-90. Norris and Kristensen appear to have the most accurate assessment to date, estimating that China's Central Military Commission oversees between 8 and 12 nuclear warhead storage sites. Assessments of the number of nuclear warhead stored and maintained within the system vary widely. However, the number most often cited is around 450 warheads, with about 250 dedicated toward strategic missiles and the remainder "tactical" in nature.

³ For an excellent outline of issues associated with nuclear security, see Matthew Bunn, *Securing the Bomb 2008* (Boston: Project on Managing the Atom and the Nuclear Threat Initiative, 2008).

⁴ Second Artillery has multiple hierarchical organizational levels starting with the Second Artillery headquarters in Beijing, which oversees six army-level [*junji*; 军级] missile bases. Each missile base operates within a broad geographic area and oversees anywhere between three to seven missile brigades [*daodan lü*; 导弹旅], which in turn have between three to six launch battalions [*fashè ying*; 发射营]. For overviews of the Second Artillery, see Yu Jixun (ed.), *Second Artillery Campaign Science* [第二炮兵战役学], (Beijing: PLA Press, 2003); Chong-pin Lin, *China's Nuclear Weapons Strategy: Tradition within Evolution* (Lexington, MA: Lexington Books, 1988); Kenneth Allen and Maryanne Kivlehan-Wise, "Implementing the Second Artillery's Doctrinal Reforms," in James Mulvenon and David Finkelstein, ed., *China's Revolution in Doctrinal Affairs* (Alexandria, VA: Center for Naval Analysis, 2005), pp. 159-219; Hans M. Kristensen, Robert S. Norris, and Matthew G. McKinzie, *Chinese Nuclear Forces and U.S. Nuclear War Planning* (Wash D.C.: The Federation of American Scientists & the Natural Resources Defense Council, 2006); and Larry M. Wortzel, *China's Nuclear Forces: Operations, Training, Doctrine, Command, Control, and Campaign Planning* (Carlisle: US Army Strategic Studies Institute, 2007). For an insightful overview of the Second Artillery's military unit cover designation system, see Ellis Melvin and Harlan Jencks' appendix, "Known Second Artillery Military Unit Cover Designators (MUCDs)," in Bates Gill, James Mulvenon, and Mark Stokes, "The Chinese Second Artillery Corps: Transition To Credible Deterrence" in James C. Mulvenon & Andrew N.D. Yang (eds), *The People's Liberation Army as an Organization: Reference Volume v1.0*, 2001, pp. 573-586. Regarding the Second Artillery's MUCD system, Melvin and Jencks offer the following astute observation: "If the reader finds this system confusing, that is exactly what the Chinese intended." For a good discussion of China's nuclear strategy and doctrine, see Evan S. Medeiros, "Evolving Nuclear Doctrine," in Paul J. Bolt & Albert S. Willner, eds., *China's Nuclear Future* (Boulder and London: Lynne Rienner Publishers, 2006). The term "launch company" [*fashè lian*; 发射连] is reserved for conventional missile brigades.

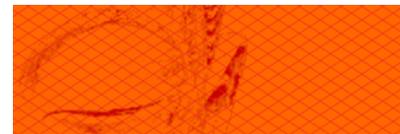
⁵ For overviews of China's fissile material storage and handling, see Nathan Busch, "China's Fissile Material Protection, Control, and Accounting: The Case for Renewed Collaboration," *Nonproliferation Review*, Fall/Winter 2002; and Hui Zhang, "Evaluating China's MPC&A System," paper presented at the Presented at the INMM 44th Annual Meeting, Phoenix, Arizona, 13-17 July, 2003. In testimony before the U.S.-China Economic and Security Review Commission on July 12, 2007, Ploughshare Foundation's Joseph Cirincione noted that China National Nuclear Corporation produces, stores, and controls all fissile material for civilian as well as military applications.

⁶ This conclusion is a preliminary analytical judgment based on the wealth of information available regarding Second Artillery's nuclear storage system, juxtaposed against the absence of even oblique references in other services.

⁷ See Jeffrey Lewis, *The Minimum Means of Reprisal: China's Search for Security in the Nuclear Age*, (Cambridge, MA: American Academy of Arts and Sciences, 2007).

⁸ For a good overview of China's views on nuclear strategy and transparency, see Li Bin, "China and Nuclear Transparency," in Nicholas Zarimpas ed., *Transparency in Nuclear Warheads and Materials: The Political and Technical Dimensions* (Oxford: Oxford University Press, 2003), pp.50-57.

⁹ The numbering sequence for the five begins by adding 20 to the missile base MUCD. For example, the 96101 Unit (51 Base) warhead support regiments include the 96121 Unit (training), 96122 (transportation), 96123 (warhead storage), 96124 (repair



and maintenance), and 96125 (communications).

¹⁰ See reference in “Army Report: Story of Lin Hualing’s Move from A Mountain Area Teacher to Missile Expert” [军报：讲述林华令从山区教师到导弹专家的故事], *PLA Daily*, June 29, 2006, at <http://lanzhou.china.com.cn/chinese/junshi/1259482.htm>, accessed on February 12, 2010. If similar to ones managed by the General Armaments Department (GAD), the working group includes experts from academia, defense industry, and the PLA.

¹¹ In Western literature to date, 22 Base has long been a glaring hole in the series of base numbers assigned to the former Commission for Science and Technology for National Defense (COSTIND), now the PLA General Armaments Department (GAD). For example, 20 Base is the designation for the Jiuquan missile test and satellite launch center, 21 Base at Lop Nur was responsible for nuclear weapons testing, and 23 Base manages China’s maritime satellite tracking and control. The 22 Base has maintained its original designation, despite Second Artillery army-level missile bases designations being numbered 51-56.

¹² The Ninth Academy is the Northwest Nuclear Weapons Research Academy. The 221 Factory closed in 1987.

¹³ The locations, in Jiuquan, Gansu province; Lop Nur, Xinjiang province; and Haiyan, Qinghai province were designated as 20 Base, 21 Base, and 22 Base respectively. The MUCD for the 22 Base was the 8122 Unit, a specialized entity subordinate to the National Defense Science and Technology Commission. The 8122 Unit was granted exclusive responsibility for warhead storage and handling. Among various sources, see “Retired Soldiers of China’s Nuclear 22 Base” [中国核军事二十二基地退役战士], Petition to the Dazu County government, June 21, 2007. Also see “Regarding the Problem of Health Support for 1972 Military Retirees” [关于72年退伍军人生活保障问题], Chongqing City Government website, September 14, 2006, at <http://www.cq.gov.cn/PublicMail/Citizen/ViewReleaseMail.aspx?intReleaseID=17027>, accessed on February 1, 2010. The original location of the 22 Base storage facility was near a village known as Shangwuzhuang, which may now host the 56 Base’s warhead storage regiment. For reference to the 1958 Shangqiu test site survey team, see John Wilson Lewis and Xue Litai, *China Builds the Bomb* (Stanford, CA: Stanford University Press, 1988), p. 175. For account of soldiers involved during the early stages of China’s nuclear weapons program experiencing radiation sickness in their later years, see Michael Sheridan, “Revolt Stirs among China’s Nuclear Ghosts,” *Times Online*, April 19, 2009, at <http://www.timesonline.co.uk/tol/news/world/asia/article6122338.ece>, accessed on February 8, 2010. Not covered, however, are court cases introduced by 22 Base soldiers involved in warhead storage and handling.

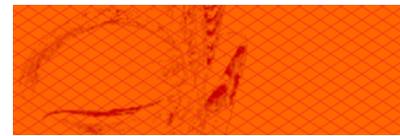
¹⁴ See *Communist China’s Weapons Program for Strategic Attack*, NIE 13-8-71 (declassified), October 28, 1971. It added that “some of this space is probably used for nuclear weapons inspection and retrofit.” The reporting suggested that launch bases included facilities for check out and mating of the warhead, as well as possibly for “separate or temporary storage.” It was uncertain if the Chinese would keep nuclear warheads stored at launch bases or in a central stockpile, then transporting them to the bases only in a crisis situation. A logistics system would be able to rapidly deploy warheads from base-level storage sites to launch positions as the missiles were being readied. The reporting notes that warheads could be stored near launch sites or even on missiles.

¹⁵ For additional background on the impact of the Cultural Revolution on the nuclear weapon development program, see John Wilson Lewis and Xue Litai, *China Builds the Bomb* (Stanford, CA: Stanford University Press, 1988), pp. 202-206. In addition to a brief discussion of the warhead storage base functions, one account asserts that the Taibai storage complex had been planned as early as 1960, with Taibai County formed in 1961 for the nuclear storage mission. See “The Leaker: Cruise Missiles Point toward Hainan Target Zone, Target is Obvious,” [漏斗子：巡航導彈劍指海南靶區，針對性太明顯了], *China.Com Blog*, December 28, 2009, at <http://big5.china.com/gate/big5/zzh1125.blog.china.com/200912/5644340.html>.

¹⁶ For background on Taibai County and its long time status as a strategic Second Artillery base, see “Situation of Taibai County” [太白县情概况] on the county’s website at http://web.bjsme.com/user/tbxhxyj/index_cn.asp, accessed on January 2, 2010. References to the 89900 Unit continue through until 1978, when COSTIND underwent a major reorganization. The central warhead storage and handling facility has also been known as the 22 Component Base [二十二器材基地]. Taibai also has been referred to in some sources as having functioned as an underground reserve command post (*yubei zhihuisuo*).

¹⁷ The political commissar during the 22 Base’s formative years was Yao Shumei [姚书梅]. He served in the position from January 1, 1962 until 1979.

¹⁸ For background, see J.W. Wang, “Tunneling and Technological Progress in Tunneling in China,” in Jian Zhao, Nicholas Shirlaw, and Rajan Krishnan (eds), *Tunnels and Underground Structures* (Rotterdam: Balkema Publishing, 2000), p. 97. Parallel and intersection rail lines can be seen on Google Earth. China’s tunneling technology since then has advanced significantly, with



completion of an 18.5 kilometer tunnel cut through the eastern edge of the Qinling Mountains south of Xian.

¹⁹ Institutes and factories under the 067 Base began moving from neighboring Fengxian to Xian in the 1990s, and is now known as the China Aerospace Science and Technology Corporation (CASC) Sixth Academy. The area along the rail line also hosts a strategic storage facility managed by the Lanzhou Military Region.

²⁰ Major General Li Zongde [李宗德] has served as 22 Base Commander since 2005. Unsubstantial reporting indicates that Li has been in the 22 Base for over 20 years, and began his career in the base's security battalion. He replaced Major General Li Qisheng [李启胜], who moved in 2005 to become commander of the 56 Base. A previous commander, Major General Dong Qingfu [董庆福], was promoted to Second Artillery Deputy Chief of Staff in 2000. The nuclear warhead base political commissar is Major General Kong Fanshun [孔繁顺], who came to the position in 2009 after serving as the director of the 52 Base Political Department. Former 22 Base Chief of Staff Chen Chuhua [陈楚华] was promoted to become 52 Base Deputy Commander in 2008. Current 22 Base Deputy Commander is Major General Wang Chensheng [王辰生], who has been in the position since 2002.

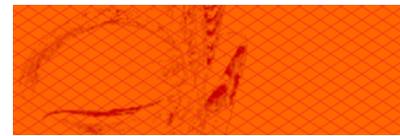
²¹ Born in 1955, the senior engineer today is Major General Feng Jiefei [冯介飞]. Major General Chen Ligu [陈礼国] serves as Director, 22 Base Equipment Department. Assigned to the 22 Base for almost 40 years, Chen had been deputy chief of staff and then deputy senior engineer. See Chen Yu, "Missile General Chen Ligu" (导弹将军陈礼国), *S&T Daily*, September 15, 2009, http://www.stdaily.com/kjrb/content/2009-08/22/content_96495.htm; and "Extraordinary Life of a Missile Expert," *Baoji News*, November 22, 2009. A cached version of one of the many stories on Chen Ligu linked him explicitly with the 22 Base and the nuclear weapons storage facility.

²² Also known as the Ninth Academy [九院], CAEP is China's primary entity responsible for design, development, and manufacturing of nuclear weapons. For good histories of China's nuclear weapons development program, see John Wilson Lewis and Xue Litai, *China Builds the Bomb* (Stanford: Stanford University Press, 1988); and Thomas C. Reed and Danny B. Stillman, *The Nuclear Express: A Political History of the Bomb and Its Proliferation* (Minneapolis: Zenith Press, 2009). According to Reed and Stillman (pp. 358-359), fabrication of nuclear warheads is carried out "near the city of Pingtung" about a two and a half hour drive north of Mianyang. Chinese sources indicate the existence of a CAEP 903 Factory [also known as the Sichuan Materials and Technology Institute; 材料与工艺研究所], located between Nanbazhen Township [南坝镇] and Pingtong Township [平通镇] within Pingwu [平武县] County, in the mountains about a 100 kilometers northwest of Mianyang. Pingwu and neighboring Beichuan Counties were two of the hardest hit by the 2008 earthquake, with a number of villages, as well as the 903 Factory, isolated. Media reporting highlights that Second Artillery engineering units, including the primary installation engineering regiment based in Luoyang, were involved in disaster relief operations in this area.

²³ Yu Jixun, *Second Artillery Campaign Science*, p. 202.

²⁴ The regiment or brigade-sized entity is known by its military unit cover designator (MUCD), 96421 Unit (formerly the 80435 Unit). Ding Haiming, Jiang Wu, and Sun Yaowu, "Second Artillery Equipment Inspection Unit: Individuals Deep in Mountains Inspect Strategic Missiles" [二炮装检部队：深山中为战略导弹做体检的人], *PLA Daily*, January 15, 2010, <http://mil.news.sohu.com/20100115/n269593967.shtml>. Also see Yue Xiaolin, Mao Yuan, and Liu Shuai, "Service Regiment Commander Sun Zhe Documents Dedicated Work," [某部勤务团团长孙哲爱岗敬业工作纪实], *China Military Network*, October 10, 2008, at http://www.chinamil.com.cn/site1/xwpdxw/2008-10/10/content_1505736.htm, accessed on January 2010.

²⁵ For a direct linkage of Hongchuan [Red River] with the 22 Base nuclear warhead storage regiment, see Zhang Rong and Gao Manhang, CMC Grants "Hongchuan Spirit" Regiment Top Level Prize" [中央军委授予“红川精神”团集体一等奖], *Guangming Daily*, February 1, 2010, at <http://cpc.people.com.cn/GB/64093/64094/10903446.html>, accessed on February 13, 2010. According to one *PLA Daily* article, "Hongchuan" is secured military facility deep in the mountains, not found on any map, without cell phone coverage, no assigned female soldiers, or family members located within a 200 kilometer radius. See Xin Shihong and Zhang Rong, "Second Artillery Soldiers Grasp Common Technologies" [二炮士官多掌握军地通用技术], *PLA Daily*, December 5, 2009. As of December 2009, the regiment's commander is Mou Shanyong [牟善勇], Political Commissar is Kong Fanshun, senior engineer is Xu Jiaqi [许家啟], and deputy chief engineer is Kan Zhen [闞震]. One article references a 22 Base presence in Qilichuan village [七里川村], about five kilometers from the Taibai County seat, and another refers to the engineering unit responsible for tunneling being based just west of Qiliqian. See Zhang Feng, "Meteorological Service Service Enters Military Base, Contributes Toward Close Relations" [气象服务进军营 共建军民鱼水情], *Baoji Weather Service Network*, September 25, 2007.



²⁶ Among specialists addressing the issue include Song Xianchang [宋杏昌]. See “Cracking Key Technologies in Second Artillery Missile Warhead Storage” [二炮导弹战斗部洞库贮存关键技术已经破解], *PLA Daily*, April 12, 2007, at <http://mil.eastday.com/m/20070412/u1a2760363.html>, accessed on February 16, 2010.

²⁷ Yue Xiaolin, Mao Yuan, and Liu Shuai, “Service Regiment Commander Sun Zhe Documents Dedicated Work,” [某部勤务团团团长孙哲爱岗敬业工作纪实], *China Military Network*, October 10, 2008, at http://www.chinamil.com.cn/site1/xwpdxw/2008-10/10/content_1505736.htm, accessed on January 14, 2010.

²⁸ See “Second Artillery Unit Carries out Investigation of Lei Feng” [对第二炮兵某部开展学雷锋活动的调查], *PLA Daily*, March 11, 2006.

²⁹ See Yu Xihong, Cao Jianbing, and Shi Qing, “Second Artillery’s Only Cavalry Unit Equipped Electronic Maps to Eliminate Blind Spots in Warning Zones” [二炮唯一骑兵分队装备单兵电子地图消除警戒盲区], *PLA Daily*, October 23, 2008.

³⁰ Zhou Hongbin and Feng Jinyuan, “A Certain Second Artillery Regiment’s Scientific Management of Special Fuel Storage - 40 Years Without Accident [二炮某团科学管理贮运特种燃料40年无事故], *PLA Daily* [解放军报], May 1, 2008.

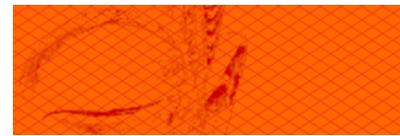
³¹ “A Certain Equipment Inspection Regiment Advances Security Through Training” [第二炮兵某装检团汲取他人教训促进安全发展], *PLA Daily*, June 4, 2007, at <http://www.allzg.com/n34053c517.aspx>, accessed on December 30, 2009.

³² For reference to the 96401 Unit’s Hongling Command Cell, see “Taibai County Begins Preparatory Work” [太白县两节一会筹备工作正式开始], *Xinhua*, July 24, 2007, at http://www.sn.xinhuanet.com/other1/2009-07/24/content_17198502.htm; and “Gao Qingfeng: Decisive Struggle in the 109 Tunnel” [高庆峰：决战109隧道], *Reminwang*, June 5, 2008, at <http://military.people.com.cn/GB/8221/74407/122512/122519/7346873.html>, accessed on December 29, 2009. For a reference citing Gao Qingfeng as commander of the Hongling Command Cell in 2006, see “Grand Opening of Taibai County 11th National Congress of the Communist Party of China” [中国共产党太白县第十一次代表大会隆重开幕], Taibai County Development and Planning Bureau announcement, October 25, 2006, at <http://taibai.mofcom.gov.cn/aarticle/dongtai/200610/20061003524464.html>. He has been cited as deputy chief of staff of the 96401 Unit and former commander of the transport regiment. Also see Xin Shihong and Zhang Rong, “Second Artillery Soldiers Grasp Common Technologies” (二炮士官多掌握军地通用技术), *PLA Daily*, December 5, 2009. Hongling may also serve as a transport control center.

³³ See Ding Haiming et.al, “Second Artillery Equipment Inspection Unit: Individuals Deep in Mountains Inspect Strategic Missiles. “Discussion of the Second Artillery’s Engineering Troops: I’m From the 308” [说说二炮工程部队 我就是308出来的], *Military World*, at <http://bbs.cnhubei.com/thread-631320-1-1.html>, accessed on January 20, 2010.

³⁴ “County Leadership Visit Officers and Men of the 96512 Unit” [县上领导到驻县96512部队看望慰问驻地官兵], Taibai County government announcement, February 5, 2010, at http://www.sxtb.gov.cn/E_ReadNews.asp?NewsID=1552, accessed on February 9, 2010. Unsubstantiated sources highlight a “308 Command Center” (308指挥所) in the Taibai area. See “Discussion of the Second Artillery’s Engineering Troops: I’m From the 308” [说说二炮工程部队 我就是308出来的], *Military World* [军事天地], at <http://bbs.cnhubei.com/thread-631320-1-1.html>, accessed on January 20, 2010. Installation engineering, including ventilation, electrical wiring, plumbing, and presumably security systems, is provided by the Second Artillery Engineering Technology Group, based in Luoyang, Henan province. The regiment most likely responsible for underground facility installation is the 96542 Unit, which was cited as a leading unit responding to the May 2008 earthquake in Sichuan.

³⁵ The regiment under the 308 Engineering Command is the 96512 Unit, also referred to as the 107th Engineering Regiment. Its commander, Col Zheng Zhilong [郑治隆], has been reported in the media as leading the so-called “Great Wall Project,” a major Second Artillery engineering effort. Speculative sources dating back to 1996 have alleged that the focus of the project has been the Taihang Mountain region [太行山区]. However, other sources indicate that the so-called “Great Wall Project” is a nationwide Second Artillery-related engineering program being carried out in the Taibai, Tianshui, Huanglong, Shangrao, and other areas of China. Assisting in the project were some of China’s foremost tunneling experts, such as Wang Mengshu [王梦恕] and Zhou Fengjun [周丰峻]. See “Second Artillery Engineering Regiment Adopts Smooth Blasting Technology to Extend ‘Underground Palace’” [二炮某工程团采用光爆技术向“地宫”延伸], *PLA Daily*, September 23, 2006, at http://military.china.com/zh_cn/news/568/20060923/13645467.html, accessed on January 21, 2010. Also see Zhang Qi, Lu Jianhong, and Li Mingri, “Second Artillery Uses High Tech Equipment in Northwest Mountain Area for Construction of



Underground Missile Storage Tunnel” [二炮用高技术装备在西北山区打造导弹地下洞库], *PLA Daily*, December 21, 2009 at <http://mil.eastday.com/m/20091221/u1a4894868.html>, accessed on March 4, 2010.

³⁶ Among various studies on radiological and other health hazards in an underground facility, see An Jiangyan, Cao Hongliu, Sun Ya'ou, “Survey of a Certain Tunnel's Air Quality and Effect on Soldiers” [某坑道空气质量调查及其与屯兵数额关系的分析], *Journal of PLA Medicine* [人民军医], 2002, Issue 45, No. 10, pp. 562-563, at http://journal.shouxi.net/upload/pdf/26/497/29286_1039.pdf, accessed on February 15, 2010. The authors are from the 22 Base Logistics Department's Institute of Preventative Inspection and Environmental Supervision [防检环监所].

³⁷ Among the standard procedures for missile checkout include computed tomography (CT). Ding Haiming, “The Silent Sword that Never Sleeps: Notes from A Visit to a Second Artillery Base Equipment Inspection Regiment Site” [长剑不语人不寐——踏访第二炮兵某基地装检团阵地手记], *PLA Daily*, January 15, 2010, at http://news.mod.gov.cn/forces/2010-01/15/content_4118078.htm, accessed on February 2010. For an indication that a *zhan* is a battalion-level organization, see “A Certain 2nd Artillery Regiment Evaluates Nuclear (Core) Cadre,” [第二炮兵某团以打赢为尺度培养选拔人才考核干部], *PLA Daily*, August 7, 2007. The article specifically discusses a certain “equipment inspection #3 station” [装检三站].

³⁸ For an explicit reference to an equipment inspection element preparing warhead for launch, see “Second Artillery Unit Unscripted Exercise Raises Force's Combat Capability” [二炮某部无“脚本”演练催升部队战斗力], *Renmin Wang*, September 23, 2008, at <http://military.people.com.cn/GB/107652967/8093917.html>, accessed on February 21, 2010. For an example of a reference to a third site under a storage regiment, see “A Certain 2nd Artillery Regiment Evaluates Nuclear (Core) Cadre,” [第二炮兵某团以打赢为尺度培养选拔人才考核干部], *PLA Daily*, August 7, 2007. One outlier to the base-level Second Artillery base-level storage system is an additional regiment subordinate to the 52 Base that is responsible for storage of short range ballistic missiles. Located in an underground facility near Shangrao, the regiment is known as the 96176 Unit, or the 52 Base Missile Component Depot [导弹器材仓库]. A subordinate battalion-level entity is said to be located near Qimen.

³⁹ See Tonghua County Record (Military), at <http://www.jlthx.gov.cn/ws/item/newsDetail.do?itemType=-1&itemid=556&id=8451>, accessed on 4 January 2010.

⁴⁰ The three Lushi County equipment inspection sites [装检站] appear to be concentrated within approximately 35 kilometers of Lushi County government seat, which is about 50 kilometers from the nearest railroad station.

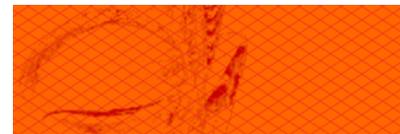
⁴¹ See Ta-chen Cheng, “China's Nuclear Command, Control and Operations,” *International Relations of the Asia-Pacific*, 2007 7(2), pp. 155-178.

⁴² RP-3 is a high density hydrocarbon fuel comparable to JP-10. See Li Liming [李立明], “Design of Central Missile Depot Support System for Certain New Missile” [某新型导弹中心库加注系统工艺设计], Conference Paper, China Space Association Launch Engineering and Ground Equipment Committee Meeting [中国宇航学会发射工程与地面设备专业委员会学术会议], 2003.

⁴³ For an explicit reference to the centralization of warhead storage, see Yu Jixun, *Second Artillery Campaign Science*, p. 242-244.

⁴⁴ Regiment headquarters moved from Liangdang County, Xipoxiang Sandushui Village [西坡乡三渡水村] to Taibai County in the mid-1990s. At least one key rail transport point used in the transshipment of nuclear warheads from the 22 Base to the six missile bases is Hongqing [宏庆] rail station, in the town of Xipoxiang. Reliable sources indicate the unit's rail battalion is located in Xipoxiang. For reference to the regiment headquarters in the Taibai area, see Wei Xiaoyan and Wang Yucheng, “Niujiagou People Enjoy “Happy Springs” [牛家沟人喜饮“幸福泉”], Xinhua Network, Shaanxi Channel, June 25, 2004, at http://www.sn.xinhuanet.com/2004-06/25/content_2377891.htm, accessed on February 22, 2010.

⁴⁵ For reference to new transport vehicles, see “New Generation Special Transport Vehicle Developed by Second Artillery Base Officially Enters Operation” [中国二炮基地研发新一代特装运输车正式列装], *PLA Daily*, May 14, 2004; and Han Haifeng and Wang Yongxiao, “Chen Liguo: The Extraordinary Life of a Missile Expert” [陈礼国：导弹专家的非凡人生], *PLA Daily*, August 23, 2009, at http://news.mod.gov.cn/forces/2009-08/23/content_4076567_4.htm, accessed on January 2, 2010. For reference to 96422 Unit oversight of key roads in the area, see “Liangdang County Road and Transportation Construction Situation and Examination” [两当县公路交通事业建设情况观察], *Gansu Daily*, June 7, 2007, at <http://ln.gansudaily.com.cn/system/2007/06/07/010372172.shtml>, accessed on December 10, 2009; and “Introduction of Basic Situation of Xipozhen” [西坡镇基本情况简介], Liangdang County website, April 9, 2007, at



<http://www.ldrk.gov.cn/city.asp?ArticleID=268&classid=24>. In addition to upgrades to the G316 highway running through the Qinling mountains, a new road, referred to as the Liangwen War Preparation Highway [两温战备公路], is being constructed that links Lianghekou [两河口] and Wenjiang [温江寺] Temple. For an account of the special rail battalion (and reference to Gao Qingfeng as then-regiment commander), see “Story of Special Missile Transport Troops” [导弹特运兵的故事], *Xinhua*, February 4, 2001, at <http://202.84.17.73/mil/htm/20010205/343627.htm>, accessed on January 12, 2010.

⁴⁶ “Gao Qingfeng: Decisive Struggle in the 109 Tunnel” [高庆峰：决战109隧道], *Reminwang*, June 5, 2008, at <http://military.people.com.cn/GB/8221/74407/122512/122519/7346873.html>, accessed on December 29, 2009. Of the 40 cars that derailed, 12 were loaded with fuel.

⁴⁷ Wang Yongxiao et.al., “Second Artillery Corps Show Prowess in Employing Missile Crane Equipment for Disaster Relief” [二炮一批新装备投入救灾 吊装导弹的大吊车显神威], *China News Service*, February 2, 2008, at <http://military.people.com.cn/GB/1076/52967/6857446.html>, accessed on February 1, 2010.

⁴⁸ For one article referencing a missile brigade rail company for missile body transport, see “PLA Missile Rail Transport Technology Achieves Breakthrough” [我军导弹铁路运输技术获得突破], *PLA Daily*, November 14, 2006, at http://news.xinhuanet.com/mil/2006-11/14/content_5327048.htm, accessed on January 21, 2010.

⁴⁹ For a reference to the transportation infrastructure and the rail battalion of the special transportation regiment, see Larry M. Wortzel, *China's Nuclear Forces: Operations, Training, Doctrine, Command, Control, And Campaign Planning*, (Carlisle, PA: U.S. Army War College, May 2007), p. 22. Xia Hongqing, “Second Artillery Service Regiment Rail Transport Company: Growing Up with the Flag” [第二炮兵某勤务团铁运连：党旗伴我成长], *PLA Daily*, July 1, 2002, at http://www.pladaily.com.cn/gb/pladaily/2002/07/01/20020701001045_army.html, accessed on February 21, 2010.

⁵⁰ Yu Jixun, *Second Artillery Campaign Science*, pp. 252-253.

⁵¹ For a comprehensive overview of warhead reliability, safety, and security issues, see Richard L. Garwin and Vadim A. Simonenko, “Nuclear Weapon Development Without Nuclear Testing?,” paper prepared for the Pugwash Workshop on Problems in Achieving a Nuclear-Free World, October 25-27, 1996, London England.

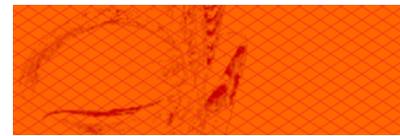
⁵² See “Retired Soldiers of China's Nuclear 22 Base” [中国核军事二十二基地退役战士], Petition to the Dazu County government, June 21, 2007. Also see “Regarding the Problem of Health Support for 1972 Military Retirees” [关于72年退伍军人生活保障问题], Chongqing City Government website, September 14, 2006, at <http://www.cq.gov.cn/PublicMail/Citizen/ViewReleaseMail.aspx?intReleaseID=17027>, accessed on February 1, 2010.

⁵³ See *Lessons from the Gulf War for Second Artillery Force Development* [海湾战争对二炮武器装备建设的启示], (Beijing: Second Artillery Headquarters Equipment Department, May 1991).

⁵⁴ The institute is directed by Wang Guoqing [王国庆], with Dr. Kong Xiangyu [孔祥玉] also playing a major role. Wang Yongxiao and Wang Feng, “Inspection and Transportation on Target: China's Strategic Missile Unit's Special Operations Troops” [装检押运报靶：中国战略导弹部队的特种兵], *China News Network*, June 21, 2006.

⁵⁵ For reporting on efforts to advance the educational level of institute engineers, see Han Haifeng, Wei Cunren, and Wang Yongxiao “Second Artillery Equipment Inspection Institute Overcomes Difficulties to Promote Doctoral Candidates To Grasp Core Control Issues” [二炮装检所破格提拔博士攻克核心控制领域难题], *PLA Daily*, February 8, 2008, at <http://mil.news.sina.com.cn/2009-02-07/0805541171.html>, accessed on January 4, 2010. Senior CAEP advisors to the 22 Base include Xu Zhilei [徐志磊]. As a senior figure in the development of China's second generation nuclear warheads, Dr. Xu was a recipient of one of China's highest prizes for defense S&T achievement for design and manufacturing of the fissile core of a nuclear device, known as the “pit.” In the 1980s, Xu was appointed as chief designer for the miniaturized warhead sub-system on two new intercontinental ballistic missiles (ICBMs). Concurrently, Xu functioned as deputy chief designer for the DF-31 program. Other key CAEP engineering consultants include Peng Xianjue [彭先觉] and Tang Xisheng [唐西生]. Liu Senlin [刘森林] from the China Institute of Atomic Energy has also served as a warhead safety and reliability consultant. Cooperation between the Second Artillery 22 Base and the civilian nuclear industry would appear to be a departure from extreme stovepiping in the past. For a discussion of bureaucratic barriers to cooperation, see Busch, p. 170.

⁵⁶ The specific CASC institute responsible for warhead and re-entry vehicle structural design is the China Academy of Launch



Technology (CALT, or CASC First Academy) 14th Research Institute, or Beijing Institute of Special Electro-Mechanics [北京特殊机电研究所]. For background on CIRP, see its website at <http://www.cirp.org.cn/>. CAEP hosts five PLA GAD laboratories that focus on issues such as shock wave and detonation physics [冲击波物理与爆轰物理], computational physics [计算物理], high density, high temperature plasma [高温高密度等离子体], and surface physics and chemistry [表面物理与化学].

⁵⁷ See “CMC and State Council Invites High Tech Expert to Beidaihe – Yang Weixin [中央、国务院邀请到北戴河休假的高技能人才—杨维新], *Government Labor Bureau*, August 6, 2004, at http://www.lm.gov.cn/gb/training/2004-08/06/content_42314.htm, accessed on March 1, 2010. Presumably working in conjunction with CAEP's Institute of Electronic Engineering, Yang developed a fuze control system [引控系统] and advanced “synchronous detonation” components. The 524 warhead design for the DF-3 was allegedly first tested in 1968, the 515 design for the DF-21/JL-1 in 1974, and the 506 warhead design for the DF-5 was first tested in 1976.

⁵⁸ See Han Haifeng, “Second Artillery Research Institute And State Key Laboratory Complete Major Tasks [二炮某研究所借助国家重点实验室完成重大课题], *PLA Daily*, October 26, 2006; and Han Haifeng and Wang Yongxiao, “PLA Second Artillery Special Weapons Inspection and Storage Capability Makes Significant Jump” [我军二炮特种武器装检贮存能力获大幅跃升], *China News Network* [中国新闻网], May 30, 2006, at <http://mil.eastday.com/eastday/mil/node62186/node62664/node62665/node137800/userobject1ai2069181.html>, accessed on January 22, 2010. The 96411 Unit, for example, commissioned Northwest Polytechnical University's Fang Jianxue [方剑青] for a study entitled “Testing Study On Acoustic Resonance Spectroscopy Method For Structural Condition Discrimination Recognition” [声学共振谱方法用于结构状态识别的实验研究].

⁵⁹ “Second Artillery Repair Factory Deploys to Battlefield Location under Information Warfare for Rapid Repair” [二炮某修配厂信息战场抢修], *China Broadcast Network* [中国广播网], April 17, 2009, http://www.cnr.cn/junshi/zgid/ep/200904/t20090417_505306080.html, accessed on December 15, 2009.

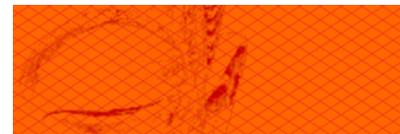
⁶⁰ The 96423 Unit's political commissar, Feng Danli [冯丹利], was associated with a Second Artillery training regiment “deep in the mountains,” probably in Qilichuan village. See Zhang Guangtian, “96401 Unit Helps Establish a New Farming Village in Qilichuan” [96401 部队援建七里川村新农村建设], *PLA Daily*, June 18, 2008; and Zhu Weishe, “Picture” [图片], *PLA Daily*, April 18, 2009, at http://www.chinamil.com.cn/site1/zbxl/2009-04/18/content_1730645.htm, accessed on January 2, 2010.

⁶¹ “The Second Artillery Uses Simulators for Missile Training to Resolve Wear and Tear Problems” [二炮用模拟器代替导弹训练破解装备损耗难题], *PLA Daily*, May 21, 2009, at http://www.chinamil.com.cn/site1/jbzsc/2009-05/21/content_1771248.htm, accessed on February 11, 2010. The unit highlighted was commanded by Xing Daomin: [邢道敏], commander of the 52 Base's training regiment, the 96171 Unit. For a discussion of warhead regiment training using live munitions, see “Nine Days Lifting the Sword” [托举神剑上九天], *S&T Daily* [科技日报], October 15, 2009, at http://www.stdaily.com/kjrb/content/2009-10/15/content_114200.htm, accessed on February 16, 2010; and “Evaluating Combat Effectiveness of a Certain Second Artillery Unit and Compliance With Military Training” [考出的战斗力二炮某部军训等级达标考核], *Xinhua*, November 8, 2008, at http://news.xinhuanet.com/mil/2008-11/04/content_10302644.htm, accessed on February 15, 2010.

⁶² See Wang Yongxiao and Xia Hongqing, “Second Artillery Base Advances Operational Capability Through Community Resources” [二炮某基地借社会资源推进战斗力建设], *PLA Daily*, January 28, 2008. For a good overview of C2 issues, see Stephen Polk, “China's Nuclear Command and Control,” in Lyle J. Goldstein and Andrew S. Erickson (ed), *China's Nuclear Force Modernization* (Newport: Naval War College, 2005).

⁶³ “Zhang Guangzhong: The Second Artillery Force Nuclear Missile Unit ‘Leading Soldier’” [张光忠: 第二炮兵核导弹方队“领军人”], *Xinhua*, September 29, 2009, at http://news.xinhuanet.com/politics/2009-09/29/content_12127389.htm, accessed on February 14, 2010. The 96363 Unit is located in Tianshui's Mapaoquanzhen [马跑泉镇], specifically Shenzipingcun [什字坪村]. See “Maiji District Achieves Remarkable Results in Spiritual Civilization ‘113 Project’” [麦积区精神文明建设“113工程”成效显著], Maiji government website, December 16, 2009, at http://www.maiji.gov.cn/html/jswm/200912160908597635_4.html, accessed on January 10, 2010.

⁶⁴ As one of the Second Artillery's older brigades, the 96363 Unit (formerly the 80412 Unit, or “812 Brigade”) is said to have moved to western foothills of the Qinling mountain range after conversion from the DF-4 to the solid fueled 13,000 kilometer



range DF-31A intercontinental range ballistic missile (ICBM) during the first half of this decade. Launch sites are allegedly east of the brigade headquarters in the western Qinling mountain range, where the Second Artillery's primary tunneling regiment [the 96512 Unit] has been reported to be active.

⁶⁵ The brigade currently deployed to Delingha [the 96367 Unit], appears to have been stood up around 2004. Responsible for overseeing the brigade's conversion to a new system as early as 2001, Zhang Guangzhong [张光忠] has been commander of the 96363 Unit since at least 2004. See "Zhang Guangzhong: The Second Artillery Force Nuclear Missile Unit 'Leading Soldier'" [张光忠: 第二炮兵核导弹方队“领军人”], *Xinhua*, September 29, 2009, at http://news.xinhuanet.com/politics/2009-09/29/content_12127389.htm, accessed on February 14, 2010. A number of underground facilities in this area can be seen on Google Earth. Seemingly well-informed analysts have noted the increasingly cooperative operational relationships between the various bases, including cross-regional mobility exercises, and common use of launch sites and support facilities.

⁶⁶ Ma Bo and Liu Hong, "Discussion of Underground Mobile Railed Launched-Strategic Missiles" [战略导弹地下铁路机动发射方式探讨], *Missiles and Space Vehicles* [导弹与航天运载技术], February 2005, pp. 49-60. The authors are from CALT's 15th Research Institute [Beijing Institute of Launch Technology; 北京航天发射技术研究所]. Ma Bo is a senior launch system designer and a deputy program manager of an unidentified missile system.

⁶⁷ For an assessment of China's 2008 Defense White Paper and the Second Artillery's evolving mission, see Huang Zijuan, "White Paper: Second Artillery Preparations for Integrated Nuclear and Conventional Strategic Capability and Nuclear Counterattack" [白皮书: 二炮已具备核常兼备战略力量及核反击能力], *Renmin Wang*, January 20, 2009. Within the last 15-20 years, the number of Second Artillery missile brigades has grown from 14 in 1992 to at least 28 in 2010. Five are equipped with short range ballistic missiles. Based on authoritative Chinese sources, missile brigades that appear to have been formed within the last five years are in the areas of Delingha (new brigade to replace unit that moved to Tianshui), Kurle, Yichun, Qingzhen, Chuxiong (possibly collocated with existing brigade), Chizhou (possibly collocated with existing brigade), and possibly Qingzhou.

⁶⁸ For an excellent summary of China's SSBN development, see Andrew S. Erickson and Michael S. Chase, "China's SSBN Forces: Transitioning to the Next Generation," Jamestown Foundation *China Brief*, Vol. 9 (12).

⁶⁹ At least one potential area of discussion could be what the International Atomic Energy Agency (IAEA) refers to as "design basis threat." For one discussion on China's physical protection system, see Tang Dan, Yin Xiandong, Fang Ni, Guo Cao, "Physical Protection System and Vulnerability Analysis Program in China," presented to International Seminar on Disarmament and the Resolution of Conflict (ISODARCO), Beijing, China, October, 2002. The authors are from CAEP's Institute of Electronic Engineering. Also see Nathan Busch, "China's Fissile Material Protection, Control, and Accounting: The Case for Renewed Collaboration," *Nonproliferation Review*, Fall/Winter 2002; and Hui Zhang, "Evaluating China's MPC&A System," paper presented at the Presented at the INMM 44th Annual Meeting, Phoenix, Arizona, 13-17 July, 2003.