

HALF LIVES:

A PRELIMINARY ASSESSMENT OF CHINA'S NUCLEAR WARHEAD LIFE EXTENSION AND SAFETY PROGRAM



PROJECT
2049
INSTITUTE

Ian Easton and Mark Stokes

July 29, 2013

Ian Easton is a Research Fellow at the Project 2049 Institute. Before his current fellowship at the Project 2049 Institute, he spent some two years at the Center for Naval Analyses (CNA) as a China analyst, where he collected, translated and analyzed primary source Chinese language materials on behalf of U.S. Navy, Department of Defense and other government sponsors. Ian spent a total of five years in Taiwan (the Republic of China) and the People's Republic of China. During his time in the region he worked as a research intern for the Asia Bureau Chief of Defense News. He also consulted at a Taiwanese think tank, the Foundation on Asia-Pacific Peace Studies, and Island Technologies Inc., a software company. Ian holds an M.A. in China studies from National Chengchi University in Taipei, a B.A. in international studies from the University of Illinois at Urbana-Champaign, and a certification in advanced Mandarin Chinese. He received his formal language training at National Taiwan Normal University's Mandarin Training Center in Taipei, and Fudan University in Shanghai.

Mark Stokes is the Executive Director of the Project 2049 Institute. A retired 20-year U.S. Air Force veteran, Mark was team chief and senior country director for the People's Republic of China and Taiwan in the Office of the Secretary of Defense between 1997 and 2004. He previously had served as assistant air attaché at the U.S. Embassy in Beijing and as a strategic planning staff officer within the U.S. Air Force Directorate of Operations. Mark's private sector experience includes service as executive vice president of Laifu Trading Company, based in Taiwan. He was subsequently vice president and Taiwan country manager for Raytheon International. He also was a member of the Board of Governors of the American Chamber of Commerce in Taiwan. He is a 1983 graduate of Texas A&M University, and holds graduate degrees in International Relations and Asian Studies from Boston University and the Naval Postgraduate School. A graduate of the Defense Language Institute, he has working proficiency in Mandarin Chinese.

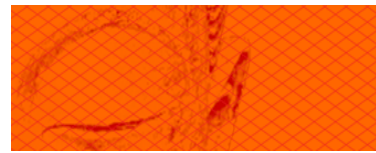
Cover Image: Early Chinese Nuclear Test

Source: Chinese Academy of Engineering Physics

About the Project 2049 Institute

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.

www.project2049.net



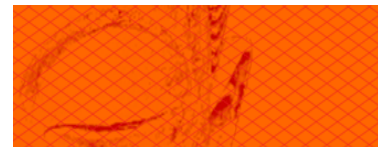
Introduction

Nuclear warheads and their associated delivery vehicles (ballistic and cruise missiles) represent the most powerful and potentially destabilizing weapons in the world today. While rapid advances in information and communications technology have endowed conventional weapons systems with the “intelligence” and precision to take on a greater number of strategic missions—for example targeting aircraft carrier groups and critical command nodes—nuclear weapons remain the *sine qua non* of deterrence. Indeed, while every nation’s leadership fears war to some degree, the threat of war is only truly horrific for a leader who faces an enemy armed with nuclear weapons. There is something profoundly different about nuclear weapons. They are uniquely destructive and abhorrent.

As such, the People’s Republic of China (PRC) is improving its nuclear deterrent to undermine the coercive effects of other countries nuclear weapons. The People’s Liberation Army’s (PLA) Second Artillery Force is building a next generation intercontinental ballistic missile (ICBM), and the PLA Navy is gradually working toward the goal of fielding nuclear submarines capable of launching a new submarine launched ballistic missile (SLBM).¹ How many new nuclear weapons China intends to produce and deploy in the years ahead is unclear. It is also unclear how China will be able to certify its new warheads in the absence of testing. Although China has not ratified the Comprehensive Nuclear-Test Ban Treaty (CTBT) that was adopted by the United Nations General Assembly in 1996, it appears to have refrained from exploding any of its nuclear devises since the treaty was introduced. With an aging fleet of proven weapons and a growing number of untested new warheads coming online, how will China store and maintain its nuclear stockpile in a manner that best ensures safety and reliability?

The answer to this question may be found in an examination of China’s nuclear warhead life extension and reliability program. The U.S. National Nuclear Security Administration (NNSA) defines the term “life extension program” (LEP) as “a program to repair/replace components of nuclear warheads to assure the ability to meet military requirements.”² By increasing the amount of time that a nuclear warhead can safely and reliably remain in its national stockpile, China can maintain its credible nuclear deterrent without conducting new underground nuclear tests – and limit the number of new and difficult-to-certify warheads that it needs to produce. The longer a warhead’s “life” is before it has to be removed and replaced because of reliability or safety concerns, the better.

This study will attempt a preliminary investigation of China’s nuclear warhead life extension programs, as well as Chinese efforts to ensure the safety, security, and reliability of its stockpile. We will seek to identify the key organizations and



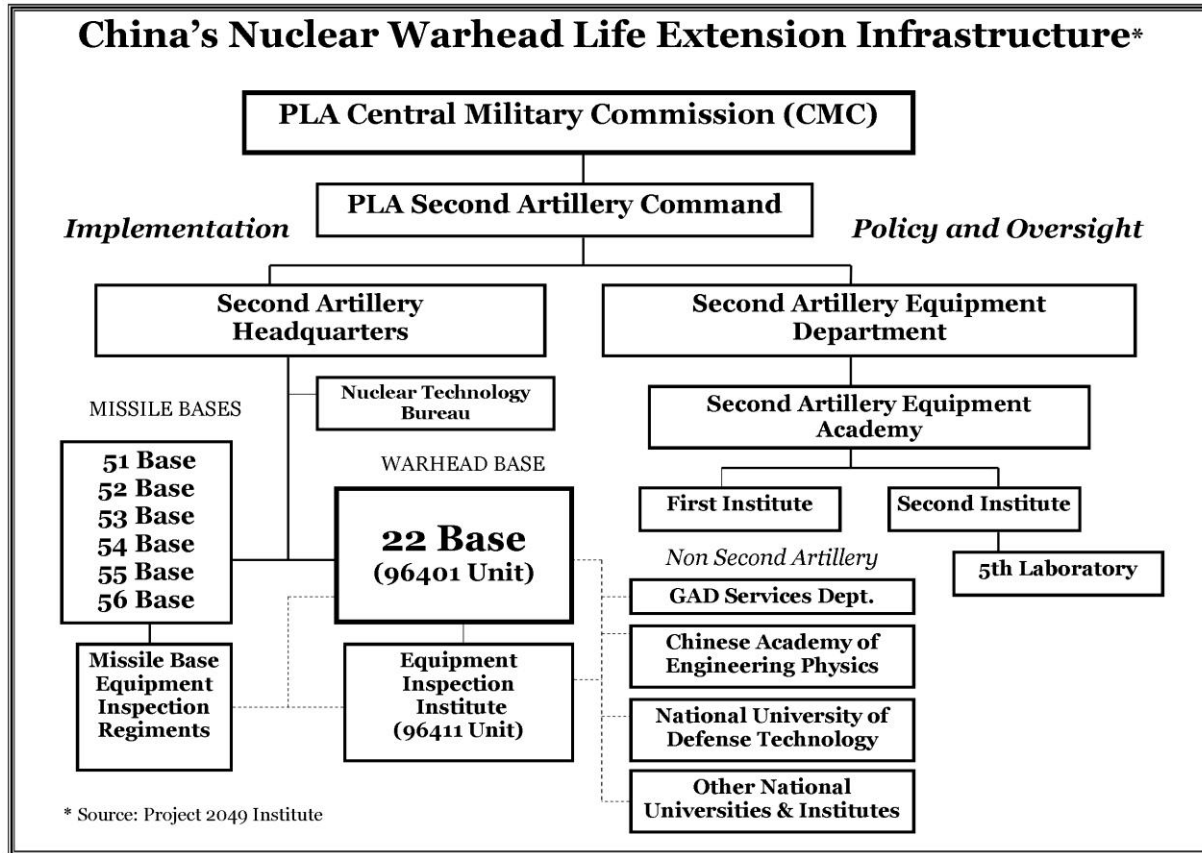
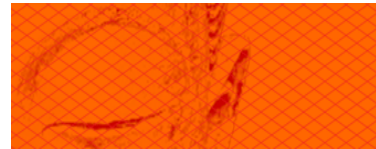
personalities involved in the program. We will also try to understand how China's nuclear community coordinates its research and assures security at critical sites. After describing some the successes China has made in this area, the study will conclude with a brief exploration of some of the challenges that remain for a successful nuclear program.

China's Nuclear Warhead Life Extension Program

Under cognizance of the Chinese Communist Party (CCP) Central Military Commission (CMC), the PLA Second Artillery Force is responsible for nuclear policy, force planning, and ensuring the health of the PLA's existing inventory of nuclear warheads. A critical aspect of the Second Artillery Force management mission is extending the life of assigned nuclear warheads through the repair and replacement of key components to combat the natural deterioration of nuclear warhead components that are kept in storage. The Second Artillery's nuclear life extension program increases the time a weapon remains available in a safe and reliable manner. In short, the Second Artillery's "life extension and refurbishment" (延寿整修) program is viewed as an integral part of "maintenance support" (维修保养).³

A number of organizations within the Second Artillery are responsibilities for various aspects of warhead inventory management. The Second Artillery Headquarters Department manages separate operational systems for warheads and missiles, which are allocated to launch brigades under six corps-level missile bases numbered from 51 to 56. The Second Artillery Headquarters Department develops overall nuclear-related operational requirements. Within the Headquarters Department, the former 22 Base commander, Major General Li Zongde (李宗德), now serves as Second Artillery Deputy Chief of Staff. His portfolio most likely includes operational aspects of Second Artillery warhead readiness. The Headquarters Department also oversees a Nuclear Technology Bureau, which is presumably responsible for emergency management of mass incidents.

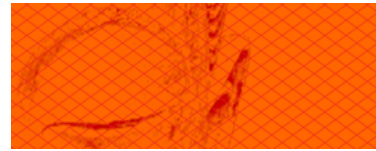
The Second Artillery Equipment Department is responsible for force acquisition and sustainment, including the development of warhead life extension and reliability policies and program oversight.⁴ The Second Artillery Equipment Department works closely with the PLA General Armaments Department (GAD) to leverage national-level technology development programs, and presumably ensures that the production of reliable components exists and that sufficient fissile material are available to satisfy warhead requirements. The Second Artillery Bureau (also referred to as the Nuclear Bureau) under the GAD's Services Department may function as an acquisition policy coordinating body.



The Second Artillery Equipment Research Academy appears to support the Equipment Department in detailed program management and development of technical requirements.⁵ The Equipment Research Academy consists of as many as seven research institutes. While detailed functional responsibilities of each individual institute is uncertain at the current time, at least two entities appear to be involved in warhead-related programs.⁶

First, the Equipment Research Academy's Second Research Institute, also known as the Second Artillery Computing Institute, appears to be responsible for warhead-related electronic components and safety issues. In minimizing the possibility of an accidental or inadvertent detonation, electronics associated with a warhead are a particularly important safety concern. The CMC has commended the Second Institute for its important contributions to the modernization of new generation weapons.⁷

The case of one particular Second Institute senior engineer, Dr. Lin Hualing (林华令), may be illustrative of the institute's responsibilities. Lin currently serves as deputy director of the Second Institute's 5th Lab.⁸ As a member of a Second Artillery Equipment Academy team that oversees and evaluates activities of operational units implementing China's nuclear warhead refurbishment program, Dr. Lin appears to be responsible for missile and warhead-storage management, including testing and



completing readiness certification based on requirements contained in the tactics, techniques, and procedures (TTP) documentation.⁹

Born in 1963, Dr. Lin taught middle-school physics classes in a rural mountain village before being admitted into China's National University of Defense Technology (NUDT). After completing his doctorate-degree theoretical and applied nuclear detonations at NUDT in 1991,¹⁰ Lin Hualing was assigned to the Second Artillery's First Research Institute in Beijing, where he worked on problems related to the storage of nuclear missiles and warheads.¹¹ In this position, Dr. Lin has been responsible for writing software application programs that not only improved the storage of weapons, but also provided methods for estimating the explosive power of warheads.¹² Around 2002, Dr. Lin became a member of the Second Artillery Warhead Expert Group (第二炮兵弹头专家组成员), and began surveying underground storage facilities, inspecting key warhead components, and certifying readiness and safety.¹³

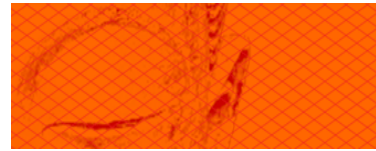


Other prominent figures within the Second Institute include senior nuclear safety engineer, Zhu Wenkai (朱文凯), who fills one of the Second Artillery's two seats on the 31-member China Nuclear Technology and Public Security Expert Committee.¹⁴ The Second Institute's 5th Lab is directed by Dr. Li Shicai (李世才).¹⁵ Dr. Zhou Peigu (周培毅) is the 5th Lab's target range engineer;¹⁶ and Song Renchang (宋杏昌) is a Second Institute engineer specializing in protecting warheads and missiles from electromagnetic radiation that could damage electronic components.¹⁷

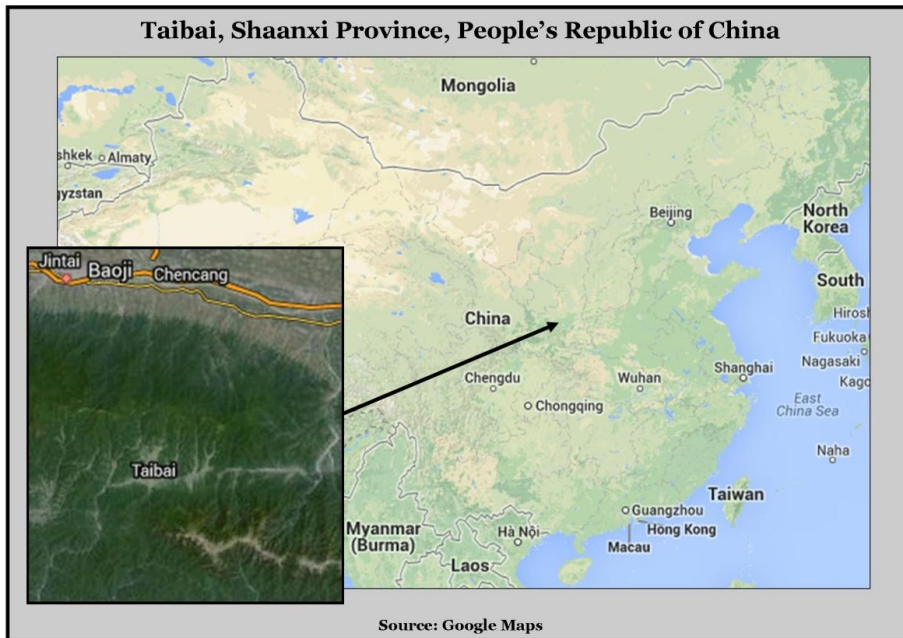
Operational Management

While the Second Artillery Equipment Department has responsibility for overseeing development of technical requirements and overall acquisition management, the principle organization responsible for monitoring the state of warheads and implementing China's nuclear weapon life extension program appears to be the Second Artillery's central warhead storage and handling complex, referred to as 22 Base. The base command is situated in Baoji City in Sha'anxi Province.¹⁸

The 22 Base leadership oversees a large infrastructure for warhead storage and handling. Major General (MG) Mo Junpeng (莫俊鹏) was assigned as 22 Base commander in 2012. He previously served as Second Artillery Equipment Department Deputy Director, and



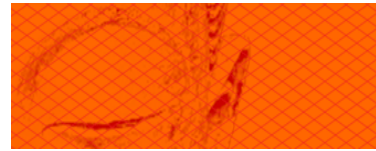
was promoted to MG in July 2008.¹⁹ 22 Base Political Commissar, Wang Dingfang (王定放), chairs the 22 Base CCP Party Committee, which, among a range of other responsibilities, allocates limited research and development funding in support of the 22 Base operational mission.²⁰



The 22 Base leadership oversees a number of brigade- and regiment-level organizations responsible for various aspects of warhead stockpile management. The chief engineer of the 22 Base and his staff are responsible for technical aspects of the 22 Base mission. As of 2012, Li Guofu (李国福) was 22 Base Chief Engineer.²¹ His deputy, Major General (MG) Chen Ligu (陈礼国; b. 1953), has served in the Second Artillery Force's nuclear warhead development and management system for over 40 years. Reports commemorating the latter's contributions to China's nuclear warhead life extension and reliability may be illustrative of the organization's technical responsibilities.

With roots in Henan Province, Chen Ligu was commissioned into the PLA in December 1970, three months before his 18th birthday. According to PLA-affiliated publications highlighting health risks, Chen participated in early ground and air testing of nuclear weapons, and accumulated extensive warhead repair experience. MG Chen is credited with being the first in China to install a live detonation device on a strategic missile and participating in the initial testing of an air-delivered nuclear device.²²

As a CCP member, Chen worked his way up to become 22 Base Deputy Chief of Staff and subsequently Deputy Chief Engineer in 1997.²³ From 2001 to 2009, MG Chen directed the 22 Base Equipment Department. While in this position, Chen is credited with

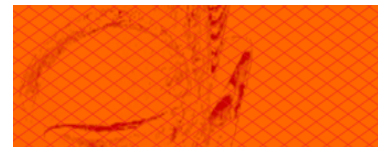


making significant contributions toward improving the safety and reliability of China's aging nuclear weapon inventory.²⁴ According to *PLA Daily* reporting, warheads and components had previously been stored in humid, damp underground facilities for an excessive period of time without sufficient environmental protection measures. A survey team concluded that the safety of China's warhead stockpile had become increasingly tenuous. Other reports in 2007 indicated significant discipline, training, and education problems within the warhead management system as well.²⁵

Chen Liguo led efforts to improve stockpile safety, reliability, and service life.²⁶ Presumably under the purview of the Second Artillery Equipment Department and GAD Services Department, Chen led an initiative to leverage expertise within the civilian defense industry and PLA organizations outside of the Second Artillery. The 22 Base concluded support contracts with as many as 16 civilian consultants and signed formal agreements with three research, development, and industrial entities: China Academy of Engineering Physics (CAEP; 中国工程物理研究院); China Institute of Radiation Protection (CIRP; 中国辐射防护研究院, or 中辐院 for short); and China Aerospace Science and Technology Corporation (CASC; 航天科技集团).²⁷ 22 Base also established cooperative relationships with six national key laboratories and “technology achievement incubator bases” (科研成果孵化基地), the National University of Defense Technology (NUDT), Northwest Polytechnical University (NPU), ten other institutes; and 26 civilian scientists and engineers. Over 250 members of the 22 Base were assigned to obtain degrees or training at NPU and NUDT, and over 100 were sent on fellowships with defense industrial design, development, and manufacturing entities.²⁸

In addition to drafting training and educational materials for nuclear operators, Chen is credited with leading the design and implementation of a tactical support system for monitoring critical components. The system reportedly improved warhead safety by a factor of ten. As an indication of the importance of his work, a visiting CMC delegation reportedly told Chen: “You guys are here deep inside the mountains quietly guarding our (nuclear) armaments with dedication. You serve as nameless heroes. The party and the people will not forget you!”²⁹



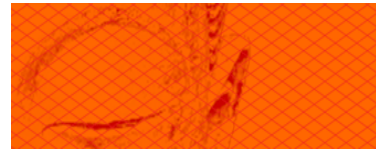


After a number of reportedly life-threatening incidents in the course of maintaining nuclear warheads, including health issues such as a lymph node cyst in his throat, friends encouraged Chen Liguo to retire from active duty and accept a lucrative civilian position. Chen reportedly refused, citing his dedication to serve the communist party for as long as possible.³⁰ His commitment to ensuring the safety and reliability of nuclear weapons was publically eulogized in the context of his ailing wife: “I have a dream. My dream is that life could be 10,000 years long. That way, I could split my life into two parts. I would use half of the time to take care of missiles, and half to take care of you!”³¹

Responsibility for day-to-day technical monitoring of China's existing warhead stockpile resides with the 22 Base Equipment Inspection Institute (96411 Unit).³² Granting particular attention to the core or pit (核心部件), the institute, which is a brigade-level organization, likely performs engineering analysis and environmental testing to ensure that China's nuclear weapon stockpile remains safe and reliable. A separate regimental-level unit under the 22 Base command (96421 Unit) is responsible for managing the warhead storage depot facilities located in Taibai County, just south of Baoji deep in the Qinling Mountains. Yet another regiment (96422) is responsible for the transportation of warheads and associated materials.³³

The director of the 22 Base Equipment Inspection Institute (96411 Unit),³⁴ Wang Guoqing (王国庆), is also a key figure in China's nuclear warhead life extension and refurbishment program.³⁵ Originally from Fengxiang County just north of the 22 Base, Wang Guoqing has been credited as being first outside the Second Artillery warhead expert group to perform a repair operation on a “sick” warhead core.³⁶ Wang is also known for establishing a seminar platform for connecting specialists researching warhead life-extension and repair (延寿整修) issues.³⁷ Similar to national key laboratories, the 22 Base maintains a large number of communications specialists to assist with building and maintaining classified networks that allow all the many geographically dispersed units involved to communicate with each other.³⁸

Based upon a survey of available media reporting and other publicly available material, a limited number of individuals appear to be leading and driving China's nuclear warhead life extension, safety, and reliability efforts. Only a few highly trusted PLA staff officers, scientists, engineers, technical specialists, and political officers are likely to be able to fully “read-into” the inner workings of the program. In addition, it appears that CAEP, the civilian defense industrial organization responsible for nuclear weapons engineering R&D and manufacturing, used to provide minimal follow-on support to their principle customers, the Second Artillery Force, after warhead delivery from their assembly factory to the 22 Base custodians. The shift toward greater civil-military interaction in the mid-2000s appears to have been driven by safety and reliability concerns.

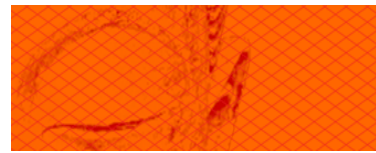


As a final note, the Second Artillery leadership also has expanded the role of the 22 Base to include emergency response to major nuclear and chemical contingencies. In the 2007-2008 timeframe, the 22 Base formed a Second Artillery Contingency Management Group (应急处置大队) as one of the PLA's premier

organizations charged with responding to nuclear or chemical accidents. Carrying a military cover designation of the 96426 Unit, the group is headquartered in Baoji.³⁹ Perhaps related, the civilian Taibai County government began stepping up emergency management planning in 2007.⁴⁰ The Taibai County government also completed construction of an emergency-response command facility (应急指挥场所).⁴¹

Over the next five years, Taibai County authorities are planning to install a wide area surveillance system and database that tracks “major danger sources” (重大危险源数据库).⁴² As part of this effort, the local government plans to begin surveying and mapping major sources of radioactivity (重点放射源), to include the distribution of dangerous radioactive materials (放射性危险品).⁴³ The local government also plans to strengthen the monitoring of the county's critical infrastructure, including hydro-electrical power, high density power lines, transportation passageways, bridges, tunnels, and communications nodes.⁴⁴





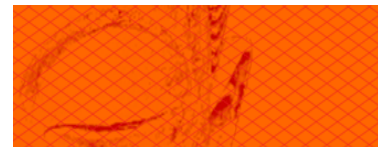
Role of Missile Bases

The Second Artillery nuclear warhead storage and handling system encompass not only the 22 Base, but also facilities subordinate to each of the Second Artillery's six missile bases. Base-level warhead handling units are generally referred to as Equipment Inspection Regiments (装检团). Each regiment oversees at least three facilities (装检站), with each having as many as seven subordinate sites. The base-level Equipment Inspection Regiments appear to play a role in improving nuclear weapon safety, reliability, and service life.

The Second Artillery Equipment Department, presumably in coordination with 22 Base authorities, has sought to integrate and standardize the inspection, repair, and maintenance of warheads and other major weapon systems throughout the force. Centralization allows for multiple, geographically isolated units to coordinate their efforts to tackle critical problems associated with warhead and missile readiness. Coordination has not been seamless. In some cases, multiple units have worked on the same problem at the same time. This suggests that units are either “stove-piped” and unaware of their peers' efforts, or that Second Artillery Equipment Department authorities build redundancy into high-priority technology development efforts.⁴⁵

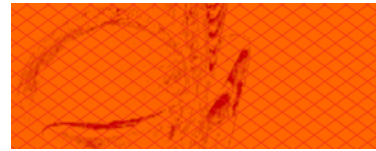
The Second Artillery 55 Base Equipment Inspection Regiment (96323 Unit) may serve as an illustrative example. Headquartered in the western Hunan city of Huaihua, 55 Base consists of ICBM brigades in Hunan and a ground launched cruise missile brigade in neighboring Jiangxi province. The 55 Base Equipment Inspection Regiment is responsible for the storage and handling of warheads and probably missiles allocated to the base.⁴⁶ This unit has reportedly solved problems that had stumped researchers at other Second Artillery R&D organizations and weapons manufacturing facility experts.⁴⁷ The 55 Base Equipment Inspection Regiment had been challenged by excessive inspection times that have affected operational readiness. The regiment's commander and chief engineer mobilized the unit's officers and enlisted specialists to resolve the shortcoming.

After a detailed assessment, the team modified inspection procedures and introduced “new technologies and materials” that greatly improved reaction time and readiness. At least one capability designed by the Equipment Inspection Regiment is referred to as Management Information System for Forward Positions (阵地管理信息系统). The “tailor-made” system links the regiment's underground facilities and shares safety indicators such as temperature and moisture, fire alarms, and security surveillance information.⁴⁸



The regiment produces the technical manuals, regulations, standards, and procedures for maintaining and sustaining the 55 Base's weapons systems. The regiment keeps a database of weapons' health indicators over their entire lifetimes. Each weapon has a file that includes data collected from tests conducted when the weapon left the factory, periodic maintenance tests, and field tests. When data collected during tests indicates problems, results are labeled in the three categories of: unstable, but within acceptable limits; significantly off-standard; and critical state. When there are such problems, an expert group is assigned to deliberate and analyze the weapon's file. When weapons or their subcomponents break down, data is maintained on file as to how corrections or repairs were made.⁴⁹ However, it is not clear that it is the regiment's expert scientists and technicians that ultimately decide when a malfunctioning weapon should be deactivated. It is possible that such decisions are made by political officers and not specialists.⁵⁰

There does appear to be a certain amount of flexibility built into the Second Artillery's system for developing "best practices" for missile and warhead maintenance. This allows for individual equipment inspection units deployed across China to create technical operating manuals and other educational materials tailored to their unique weapons systems.⁵¹ At the same time, there is also a vertical hierarchy of technical manuals, political directives, safety regulations, operating standards, and fixed procedures that are "pushed-down" from the Second Artillery Equipment Academy.⁵² In some cases, Second Artillery field units with particularly strong records of success will see some of the materials they write promulgated across the force.⁵³



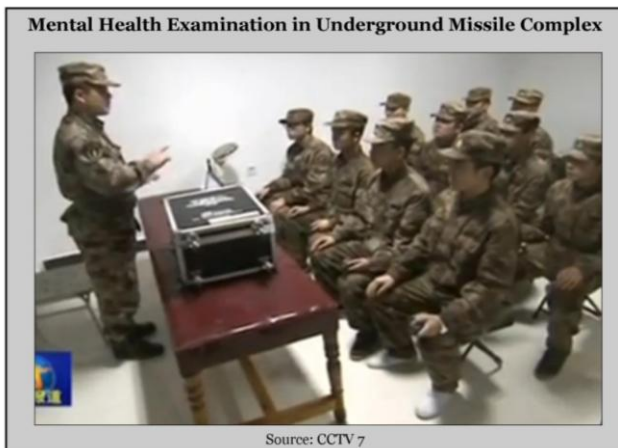
Chinese ICBM Undergoes Inspection and Testing



Source: Xinhua

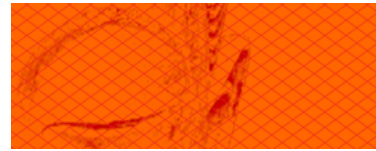
Human Factors in Missile/Warhead Management

The Second Artillery's missile and warhead stockpile management also involves physical and psychological challenges. During a May 2013 wartime simulation, a unit was sealed in a tunnel complex behind thick hydraulic blast doors for 72 hours, and then subjected to a series of intense wartime scenarios under the guidance of senior units. The technical challenges the unit encountered involved simulated data and signal failures. Another challenge the unit faced was the lengthy process required to assemble, check-out, and then transfer missiles with their attached warheads to launching units. Reportedly, the process required over 200 orders to be read in order for 100 separate components to be assembled into a launch-ready weapon.⁵⁴



Source: CCTV 7

Participants in the drill experienced difficulty in maintaining stamina due to stress and the physical exertion involved in handling bulky missile and warhead components. During the exercise, one soldier was hospitalized after her leg was rammed by a missile trailer. The unit practiced donning their protective hazardous material suits under stress after running sprints up and down a 100-meter-long tunnel. However, the most problematic



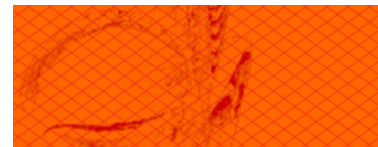
challenge was the constant odor of fuel in the poorly ventilated tunnels that resulted in some soldiers having a strong physical reaction. Reportedly the air was so foul that soldiers began suffering a significant lack of appetite, nausea, and other signs of discomfort after the first 24 hours of exposure. At least one soldier experienced violent vomiting.⁵⁵

The psychological challenges that the unit faced were also a significant factor that tested their performance during the wartime simulation. The exercise included an element whereby two members of a small team were pulled out of the simulation because of “psychological stress” (心里紧张). This forced the remaining team members to complete their tasks without two critical sets of helping hands. While no members of the unit actually broke down psychologically during the 72-hour simulation, the underground environment and stress of the constant assembling and disassembling of warheads and missiles did take its toll. After the 50 hour mark, the tunnel complex’s psychological counseling office (心理咨询室) reportedly begin filling up with patients. The on-duty military doctor ran tests on the visiting soldiers, but relied mostly on words of encouragement, telling them to “stay strong” (要坚持).⁵⁶



The challenges that this training exercise demonstrated appear to be ongoing. Many of the same type of problems occurred at an earlier 15 day wartime simulation carried out at an underground missile complex in June 2012. During the exercise, soldiers evinced appetite changes, homesickness, exhaustion, distraction, and “spacing out” after the first 2-3 days underground. By the fifth day of the exercise, the

psychological counseling office began to fill up with patients. According to the on-duty doctor, psychological files are maintained on all the troops in the complex, but while all the soldiers experience some anxiety and irritability, his job is to perform psychological counseling and intervention only when it is necessary. In order to help alleviate the building stress, the political commissars organized a karaoke party on the sixth night of the exercise. They also organized movie nights. On the ninth night, a “cultural performance detachment” (文艺演出小分队) was brought into the otherwise sealed tunnel complex to improve morale.⁵⁷

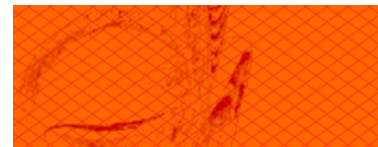


The Second Artillery Political Department allegedly has established requirements for PLA warhead engineers be able to operate for over three months in isolated underground bunker complexes.⁵⁸ However, authoritative reports conflict with these claims. Despite improvements in other areas of China's life extension and refurbishment program, the complex task of assembling and disassembling nuclear warheads and missiles in underground facilities appears to present challenges for the Second Artillery's technical community. The inherent danger of the work and the limited budgetary resources available also weigh heavily on the technical personnel that work with China's nuclear weapons.

The psychological challenge of working in underground facilities may be exacerbated by the dangers inherent in the warheads themselves. China's nuclear warheads have been known to experience unforeseen anomalies that can put the lives of those working on them in jeopardy.⁵⁹ Adding to the danger, the warheads reportedly have trigger devices that are sensitive to static electric shocks that can cause them to explode and kill nearby technicians.⁶⁰ For this reason technicians wear specialized protective suits with boots and gloves when working with warheads.⁶¹ They also periodically ground their hands on copper rods to get rid of built-up static.⁶²

Budgetary constraints are also a significant challenge to China's warhead life-extension and refurbishment program. Indeed, the program is noted for its expense and for the limited amount of resources available.⁶³ For example, one researcher at the 22 Base Equipment Inspection Institute reportedly implored his colleague to cease working on a system for collecting and analyzing certain weapons testing data saying: "Please forget about it. Our unit only has just a bit of research funding. We can't even fully support key-point projects. How are we going to pay for yours?"⁶⁴ On another occasion, the serving director of the 22 Base Equipment Department discovered that workmen were installing dangerously substandard safety equipment in a nuclear warhead handling facility that was being renovated. When confronted, the workmen claimed that they had decided to purchase the substandard equipment after facing difficulty obtaining the expensive and hard-to-find materials that they had been directed to install.⁶⁵

As a final note, underground facilities may be subject to chemical and radiological leaks. One account highlights "very good protection measures" within underground facilities, yet radiation and other hazards are not uncommon. In the words of one PLA Daily article: "(despite protections) some hazardous elements will still float through the air (空气里还是会飘浮一些有害元素)".⁶⁶

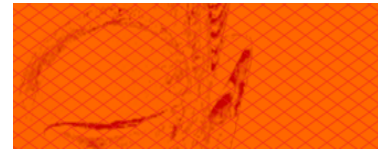


Conclusion

This preliminary investigation indicates a large effort underway to extend the useful lifetimes of China's nuclear warheads, and to maintain their safety and reliability as they age. This effort includes a number of supporting organizations, such as CAEP, and military technical units whose work is coordinated by the PLA Second Artillery Equipment Department and carried out at the 22 Base in Taibai, Sha'anxi. Key technical leaders involved in the program appear to exert some influence over the program's direction through their roles as advisors to decision-making political committees. This is a positive sign that China may be conducting its program in a responsible manner. It is not clear, however, that the political committee system in place always allows for its participants to make policies that optimize all the requirements of safety and reliability.

Indeed, there are indications that China continues to face significant challenges in keeping its nuclear weapons 100% safe. Beijing does go to extreme lengths to protect its stockpile from theft or misuse. However, many of the procedures that are used to keep its weapons from falling into the wrong hands may inadvertently contribute to the creation of an "insider threat." For example, some members of the Second Artillery technical community that handle China's nuclear warheads and missiles on a day-to-day basis have been reported to suffer from psychological problems. The stress that these soldiers, scientists, and technicians work under appears to be compounded by the conditions that exist at key facilities, including underground nuclear missile complexes and nuclear warhead labs. A lack of adequate funding also appears to contribute to safety concerns.

Looking ahead, as China considers the number of new nuclear warheads and delivery systems that it will produce over the coming decades, it will be important to implement safeguards to assure that its relevant maintenance systems are staffed with healthy and well-balanced personnel. This will require trade-offs. China's warhead life extension and refurbishment program as it is currently configured appear to prioritize technical achievement over all other factors. This sense of urgency may stem from a concern that China's nuclear community will be unable to certify its weapons at some point without further testing – something that Beijing hopes to avoid because it could invite international approbation. Whatever the reason for the choices it has made, Beijing's willingness to allow for greater transparency and a continuing examination of its nuclear program are positive first steps toward a more mutually beneficial dialogue with the United States on warhead safety and reliability issues.



Profile of an Underground Nuclear Missile Complex*

In July 2012, an official Chinese Communist Party media outlet, the People's Daily, featured a fairly detailed story on an underground Second Artillery Missile Complex. According to the story the complex is based inside a large mountain. The complex is nicknamed the "Dragon's Lair" [龙宫]. Its main entrance is protected by a thick blast door made of specialized materials. This door is concealed from the outside by thick vegetation and camouflaged installations. The inside of the facility is cold (constantly around 20 degrees Celsius), smells of fuel, and features the constant droning of ventilation machines. Inside the main blast door there are a series of specialized interior doors to protect against biological, chemical, and nuclear attack; to serve as dehumidifiers; and to protect against noise leaks to the outside.

Sealed inside this series of protective doors is the soldiers' living quarters; support and provisions areas; operating and training areas; and several large functional areas. The most well protected area is the soldiers living quarters. This area is an internal barracks that features a series of dormitory style rooms with narrow bunk beds. It has shower facilities, toilet facilities, a dining hall, a recreational club, a game room for chess, and a reading room. The recreational club has a television, a karaoke machine, cards for poker games, and a number of official notices on the wall. The rooms in the living quarters fall along a main tunnel that features around 100 retractable beds built into the wall. These beds are stacked three high to provide extra bunk space. In the event of an emergency, soldiers from across the "Dragon's Lair" are to put on the gas masks that they keep nearby at all times. They are then to run to the decontamination showers and, after decontaminating, retreat into the living quarters.

Outside the living quarters is the rest of the tunnel complex, which stretches across the mountain in a network that is described as a "shockingly large underground city." The operating and training area inside the complex is comprised of a series of workshops where the missiles are assembled, mated together with warheads, and rigorously tested before being transported on underground trailers to launch sites. This area is protected by sentry posts where all those entering are made to put on protective overhauls and boots before going in.

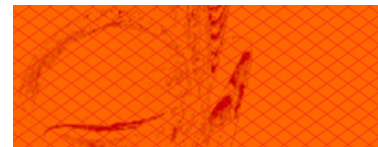
The support and provisions area is likely where control rooms are located. In these rooms individual teams carefully monitor data indicators on the facilities' air, water, electricity and other essential supplies. There are specialized areas for storing unarmed warheads and missiles. The base also features a clinic, and a psychological counseling office, staffed by a cheery military doctor. The entire complex is lit by bright florescent lights; and every room has smoke detectors and a 24 hour clock on the wall.

Outside the complex are guard posts that are concealed in the thick vegetation. Due to the swarms of biting mosquitoes, bugs and ants in the area, the guards have to wear protective masks over their faces. Rain, boredom, and surprise inspections are a constant burden. However, unlike those inside the underground complex below, they have the luxury of being allowed to smoke.

* Zhang Tiehan, "Second Artillery Unit Enters into Isolated Survival Training Underground to Complete Missile Testing [二炮部队进行密闭生存训练 在地下完成导弹测试]," *Renmin Ribao* [People's Daily], July 6, 2012, at <http://military.people.com.cn/n/2012/0706/c172467-18462076-1.html>.

NOTES

¹ *Military and Security Developments Involving the People's Republic of China 2013* (Arlington, VA: Office of the Secretary of Defense, 2013), p. 7, at http://www.defense.gov/pubs/2013_China_Report_FINAL.pdf.



² See “Life Extension Programs,” *National Nuclear Security Administration*, undated, at <http://nnsa.energy.gov/ourmission/managingthestockpile/lifeextensionprograms>.

³ Zhang Xueming, et al., “Second Artillery Passes 5 Strict Checks to Assure Missiles Can Fight Anytime (二炮 5 个关口严格把关确保导弹随时能战),” (*PLA Daily*), January 14, 2013, at <http://military.people.com.cn/n/2013/0114/c1011-20188580.html>.

⁴ Ibid.

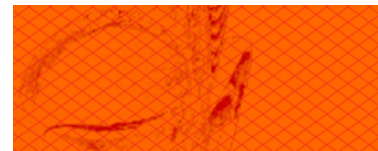
⁵ For example, the Academy's Operations Support Department has produced a number of studies on anti-ship ballistic and anti-satellite technologies. Authors of articles on ASBM and ASAT requirements include Tan Shoulin (谭守林), Wang Minghai (王明海), Li Xinqi (李新其), Zhang Daqiao (张大巧), and Tang Baoguo (唐保国). Most are affiliated with the Engineering Academy's 603rd Instruction and Research Lab (603 教研室). The Department of Automated Control's 303 Lab (二炮工程学院 303 教研室) has performed technical analysis on near space flight vehicles.

⁶ See Wang Tie, “Dedication is a Pursuit: The Story of How Lin Hualing Went from Rural Teacher to Missile Expert (认真是一种追求: 讲述林华令从山区教师到导弹专家的故事),” *PLA Daily*, June 29, 2006, p. 11, available online at <http://www.pladaily.com.cn/site1/images/2006-06/29/jfjb11b629b.PDF>.

⁷ Personnel from the institute reportedly have deployed to test sites in western China on a frequent basis. Wang Tie, et al., “Second Artillery Missile Warhead Storage Facility Cracks Critical Technologies (二炮导弹战斗部洞库贮存关键技术已经破解),” *PLA Daily*, April 12, 2007, available online at <http://mil.eastday.com/m/20070412/u1a2760363.html>.

⁸ Note that Dr. Lin has also published research under an affiliation with of the Beijing Institute of Technology's Institute of Mechanical Engineering, an institute has a long history of supporting the PLA through the design of solid rocket motors, missiles, warheads, and missile launchers. See Beijing University of Technology website's introductory page on its Mechanical Engineering Institute at <http://www.bit.edu.cn/xxgk/xysz/yhxy/45271.htm>. For a reference linking Dr. Lin to the institute, see Lin Hualing, et al., “Research on the Compression Equilibrium of Mixed Materials after a Shockwave (混合物冲击压缩后平衡态的研究),” *Chinese Journal of High Pressure Physics*, March 2004, pp. 59-69. According to this report, Dr. Lin's email address at the time of publishing was linhual7215@sina.com.cn. For his affiliation with the Second Artillery Equipment Academy's Second Institute see Song Jiangjie, Zhang Zhenyu, Tan Xiaoli, Lin Hualing, and Cheng Lirong, “A review of models describing shock-induced ignition and detonation of solid heterogeneous explosives (固体非均质炸药冲击点火与起爆模型研究进展),” *Explosion and Shockwave Journal*, Vol. 32, Issue 2 (August) 2012, pp. 121-128; and Jiang Zengrong, Li Shicai, Lin Hualing, and Wang Haifu, “Simulation of the Influence of Impact Depth on Runway Penetrating Warhead Damage Effects (炸点深度对反跑道侵爆但头部毁伤效果影响数值模拟),” *Ninth Annual National Shockwave Physics Studies Conference Paper*, August 2009, p. 175. Available online at <http://www.doc88.com/p-393367807771.html>. Note that the 5th Laboratory is tasked with testing the effects of missile explosions (专门检测导弹爆炸效应). Wang Tie, et al., “Second Artillery Missile Warhead Storage Facility Cracks Critical Technologies (二炮导弹战斗部洞库贮存关键技术已经破解),” *PLA Daily*, April 12, 2007, available online at <http://mil.eastday.com/m/20070412/u1a2760363.html>.

⁹ Dr. Lin is credited with making an “innovative set of forecasting methods” to calculate changes over time, helping to solve numerous difficult problems associated with the storage of one particular warhead type. Wang Tie, et al., “Second Artillery Missile Warhead Storage Facility Cracks Critical Technologies (二炮导弹战斗部洞库贮存关键技术已经破解),” *PLA Daily*, April 12, 2007, available online at <http://mil.eastday.com/m/20070412/u1a2760363.html>.



¹⁰ While was a student at NUDT, Lin Hualing's thesis addressed experiments conducted by the China Academy of Engineering Physics' Light Gas Gun Laboratory (中国工程物理研究院轻气炮研究室). The laboratory is a State Key Laboratory located in Mianyang, and is linked with the Chengdu University of Science and Technology (now known as Sichuan University). Jing Fuqian (经福谦), then at the Chinese Academy of Engineering Physics Institute of Fluid Physics (第二机械工业部九院流体物理研究所所长), served as a thesis advisor. Jing Fuqian's contributions to China's nuclear weapons program included research on implosion dynamics, materials states under extremely high pressure and temperatures, and shockwave behavior. Jing solved problems associated with measuring the effects of China's underground nuclear tests; led the development of China's gas gun payloads technology; and founded the State Key Laboratory for National Defense Technologies related to shockwave physics and detonation physics (冲击波物理与爆轰物理国防科技重点实验室). See Wang Tie, "Dedication is a Pursuit: The Story of How Lin Hualing Went from Rural Teacher to Missile Expert (认真是一种追求: 讲述林华令从山区教师到导弹专家的故事)," PLA Daily, June 29, 2006, p. 11, available online at <http://www.pladaily.com.cn/site1/images/2006-06/29/jfjb11b629b.PDF>; and "Jing Fuqian (经福谦)," Baidu, undated, <http://baike.baidu.com/view/81349.htm>. See also Lin Hualing, et al., "Research on the Compression Equilibrium of Mixed Materials after a Shockwave (混合物冲击压缩后平衡态的研究)," *Chinese Journal of High Pressure Physics*, March 2004, pp. 59-69. According to this report, Dr. Lin's email address at the time of publishing was linhual7215@sina.com.cn.

¹¹ See Lin Hualing and Yu Wanrui, "Numerical Model of Radioactivity Level in Shockwave Temperature Measurement (冲击温度测量中辐射度的数值模拟)," *Gaoya Wuli Xuebao* (Chinese Journal of High Pressure Physics), March 1995, pp. 59-68; and Lin Hualing and Yu Wanrui, "A Theoretical Study on Heat Conduction Following Shock Compression (冲击压缩后热传导的理论研究)," *Gaoya Wuli Xuebao* (Chinese Journal of High Pressure Physics), March 1994, p. 49-56.

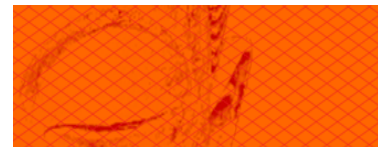
¹² Lin is cited for completing over ten key projects over the course of his career, seven of which have received national and PLA advanced technology awards. He is known by his peers as being unique in his ability to write software applications programs tailored to each project that he works on. See Wang Tie, "Dedication is a Pursuit: The Story of How Lin Hualing Went from Rural Teacher to Missile Expert (认真是一种追求: 讲述林华令从山区教师到导弹专家的故事)," PLA Daily, June 29, 2006, p. 11, available online at <http://www.pladaily.com.cn/site1/images/2006-06/29/jfjb11b629b.PDF>.

¹³ Wang Tie, "Dedication is a Pursuit: The Story of How Lin Hualing Went from Rural Teacher to Missile Expert (认真是一种追求: 讲述林华令从山区教师到导弹专家的故事)," PLA Daily, June 29, 2006, p. 11, available online at <http://www.pladaily.com.cn/site1/images/2006-06/29/jfjb11b629b.PDF>.

¹⁴ Among various sources, see Nuclear Technology and Public Security Expert Committee (核技术与公共安全专业委员会), *IHEP website*, September 15, 2010, at http://www.ihep.cas.cn/xh/hdzz/nedszuzhi/nedszuzhi-zhuangwei/201009/t20100915_2963981.html.

¹⁵ Dr. Li has been highlighted as leading Equipment Research Academy participation missile flight tests, sometimes on short notice. He is praised for risking his life on multiple occasions on the missile target range to collect data for assessing warhead effects, sometimes working all through the night to collect optical and x-ray samples of blast damage to take back to Beijing for further investigation. What makes this particularly dangerous is the presence of multiple types of unexploded ordinance, including cluster munitions that sometimes spread proximity mines across the range. See Wang Tie, et al., "Second Artillery Missile Warhead Storage Facility Cracks Critical Technologies (二炮导弹战斗部洞库贮存关键技术已经破解)," PLA Daily, April 12, 2007, available online at <http://mil.eastday.com/m/20070412/u1a2760363.html>.

¹⁶ Dr. Zhou is responsible for leading the construction of large, complex targets on the test range that can weigh up to hundreds of tons. On at least one special missile test exercise this included the construction of a target range with variety of targets on a high plateau. To optimize test results and data collection, the



team buried nearly a kilometer of electronic cables and installed nearly a hundred test sensors in order to test impacts on targets from different angles, directions and locations. As a testament to the treacherous terrain around the test range, Dr. Zhou once had to be hospitalized after his jeep went off the side of the road, crushing the vehicle (and some of his ribs) and trapping him in the backseat until he could kick out the window to escape. See Wang Tie, et al., “Second Artillery Missile Warhead Storage Facility Cracks Critical Technologies (二炮导弹战斗部洞库贮存关键技术已经破解)”, *PLA Daily*, April 12, 2007, available online at <http://mil.eastday.com/m/20070412/u1a2760363.html>.

¹⁷ Song also works to protect against the danger that high pressure electronic shocks could either detonate the warheads prematurely or destroy warhead detonators altogether. Song reportedly will work solo on dangerous unexploded warheads when they malfunction in order to correct their engineering flaws and fix their detonators. Wang Tie, et al., “Second Artillery Missile Warhead Storage Facility Cracks Critical Technologies (二炮导弹战斗部洞库贮存关键技术已经破解)”, *PLA Daily*, April 12, 2007, available online at <http://mil.eastday.com/m/20070412/u1a2760363.html>.

¹⁸ For more on the Second Artillery's 22 Base, see Mark Stokes, “China's Nuclear Warhead Storage and Handling System,” *Project 2049 Institute Occasional Paper*, March 12, 2010, at http://project2049.net/documents/chinas_nuclear_warhead_storage_and_handling_system.pdf.

¹⁹ “Second Artillery Equipment Department Deputy Director Mo Yunpeng Pays Visit to Company” (二炮装备部副部长莫俊鹏来公司视察), CNGC Website, November 20, 2009, <http://www.jnmgcl.com/newsinfo.asp?id=137>. For most recent report affiliating with known 22 Base figures, see <http://www.people.com.cn/h/2012/0629/c25408-2672127583.html>.

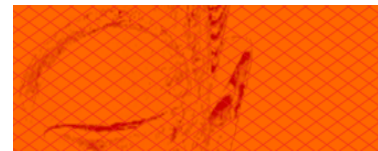
²⁰ MG Wang Dingfang formerly served as Meizhou brigade (96169 Unit) Political Commissar, Director, 55 Base Political Department, and as a division chief within Second Arty Political Department.

²¹ Li Guofu most likely replaced MGen Feng Jiefei (冯介飞), who was in the position as of 2009. Born in 1955, Feng Jiefei was assigned as 51 Base Chief Engineer. See Zhang Jiandong, Ma Hongbin, and Zhang Rong, “Second Artillery Expert Successfully Rids Missile of Malfunction with Warhead Surgery (二炮装备专家在导弹心脏上开刀 成功排除故障)”, (*Liberation Army Daily*), March 23, 2012, accessible online at http://news.xinhuanet.com/mil/2012-03/23/c_122872743.htm. Please note that Zhou Xi (周喜) had previously been listed as a Chief Engineer, though it appears that he is no longer at the 22 Base. One recent document lists him as an Engineer at the Suzhou Nuclear Security Center (苏州核安全中心). See “National Nuclear Security Bureau Inspection Group Name List,” *Jiangsu Hedian Youxian Gongsi* (Jiangsu Nuclear Power Co. Ltd.), May 2, 2013, at <http://www.mep.gov.cn/gkml/hbb/haq/201305/W020130508499951551802.pdf>. For a reference to him serving at the 22 Base, see Xu Yeqing, et al., “High Level Engineer Chen Liguu: The Personal Charm of a Missile Expert (高级工程师陈礼国：导弹专家的人格魅力)”, *PLA Daily*, August 28, 2009, at http://chn.chinamil.com.cn/xwpdxw/2009-08/28/content_4029499.htm.

²² Xu Yeqing, Chen Shoufu, and Zhang Rong, “High Level Engineer Chen Liguu: The Personal Charisma of a Missile Expert (高级工程师陈礼国：导弹专家的人格魅力)”, *PLA Daily*, August 28, 2009, accessible online at http://news.mod.gov.cn/big5/forces/2009-08/28/content_4083029.htm.

²³ “Third Annual National Virtuous Model Human Awards: An Introduction to the Military System's Candidates (军队系统候选人事迹简介)”, *PLA Daily*, May 30, 2011, p. 3, accessible online at http://www.chinamil.com.cn/jfjbmap/content/2011-05/20/content_57998.htm.

²⁴ In 2007, Chen was passed over for promotion to Chief Engineer due to mandatory age limitations. The Chief Engineer position instead went to a former subordinate of Chen named Zhou Xi (周喜). However, Chen was given the honorific title of officially “conducting Chief Engineer-level work” (做总工程师工作). As a side note, Chen has been referenced as directing the the 22 Base Technology Lab (技术室) at one



point in his career. Among various sources, see Zhang Xuanjue, et al. “General Chen Ligu: Talent of the Sharp Long Sword Technology (少将陈礼国：磨砺长剑的科技将才),” *Liaowang News Weekly*, August 8, 2009, at <http://news.sohu.com/20090808/n265803361.shtml>; “Missile Expert Chen Ligu: A Real Life Love Letter to All(导弹专家陈礼国---心有真情书写大家),” CCTV 7 *Junshi Baodao* (CCTV 7 Military Report), available online at <http://v.ku6.com/show/1ZocD6HLqkHpbHUr.html>; Zhang Xuanjie and Qin Jie, “General Chen Ligu: The Technical Talent Sharpening Our Long Swords (陈礼国：磨砺长剑的科技将才),” *Liaowang Xinwen Zhoukan* (Liaowang News Weekly), August 8, 2009, available online at <http://news.sohu.com/20090808/n265803361.shtml>; and Xu Yeqing, Chen Shoufu, and Zhang Rong, “Senior Engineer Chen Ligu: The Personal Charisma of a Missile Expert (高级工程师陈礼国：导弹专家的人格魅力),” *PLA Daily*, August 28, 2009, accessible online at http://news.mod.gov.cn/big5/forces/2009-08/28/content_4083029.htm. The 22 Base Equipment Department's chief engineer is Yao Chunhua (姚春华).

²⁵ Among various sources, see Zhang Xuanjie and Qin Jie, “General Chen Ligu: The Technical Talent Sharpening Our Long Swords (陈礼国：磨砺长剑的科技将才),” *Liaowang Xinwen Zhoukan* (Liaowang News Weekly), August 8, 2009, available online at <http://news.sohu.com/20090808/n265803361.shtml>. For reference to 22 Base discipline, training, and education problems, see “Second Artillery Base Enhances “Triple Consciousness” Education and Work” (二炮某基地围绕增强“三个意识”开展作风教育整顿), *PLA Daily*, March 23, 2007.

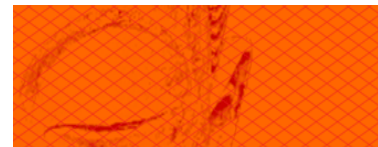
²⁷ Located in Taiyuan, CIRP is responsible for R&D on nuclear safety issues, including nuclear emergency response. See Xu Yeqing, Chen Shoufu, and Zhang Rong, “High Level Engineer Chen Ligu: The Personal Charisma of a Missile Expert (高级工程师陈礼国：导弹专家的人格魅力),” (*Liberation Army Daily*), August 28, 2009, accessible online at http://news.mod.gov.cn/big5/forces/2009-08/28/content_4083029.htm; “Third Annual National Virtuous Model Human Awards: An Introduction to the Military System's Candidates (军队系统候选人事迹简介),” (*Liberation Army Daily*), May 30, 2011, p. 3, accessible online at http://www.chinamil.com.cn/jfjbmap/content/2011-05/20/content_57998.htm; and “Generals of the PLA Second Artillery Force (中国人民解放军第二炮兵将领),” *Junshi Zhishi* (Military Knowledge), July 24, 2012, at http://www.360doc.com/content/12/0911/13/1257444_235516069.shtml. At least one key CASC engineer involved in warhead interface with ballistic missile delivery systems is Tang Tongwu (唐统悟).

²⁸ See “Second Artillery Develops Integrated Counter-Virus and Counter Electromagnetic Interference System” 中国二炮研制出集防病毒抗电磁干扰于一体系统, *PLA Daily*, August 23, 2009, at <http://mil.eastday.com/m/20090823/u1a4601986.html>; 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 Zhang Jiandong and Zhang Rong, “Second Artillery Base Cultivates 200 Doctorate and Master's Degree Holders to Tackle over 100 Difficult Armament Projects (二炮某基地培育博士硕士 200 名 攻克装备难题百余项),” *PLA Daily*, May 8, 2011, at http://news.mod.gov.cn/forces/2011-05/08/content_4240518.htm; and Zhang Xuanjie and Qin Jie, “General Chen Ligu: The Technical Talent Sharpening Our Long Swords (陈礼国：磨砺长剑的科技将),” *Liaowang Xinwen Zhoukan* (Liaowang News Weekly), August 8, 2009, available online at <http://news.sohu.com/20090808/n265803361.shtml>.

²⁹ Zhang Xuanjie and Qin Jie, “General Chen Ligu: The Technical Talent Sharpening Our Long Swords (陈礼国：磨砺长剑的科技将才),” *Liaowang Xinwen Zhoukan* (Liaowang News Weekly), August 8, 2009, available online at <http://news.sohu.com/20090808/n265803361.shtml>.

³⁰ *Ibid.*

³¹ Reportedly, Chen was engaged in the testing of a new strategic missile system when his wife, Huang Shaolin (黄晓琳), slipped into a coma, a condition she has been in for a number of years. See Xu Yeqing,



Chen Shoufu, and Zhang Rong, “Senior Engineer Chen Ligu: The Personal Charisma of a Missile Expert (高級工程師陳禮國：導彈專家的人格魅力),” (*Liberation Army Daily*), August 28, 2009, accessible online at http://news.mod.gov.cn/big5/forces/2009-08/28/content_4083029.htm; and “Missile Expert Chen Ligu: A Real Life Love Letter to All (導彈專家陳禮國---心有真情書寫大家),” CCTV 7 *Junshi Baodao* (CCTV 7 Military Report), available online at <http://v.ku6.com/show/1ZocD6HLqkHpbHUr.html>.

³² Ibid.

³³ Mark Stokes, “China’s Nuclear Warhead Storage and Handling System,” *Project 2049 Institute Occasional Paper*, March 12, 2010, p. 5, at http://project2049.net/documents/chinas_nuclear_warhead_storage_and_handling_system.pdf.

³⁴ Ibid.

³⁵ Zhang Jiandong, Ma Hongbin, and Zhang Rong, “Second Artillery Expert Successfully Rids Missile of Malfunction with Warhead Surgery (二炮裝備專家在導彈心臟上開刀 成功排除故障),” (*Liberation Army Daily*), March 23, 2012, accessible online at http://news.xinhuanet.com/mil/2012-03/23/c_122872743.htm. For Wang’s affiliation with the 96411 Unit see Wu Fan, Wang Guoqing, and Fu Guoqing, “Research on Intelligent Support System Based on Electro-mechanical Equipment with Artificial Intelligence (基于人工智能的机电设备智能保障系统研究),” *Jisuanji Celiang Yu Kongzhi* (Computer Measurement and Control), No. 14, 2006, pp. 1046-1048. Accessible online at <http://wenku.baidu.com/view/7dd8c296dd88d0d233d46a33.html>.

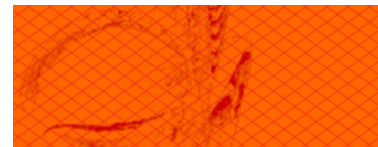
³⁶ Ibid. It is possible that Wang is not a member of the warhead expert’s group because of his previous research focus on tactical command and control and decision-making, although he is also a specialist on missile system integration.

³⁷ Zhang Jiandong, Ma Hongbin, and Zhang Rong, “Second Artillery Expert Successfully Rids Missile of Malfunction with Warhead Surgery (二炮裝備專家在導彈心臟上開刀 成功排除故障),” *PLA Daily*, March 23, 2012, accessible online at http://news.xinhuanet.com/mil/2012-03/23/c_122872743.htm.

³⁸ The 22 Base has established a civil-military partnership with local telecommunications representatives to form joint China Unicom-PLA units (聯通旅團部隊) and operational stations (作戰陣地) with automated command networks. Such networks allow for the secure transmission of classified information on an information exchange network with nearly 10,000 program control switching gateways, and provide some 100 new communications transmission station platforms (通信傳輸台站) to assure the communications network can operate under stress. See Zhang Jiandong and Zhang Rong, “Second Artillery Base Cultivates 200 Doctorate and Master’s Degree Holders to Tackle over 100 Difficult Armament Projects (二炮某基地培育博士碩士 200 名 攻克裝備難題百餘項),” *PLA Daily*, May 8, 2011, at http://news.mod.gov.cn/forces/2011-05/08/content_4240518.htm.

³⁹ See “Second Artillery Unit Exercises Several Concepts in Realistic Wartime Environment” (第二炮兵某部實戰背景演練 多方案應對未來戰爭), *S&T Daily*, February 28, 2012, at http://news.xinhuanet.com/mil/2012-02/28/c_122764358.htm; and “Second Artillery Unit Conducts Chemical Defense Exercise” (第二炮兵某部開展防化實戰演練), *China News Network*, November 19, 2011, at http://www.chinadaily.com.cn/hqgj/jryw/2011-11-19/content_4421606.html.

⁴⁰ The government established a “Master Emergency Response Plan for Sudden Public Incidents in Taibai County” (太白縣突發公共事件總體應急預案), which includes 18 separate emergency plans for responding to specific scenarios, along with emergency response plans for the 49 military and civil government departments in the area. As of 2012, Taibai County had four professional emergency response detachments with a total manpower of over 400 personnel. These emergency response detachments are further bolstered by over 1200 reserve force emergency responders drawn from local work units. During the period of time covered by the 11th Five-Year Plan (2006-2010), Taibai’s emergency responders focused



on building basic skills in the five areas of: flood control, firefighting, forest firefighting, mine rescue, public security policing, and emergency medical rescue. See “Taibai County’s Plan for Building an Emergency Response System for Sudden Public Incidents in the 12th Five-Year Plan (Draft Copy) (太白县“十二五”突发公共事件应急体系建设规划 (草案)), *Taibai County Government*, November 23, 2012, at <http://www.sxtb.gov.cn/?viewinfor-306-0-37022.htm>.

⁴¹ It had also made some progress on completing an integrated emergency response system. By 2015 the local government plans to establish a comprehensive emergency response training base where all relevant units will be required to engage in one large scale joint emergency response exercise a year. Taibai County also plans on establishing a Public Security Bureau “Counter Terror Command Exercise Base” (公安局反恐指挥培训基地). To educate the local public on how to react in the event of an accident or natural disaster, the County Government is releasing an “Educational Reading Book on Public Safety” (公共安全教育读本) to the local elementary and middle schools. By 2015 it hopes to have achieved a 70% coverage rate in terms of educating the local “masses” on basic emergency preparedness through a media campaign using radio, television, and internet broadcasts. See “Taibai County’s Plan for Building an Emergency Response System for Sudden Public Incidents in the 12th Five-Year Plan (Draft Copy) (太白县“十二五”突发公共事件应急体系建设规划 (草案)), *Taibai County Government*, November 23, 2012, at <http://www.sxtb.gov.cn/?viewinfor-306-0-37022.htm>.

⁴² *Ibid.* Note that this source also highlights that Taibai’s security services completed the construction of a video surveillance system along the Jiangmei Highway (S210) that runs directly through Taibai County to connect Baoji City with Hanzhong City in the south. This video surveillance system (视频监控系统) also covers the other main roads in Taibai County. Another source notes that the Jiangmei Highway project began in 2000, with the first section completed in late 2002. It involved the construction of some 170 kilometers of roads, seven tunnels, 44 bridges. Along with the economic development of this mountain area, the promotion of national defense was listed as being a major positive outcome of the project. See “Jiangmei Highway (姜眉公道),” *Baidu Encyclopedia*, at <http://baike.baidu.com/view/485591.htm>.

⁴³ “Taibai County’s Plan for Building an Emergency Response System for Sudden Public Incidents in the 12th Five-Year Plan (Draft Copy) (太白县“十二五”突发公共事件应急体系建设规划 (草案)), *Taibai County Government*, November 23, 2012, at <http://www.sxtb.gov.cn/?viewinfor-306-0-37022.htm>.

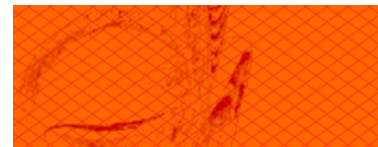
⁴⁴ *Ibid.*

⁴⁵ Zhang Xueming, et al., “Second Artillery Passes 5 Strict Checks to Assure Missiles Can Fight Anytime (二炮 5 个关口严格把关确保导弹随时能战),” *PLA Daily*, January 14, 2013, at <http://military.people.com.cn/n/2013/0114/c1011-20188580.html>.

⁴⁶ For details, see Mark Stokes, “China’s Nuclear Warhead Storage and Handling System,” *Project 2049 Institute Occasional Paper*, March 12, 2010, at http://project2049.net/documents/chinas_nuclear_warhead_storage_and_handling_system.pdf.

⁴⁷ “Second Artillery Equipment Inspection Unit: The People Deep in the Mountains with Strategic Missile Experience (二炮装检部队：深山中为战略导弹做体验的人),” *PLA Daily*, January 15, 2010. Dai Weide (戴伟德) was 55 Base Equipment Inspection Regiment Political Commissar in early 2010.

⁴⁸ Note that the 55 Base Equipment Inspection Regiment’s Communist Party Committee directs the unit’s research efforts, probably according to guidance from the Second Artillery Equipment Department. Every year the regiment’s party committee will select one or two major research topics for the unit to focus on. The committee will then organize resources for conducting the relevant research work. “Second Artillery Equipment Inspection Unit: The People Deep in the Mountains with Strategic Missile Experience (二炮装检部队：深山中为战略导弹做体验的人),” *PLA Daily*, January 15, 2010.



49 Ibid.

50 Indeed there is little indication that weapons specialists are empowered to make executive decisions concerning the fate of the warheads and missiles that they maintain. Decisions are likely made by political commissars trained to take expert's technical recommendations into consideration while weighing them alongside political and other "big picture" factors. One indication of this tendency is illustrated by the fact that the 55 Base Equipment Inspection Regiment's Communist Party Committee decides which technical problems the regiment will attempt to solve during its annual research programs. The same thing was seen at the 22 Base. For one example, see "Second Artillery Equipment Inspection Unit: The People Deep in the Mountains with Strategic Missile Experience (二炮装检部队：深山中为战略导弹做体验的人)," *PLA Daily*, January 15, 2010.

51 See "Second Artillery Equipment Inspection Unit: The People Deep in the Mountains with Strategic Missile Experience (二炮装检部队：深山中为战略导弹做体验的人)," *PLA Daily*, January 15, 2010.

52 Zhang Xueming, et al., "Second Artillery Passes 5 Strict Checks to Assure Missiles Can Fight Anytime (二炮 5 个关口严格把关确保导弹随时能战)," *PLA Daily*, January 14, 2013, at <http://military.people.com.cn/n/2013/0114/c1011-20188580.html>.

53 For example, some elements of one particular Second Artillery unit's inspection and operating procedures and technical standards became used by the entire Second Artillery Force and even impacted on PLA standards set at the general department level. See "Second Artillery Equipment Inspection Unit: The People Deep in the Mountains with Strategic Missile Experience (二炮装检部队：深山中为战略导弹做体验的人)," *PLA Daily*, January 15, 2010.

54 Zhang Tiehan and Ren Fangzheng, "Female Missile Troops Simulate Wartime Procedures Continually for 3 Days: One 'Special Situation' After the Next (导弹女兵连续 3 天模拟作战流程 "特情"接二连三)," *Guofang Junwang* (Ministry of Defense Online), May 14, 2013, at http://chn.chinamil.com.cn/zgjq/2013-05/14/content_5340973.htm.

55 Ibid.

56 Ibid.

57 Ibid.

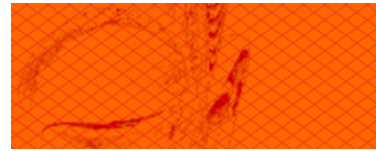
58 Ibid.

59 In at least one such occasion, the on-duty technicians had to evacuate the laboratory and specialists had to be called in to "rescue" the warhead. See Zhang Xuanjie and Qin Jie, "General Chen Liguo: The Technical Talent Sharpening Our Long Swords (陈礼国：磨砺长剑的科技将才)," *Liaowang Xinwen Zhoukan* (Liaowang News Weekly), August 8, 2009, available online at <http://news.sohu.com/20090808/n265803361.shtml>.

60 Given this pressure, warhead technicians have been known to suffer nervous breakdowns midway through the installation of detonator devices, forcing others to relieve them and finish the job. See Zhang Xuanjie and Qin Jie, "General Chen Liguo: The Technical Talent Sharpening Our Long Swords (陈礼国：磨砺长剑的科技将才)," *Liaowang Xinwen Zhoukan* (Liaowang News Weekly), August 8, 2009, available online at <http://news.sohu.com/20090808/n265803361.shtml>.

61 Ibid.

62 Ibid.



⁶³ Ibid.

⁶⁴ Zhang Jiandong, Ma Hongbin, and Zhang Rong, “Second Artillery Expert Successfully Rids Missile of Malfunction with Warhead Surgery (二炮装备专家在导弹心脏上开刀 成功排除故障),” (*Liberation Army Daily*), March 23, 2012, accessible online at http://news.xinhuanet.com/mil/2012-03/23/c_122872743.htm.

⁶⁵ Note that while the workmen were reportedly berated, it is not entirely clear from the report that corrective actions were taken to make sure the dangerous safety equipment was replaced and such incidents would not occur in the future. The equipment that the workers were directed to install consisted of expensive copper rods that are used by warhead technicians to discharge static electricity in order to avoid accidentally setting off sensitive (and explosive) components. In this case the workmen had installed thin copper wires instead. Zhang Xuanjie and Qin Jie, “General Chen Liguo: The Technical Talent Sharpening Our Long Swords (陈礼国：磨砺长剑的科技将才),” *Liaowang Xinwen Zhoukan* (*Liaowang News Weekly*), August 8, 2009, available online at <http://news.sohu.com/20090808/n265803361.shtml>. For more on the impact China's rapid urbanization has had on the copper market see “Copper Red Bull: The World's Most Informative Metal,” *The Economist*, September 24, 2011, at <http://www.economist.com/node/21530107>.

⁶⁶ Lin Hualing is praised for his deliberate, meticulous work ethic despite the dangers associated with his speciality. See Wang Tie, “Dedication is a Pursuit: The Story of How Lin Hualing Went from Rural Teacher to Missile Expert (认真是一种追求：讲述林华令从山区教师到导弹专家的故事),” *PLA Daily*, June 29, 2006, p. 11, available online at <http://www.pladaily.com.cn/site1/images/2006-06/29/jfjb11b629b.PDF>.