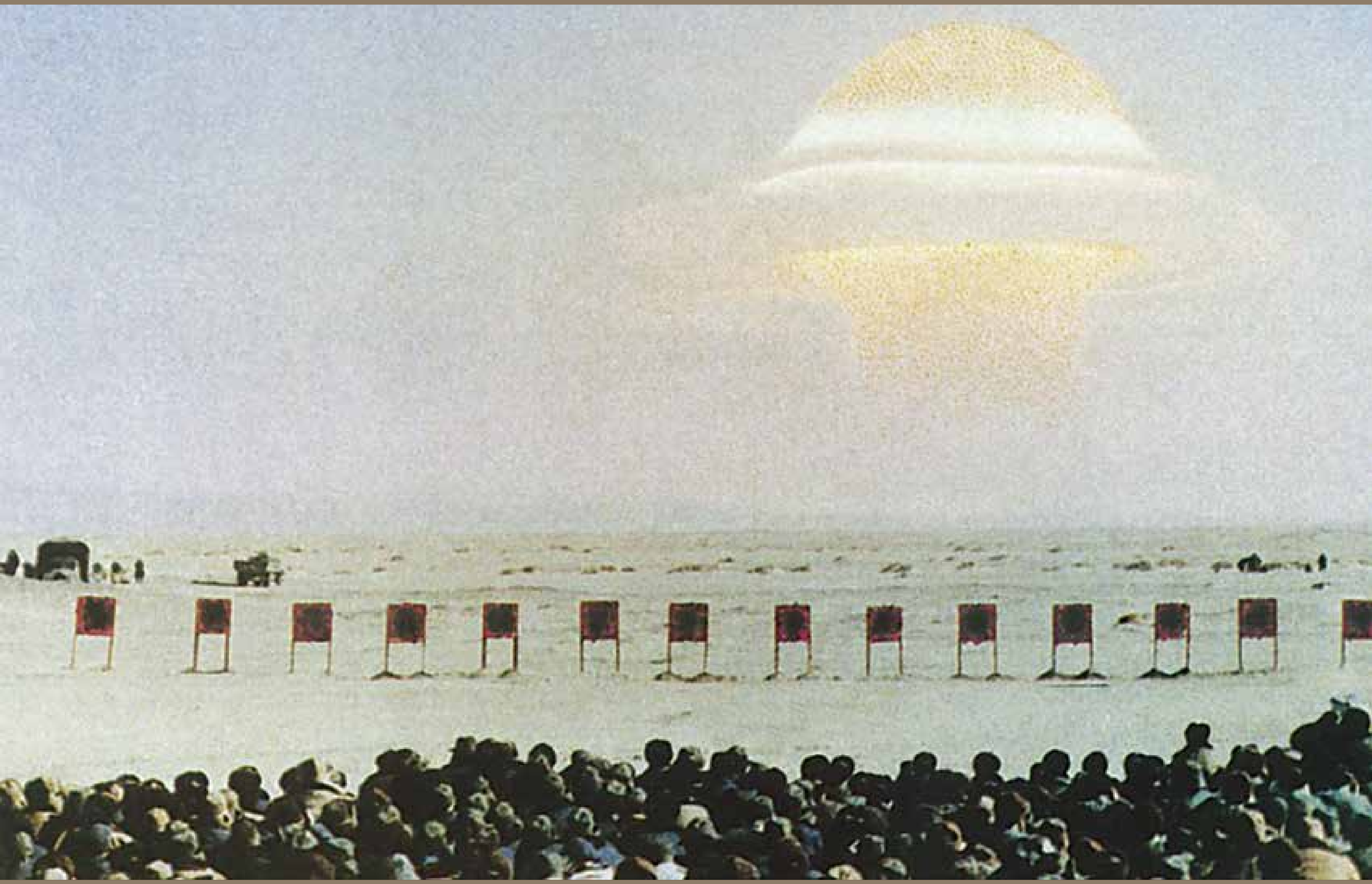
INSS

INSTITUTE FOR NATIONAL STRATEGIC STUDIES

CHINA STRATEGIC PERSPECTIVES 8

Red China's "Capitalist Bomb": Inside the Chinese Neutron Bomb Program

by Jonathan Ray



Center for the Study of Chinese Military Affairs
Institute for National Strategic Studies
National Defense University

Institute for National Strategic Studies
National Defense University

The Institute for National Strategic Studies (INSS) is National Defense University's (NDU's) dedicated research arm. INSS includes the Center for Strategic Research and Center for the Study of Chinese Military Affairs. The military and civilian analysts and staff who comprise INSS and its subcomponents execute their mission by performing research and analysis, publication, conferences, policy support, and outreach.

The mission of INSS is to conduct strategic studies for the Secretary of Defense, the Chairman of the Joint Chiefs of Staff, and the combatant commanders, to support the national strategic components of the academic programs at NDU, and to provide outreach to other U.S. governmental agencies and to the broader national security community.

Cover photo: Chinese hydrogen bomb test at Lop Nor Nuclear Test Range (Chinese government photo)

Red China's "Capitalist Bomb"

Red China's "Capitalist Bomb": Inside the Chinese Neutron Bomb Program

by Jonathan Ray

Center for the Study of Chinese Military Affairs
Institute for National Strategic Studies
China Strategic Perspectives, No. 8

Series Editor: Phillip C. Saunders

NDU Press

National Defense University Press
Washington, D.C.
January 2015

First printing, January 2015

For current publications of the Institute for National Strategic Studies, please visit the NDU Press Web site at: ndupress.ndu.edu.

Contents

Executive Summary

This paper examines why China developed an enhanced radiation weapon (ERW) but did not deploy it. ERWs, better known as "neutron bombs," are specialized nuclear weapons with reduced blast effects and enhanced radiation, making them ideal tactical and antipersonnel weapons. Declassified U.S. intelligence and Chinese press reports indicate the People's Republic of China (PRC) was interested in an ERW in 1977 and successfully tested a device on September 29, 1988. To date, however, these sources provide no evidence of deployment. This study exploits primary source documents to reconstruct the ERW program's history, assesses drivers behind decisions throughout the program, and considers broader implications for PRC decisionmaking on weapons development. This case study suggests a model of a "technology reserve" in which China develops a weapons technology to match the capabilities of another state but defers deployment. This paper presents an analytic framework for examining how the technology reserve model might apply to China's decisionmaking on ballistic missile defense (BMD), antisatellite (ASAT), and hypersonic glide vehicle (HGV) systems.

The framework considers five variables as potential drivers of China's ERW decisionmaking. Specifically, it assesses the *strategic environment* of the PRC, the *strategic value* and *normative value* of the ERW, as well as the *resource demands* and *technical feasibility* of the ERW program. The framework also considers *coalition politics* of the ERW program as an intervening variable that influenced each of the above variables throughout the program's history. The ERW program's history comprised three phases:

1. *1977–1980: Decision and Initial Research.* In 1977, Chinese media followed the controversy over the U.S. decision to develop and deploy an ERW in Europe. Soviet media denounced the ERW and grew concerned at China's silence on the controversy. After General Zhang Aiping [张爱萍] signaled the PRC's interest in the ERW in the *People's Daily*, scientists involved in the ERW program (herein referred as the weaponeers) began initial research and development (R&D). Some weaponeers argued against developing the ERW, worrying that it was unnecessary and would disrupt higher priority work on warhead miniaturization. Ultimately, they acquiesced to orders and combined the ERW and warhead miniaturization research to master common principles of the two systems.

2. *1980–1984: Research and Development.* In 1980, General Zhang told a member of a visiting U.S. delegation that China needed the ERW as a hedge against the Soviets. The weapon fit into China's military strategic guideline of "active defense" to defend against a Soviet armored thrust and invasion. By then, the weaponeers were dividing the ERW

problem into constituent parts, or "principles," and solving them individually. From 1982 to 1984, China conducted five tests related to the ERW and warhead miniaturization. On December 19, 1984, the weaponeers conducted a successful "principles breakthrough" test. One weaponeer metaphorically described the successful test by saying that "the second generation of light boats has passed the bridge."

3. *1985–1988: Pause and Reevaluation.* In 1985, China halted nuclear testing for 30 months. The pause coincided with a Soviet moratorium on testing and a leadership reshuffle that neutralized ERW proponent General Zhang. In 1986, the weaponeers warned PRC leaders that the United States and Soviet Union could conclude a nuclear test ban treaty, and they proposed accelerated testing to complete warhead designs. The Central Committee approved the report and provided funding. On September 29, 1988, China successfully tested an ERW design and added it to what one weaponeer called the "technology reserve."

No variable individually explains the ERW program's decisions and outcomes. A tense strategic environment and the ERW's high strategic value against Soviet armored divisions correlate with the program's R&D but do not explain the final test in a more relaxed strategic environment. Similarly, the ERW's normative value was initially high as a technological achievement, but a taboo against the weapon was firmly in place before the final test. Resource demands and technological feasibility were challenges at the program's beginning, and even after the weaponeers combined ERW and miniaturization research to conserve resources, the program still stalled in 1985. The 1988 final ERW design test for China's "technology reserve" reflects both a hedge against changes in China's strategic environment and the culmination of research. The evidence is incomplete, but it indicates that an ERW coalition led by General Zhang Aiping championed the program from 1977 to 1984 but fell apart before the ERW's completion.

This analytic framework and "technology reserve" model of matching a capability but deferring deployment help frame analyses of the PRC's decisionmaking for its BMD, ASAT, and HGV programs. A cursory analysis indicates arms control possibilities for BMD, continued development of ASAT capabilities, and multiple possible outcomes for HGV development.

Key themes and lessons from the ERW case study include the following:

- ***Strong leaders versus institutional capacity.*** Coalitions with strong leaders such as Deng Xiaoping and Zhang Aiping drove the ERW program in a time of weak institutions. Today, China's weapons development processes are more institutionalized but are still susceptible to factional politics.

- ***Technology parity as an ideological imperative.*** Matching other states' military technologies is an extension of Chinese techno-nationalism into weapons development decisions.

- ***Importance of potential adversaries' reactions.*** Soviet alarm over the ERW as a disruptive capability made the weapon more attractive to Chinese leaders. U.S. reactions to contemporary PRC weapons systems should be calm.

- ***Need to update Chinese open-source research techniques.*** This research benefited from studies on Chinese open-source research techniques, but such literature is dated. Newer sources such as social media, blogs, chat rooms, and updated databases highlight the need for more current discussions.

Key Leaders and Personnel in China's Enhanced Radiation Warfare Program

Deng Xiaoping (邓小平; 1904–1997): Vice Chairman of Central Committee and the Central Military Commission (CMC) in 1977, and "paramount leader" from 1978 to 1992.

Zhang Aiping (张爱萍; 1908–2003): Replaced Nie Rongzhen as head of the Science and Technology Commission for National Defense in 1975 and was appointed to the CMC and as Minister of Defense in 1982.

Zhou Guangzhao (周光召; 1929–): Director of Ninth Academy (now known as the China Academy of Engineering Physics [CAEP]) in 1977. Zhou advocated ERW research but left the academy in 1980.

Zhu Guangya (朱光亚; 1924–2011): Key interlocutor between leaders and scientists. He met with Central Special Commission members Deng, Zhang, and others in 1978 and 1979 to discuss priorities in nuclear weapons development.

Deng Jiaxian (邓稼先; 1924–1986): Director of Ninth Academy in 1979 and later Vice Chairman of Ministry of Nuclear Industry and the Commission for Science, Technology, and Industry for National Defense (COSTIND).

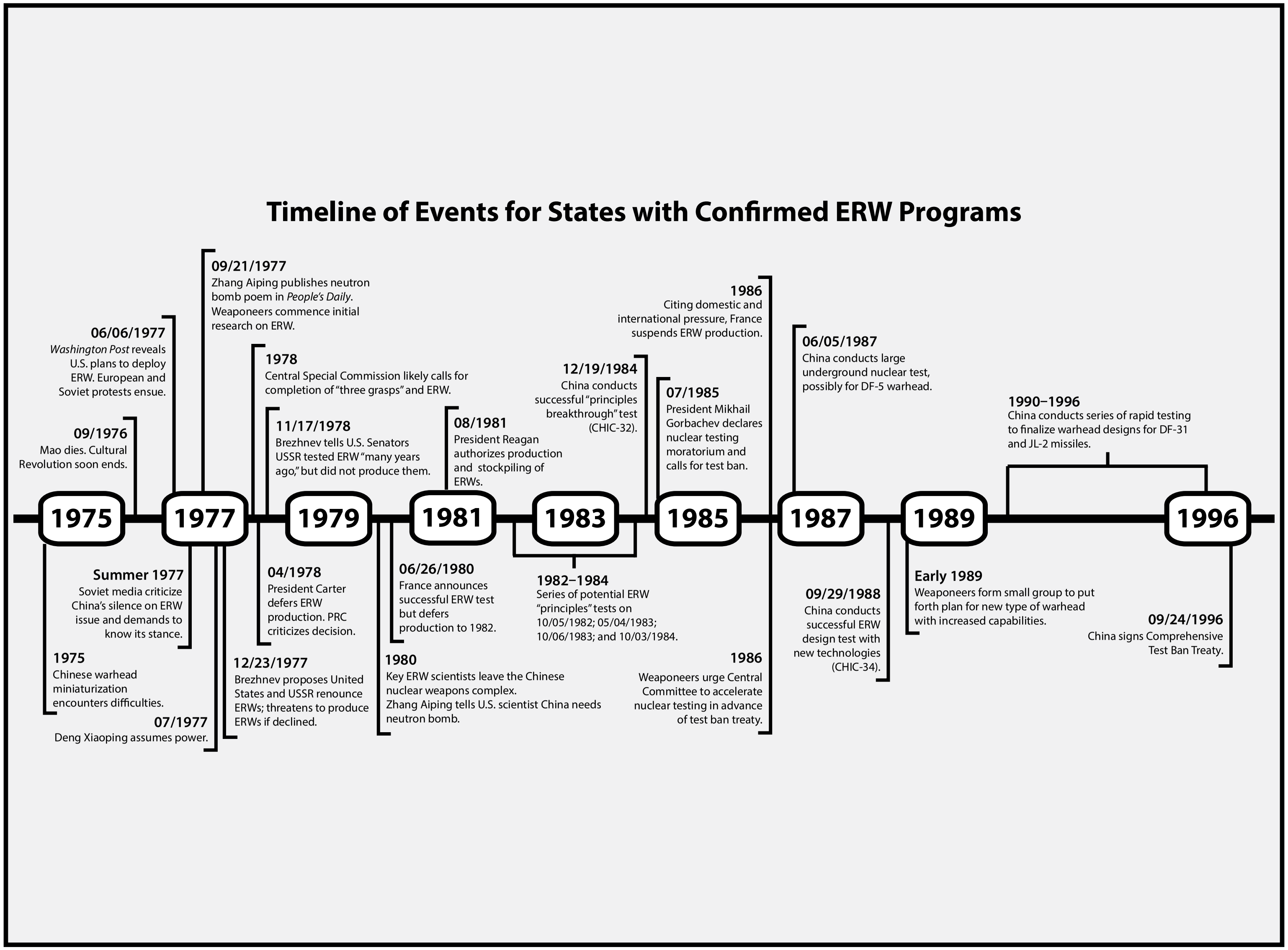
Xue Bencheng (薛本澄; 1936–): Chief Engineer of the ERW and the 1990–1996 warhead miniaturization program, an effort that he described as "climbing the precipice."

Yu Min (于敏; 1926–): Headed theoretical research for ERW and warhead miniaturization at the Ninth Academy.

Liu Huaqiu (刘华秋; 1935–): Authored initial ERW report in 1979 and was Senior Specialist at COSTIND.

He Xiantu (贺贤土; 1937–): Led a small group at the Ninth Academy in the 1970s to address ignition and secondary problems.

Chen Junxiang (陈俊祥; 1933–): Supported Ninth Academy and CAEP work in various capacities.


Timeline of Events for States with Confirmed ERW Programs
1975
1977
1979
1981
1983
1985
1987
1989
1996
1975
Chinese warhead miniaturization encounters difficulties.
09/1976
Mao dies. Cultural Revolution soon ends.
06/06/1977
Washington Post reveals U.S. plans to deploy ERW. European and Soviet protests ensue.
Summer 1977
Soviet media criticize China's silence on ERW issue and demands to know its stance.
07/1977
Deng Xiaoping assumes power.
09/21/1977
Zhang Aiping publishes neutron bomb poem in *People's Daily*. Weaponeers commence initial research on ERW.
12/23/1977
Brezhnev proposes United States and USSR renounce ERWs; threatens to produce ERWs if declined.
1978
Central Special Commission likely calls for completion of "three grasps" and ERW.
04/1978
President Carter defers ERW production. PRC criticizes decision.
11/17/1978
Brezhnev tells U.S. Senators USSR tested ERW "many years ago," but did not produce them.
1980
Key ERW scientists leave the Chinese nuclear weapons complex.
Zhang Aiping tells U.S. scientist China needs neutron bomb.
06/26/1980
France announces successful ERW test but defers production to 1982.
08/1981
President Reagan authorizes production and stockpiling of ERWs.
1982–1984
Series of potential ERW "principles" tests on 10/05/1982; 05/04/1983; 10/06/1983; and 10/03/1984.
12/19/1984
China conducts successful "principles breakthrough" test (CHIC-32).
07/1985
President Mikhail Gorbachev declares nuclear testing moratorium and calls for test ban.
1986
Citing domestic and international pressure, France suspends ERW production.
1986
Weaponeers urge Central Committee to accelerate nuclear testing in advance of test ban treaty.
06/05/1987
China conducts large underground nuclear test, possibly for DF-5 warhead.
09/29/1988
China conducts successful ERW design test with new technologies (CHIC-34).
Early 1989
Weaponeers form small group to put forth plan for new type of warhead with increased capabilities.
1990–1996
China conducts series of rapid testing to finalize warhead designs for DF-31 and JL-2 missiles.
09/24/1996
China signs Comprehensive Test Ban Treaty.

Introduction

China's nuclear force modernization and its lack of transparency have long been of interest to U.S. policymakers and analysts. One of the most opaque and debated aspects of this discussion is China's tactical nuclear weapons (TNWs), or nuclear weapons designed to be used on a battlefield.[1] Enhanced radiation weapons (ERWs), better known as "neutron bombs," are specialized TNWs with reduced blast effects and enhanced radiation, making them ideal tactical and antipersonnel weapons. Current literature on China's ERW is limited, but one author claims Chinese leaders have expressed "an unusual degree of fascination with" ERWs.[2] Declassified U.S. intelligence and Chinese press reports indicate the People's Republic of China (PRC) was interested in an ERW in 1977 and successfully tested a device on September 29, 1988.[3] To date, however, these sources provide no evidence of deployment. This study reconstructs the ERW program's history by exploiting primary source documents, and it considers the implications for analyses of PRC weapons development, including contemporary systems of concern.

An ERW is a specialized nuclear weapon optimized to produce prompt radiation. Such a device emits neutrons with high linear energy transfer, meaning the neutrons strongly interact with living tissue but not inanimate material. The ability to kill people while leaving property intact led critics to call the ERW the "perfect capitalist bomb."

A tactical nuclear weapon such as an ERW would likely be delivered by aircraft or a short-range ballistic missile (SRBM). Declassified U.S. intelligence reports do not show evidence of Chinese ERW deployment on either platform. In 1984, the Defense Intelligence Agency (DIA) reviewed Chinese air force bomber and fighter-bomber capabilities and assessed that "it is unlikely that these obsolescent aircraft could successfully penetrate the sophisticated air defense networks of modern military powers."[4] In 1996, the Central Intelligence Agency (CIA) stated China's ERW "probably is intended for a short-range missile," but other public assessments indicated this deployment probably did not occur.[5] The reports *Proliferation: Threat and Response* and *Chinese Military Power* do not mention tactical nuclear weapons (such as an ERW); the latter specifically indicates that China's SRBMs are conventionally armed.[6]

In 2011, one China expert wrote that according to U.S. Government and nongovernmental reports, China possesses a stockpile of air-deliverable nuclear weapons, but they lack a "primary mission."[7] In June 2013, the People's Liberation Army Air Force (PLAAF) began to receive newer H-6K bomber aircraft with increased range and capability to carry a new long-range land-attack cruise missile (LACM). Although these airframes could be modified to carry a nuclear-tipped air-launched LACM, the U.S.-China Economic and Security Review Commission reported, "There is no evidence to confirm China is deploying nuclear warheads on any of its air-launched LACMs."[8]

Chinese statements also give no indication of deployment. In 1982, a Chinese defense official reportedly told a French delegation that China had no tactical nuclear weapons deployed at "ground division or below."[9] This statement could indicate either nondeployment or storage of TNWs at higher command levels. In 1999, the Cox Report of the U.S. House of Representatives accused China of stealing various U.S. technologies, including designs for the W-70 Mod 3 warhead, an ERW design. The rebuttal from the Information Office of China's State Council stated that China mastered "in succession the neutron bomb *design* technology and the nuclear weapon miniaturization technology."[10] This statement confirms the ERW's development but gives no indication of deployment.

The current limited literature on China's ERW is in the context of broader discussions of Chinese TNWs. Some authors speculate that China's leaders did not deploy the ERW because of concerns over release authority, but this argument is insufficient.[11] Chinese leaders were concerned about release authority prior to the development of ERWs, and the deployment of mobile nuclear-armed medium-range ballistic missiles (MRBMs) raised the same issues of command and control. In that case, the warheads are stored separately from the missiles.[12] The impending deployment of *Jin*-class submarines with nuclear-armed JL-2 submarine-launched ballistic missiles (SLBMs) may force a different solution to concerns about release authority. Information on the ERW program itself is also sparse. For example, there are no reliable estimates of the weapon's cost or China's nuclear weapons budget at this time.[13]

Complicating the issue further, a cursory overview of the ERW's characteristics and the timing of China's program presents three additional puzzles.

First, why did China develop a weapon contrary to its doctrine? Since China's first nuclear test in 1964, its nuclear doctrine has stressed strategic nuclear forces and a No First Use (NFU) policy (not using a nuclear weapon first against any country). An ERW, however, is a TNW ideal for first use against conventional armored strikes. For instance, the U.S. rationale for the ERW was to repel a Soviet tank invasion of Europe without destroying densely populated cities. China faced a similar threat but had a different doctrine and geography. On the Sino-Soviet border, one could "drive a couple of hours and not even spot a bird," rendering concerns over damage to cities a moot point.[14]

Second, why did China develop an expensive nuclear weapon in a time of fiscal constraints when resources were being shifted to conventional weapons programs? China chose to develop an ERW, an advanced and expensive nuclear weapon, in the late 1970s when, according to a lead weaponeer, "the country was broke!"[15] Deng Xiaoping was cutting expensive military programs and promoting conventional force modernization. At that time, the weaponeers themselves were already facing technical challenges in miniaturizing existing warhead designs.[16]

Third, why was there a 4-year gap in ERW testing from 1984 to 1988? After a rapid series of five ERW-related tests from 1982 to 1984, there was a 4-year gap before China successfully tested an ERW design in September 1988. Immediately before that successful test, Liu Huaqiu [刘华秋], who was involved with the warhead's testing from 1982 to 1988, wrote two reports arguing China did not need the ERW.[17]

In addressing these puzzles, this study has two tasks as defined by Ted Greenwood, a scholar on defense decisionmaking. The first is to "bare the inner workings of a decision process, identifying the various strands and showing how they converged and diverged, overlapped and intermingled to produce the observed outcomes."[18] The second is to "suggest some generalizable propositions or hypotheses about the interrelationships of these variables that may on the one hand be testable by other scholars and on the other be useful to policymakers."[19]

Analytic Framework and Variables

For the first task, this study examines variables (or "threads") that are potential drivers of China's ERW program at three stages: Decision and Initial Research (1977–1979), Research and Development (1980–1984), and Pause and Reevaluation (1985–1988). A fourth section, Last Round of Modernization (1989–1996), is included to provide context about where the ERW program fits into China's nuclear force modernization history. Focusing on the costs and benefits of the ERW throughout these three stages addresses not only what is needed to begin such a program, but also what is necessary to sustain it to completion, production, and deployment. The analytical portion assesses the extent to which these variables still affect the ERW's status and contemporary weapons development decisions. The analytic framework focuses on the following variables (five drivers and one intervening variable).

Strategic Environment of the PRC. From 1977 to 1988, China's strategic environment transitioned from a tense Sino-Soviet standoff to a more relaxed outlook. Scott Sagan's "security model," in which states seek nuclear weapons to counter foreign threats, would give this variable the most weight.[20] This study considers events affecting China's strategic environment, such as the Soviet invasion of Afghanistan, Soviet deployments along China's borders, lessons from China's military action against Vietnam, and improved ties with the United States and later the Soviet Union. It also accounts for threat perceptions of that environment, such as Chinese assumptions of the likelihood for conflict and the nature of the conflict (that is, whether it would be conventional or nuclear).

Strategic Value of the ERW. How did Chinese leaders perceive the ERW's strategic value against likely threats? This variable encompasses the broader question of the relationship between specific weapons systems and a specific threat environment. This study assesses the threat of a Soviet armored thrust as a driver for the ERW's strategic value, and how changes in China's perception of that threat changed that value. A related question is the PRC leadership's intent in developing the weapon, such as how strictly it was intended for deterrence versus warfighting. The study also considers that competing or substitute systems may have lessened the ERW's strategic value.

Normative Value of the ERW. Would an ERW enhance China's international prestige or lead to international opprobrium? Sagan's "norms model" considers a state's decision to acquire or refrain from developing a weapon as a "normative symbol of a state's modernity and identity."[21] An ERW could contribute to China's prestige as a modern, technologically advanced power, or it could lead to an international backlash for pursuing a controversial weapon that violated China's stated nuclear policy. Discussing China's aim to "maximize" its status in foreign policy and arms control, Iain Johnston notes the roles of both back-patting and opprobrium for helping socialize China into certain agreements or norms.[22] Nina Tannenwald argues that the U.S. ERW controversy helped consolidate the "taboo" or norm against the use of nuclear weapons.[23] This study explores China's interpretation of the ERW's normative value, positive and negative, to assess its weight in China's decisions both to develop an ERW and then to defer the weapon's deployment.

Resource Demands. The ERW program required extensive political, financial, material, and personnel resources. However, the requirements for R&D, which demands significant amounts of highly trained personnel, are different from the resources necessary for production, such as sufficient plutonium, tritium, and other materials. As Deng Xiaoping reformed the defense industry and shifted priorities from 1977 through the 1980s, weaponeers were acutely aware of finite resources and were pulled into other civilian programs. One author described Chinese defense programs as "conquering resources," or competing against each other to secure political and resource support.[24] In the 1980s, Deng began decreasing military expenditures and converting defense industries into civilian ones, a process of defense conversion that would also affect resources available to the weaponeers.

Technological Feasibility. This study accounts for how feasible PRC leaders and weaponeers considered the ERW's design and production at different points in the program. In biographical accounts, the weaponeers themselves identified a number of ERW design and testing challenges and discussed approaches for solving or mitigating them. Relevant portions of this discussion are translated to make the material available to technical analysts.

Intervening Variable: Coalition Politics. Coalition politics served as an intervening variable that shaped how these five drivers affected decisions about the ERW program. This study seeks to identify relevant coalitions and politics affecting the ERW program to understand how the drivers produced the given outcome. This intervening variable is important because even if there is a consensus on the variables discussed above, different actors can place different weights on the relative importance of the variables. For example, at China's 1961 Defense Industry Conference in Beidaihe, leaders agreed that China's strategic environment was dangerous and that nuclear weapons were expensive. A coalition advocating conventional forces, led by He Long [贺龙], argued for focusing on "the development of aircraft and other conventional equipment."[25] Nie Rongzhen [聂荣臻], a key patron of China's strategic programs and supported by Minister of Defense Lin Biao [林彪], won the case for strategic weapons, arguing the programs would generate industrial spin-offs and international prestige.[26]

In the ERW case, Scott Sagan's "domestic politics" model suggests looking for a coalition of the state-run laboratories, important units within the professional military, and politicians advocating a weapon's acquisition.[27] At a granular level, this variable could include a "policy entrepreneur" who invested time, energy, and reputation into opening a policy window for the ERW program.[28] U.S. military examples of such entrepreneurism include Charles Draper's advocacy for increasingly accurate missile guidance systems and Admiral Hyman Rickover's leading the development of nuclear propulsion, earning him the nickname "Father of the Nuclear Navy."[29] In the Chinese military, Marshal Nie's support for strategic weapons programs and, more recently, the advocacy of PLA Navy commander Admiral Liu Huaqing [刘华清] for an aircraft carrier are similar examples.[30]

This study employs these variables to reconstruct the ERW's program history using primary sources as much as possible, including biographies and memoirs, technical articles, press reports, and Chinese blogs or social media. The biographies in particular provide useful insights into timing, motivations, politics, and challenges involved in the ERW program. For example, two weaponeers involved in the ERW's theory and design discuss difficulties with certain parts of the weapon. These primary sources also face limitations, most notably the lag time between the program's completion in 1988 and the biographies' publication in 2000 onward. These biographies came out soon after the Cox Report accused China of stealing U.S. nuclear weapons data.[31] Perhaps to counter espionage allegations, Chinese accounts all emphasize self-reliance and make no mention of acquiring foreign technology or weapons designs. Another limitation is that not all key personnel have published biographies. For example, the author could not locate biographies for Xue Bencheng and Hu Renyu, chief engineers for the ERW program. This study also used Chinese blogs and social media to identify research leads and sources for reliable information. For example, He Xiantu's QQ account (a Chinese social media platform) includes descriptions of his work on the ERW program.[32] This information helped identify more credible information sources, including a biography on He.[33]

To take up Greenwood's second task, this study also assesses the extent to which these variables apply today to the ERW, other Chinese weapons systems, and the nuclear weapons programs of other states. It also presents a generalizable model of a "technology reserve," in which China masters a technology or matches a capability but defers decisions on operations, strategy, and deployment. The study explains how strands came together to produce this outcome in the ERW case and examines the potential applicability of the model for Chinese decisions on BMD and ASAT capabilities as well as HGV systems. The study considers changes in China's contemporary defense industry and procurement processes and examines possibilities for arms control for these systems.

Case Study: Red China's Capitalist Bomb

ERW Primer: U.S. "Killer Neutron Warhead" Controversy and the Sino-Soviet Media War

On June 6, 1977, the Jimmy Carter administration faced an international uproar when the *Washington Post* revealed U.S. plans to develop the W79 warhead, an ERW.[34] ERW proponents argued the weapon would enhance deterrence by allowing the North Atlantic Treaty Organization to execute an effective nuclear attack against invading Warsaw Pact forces with discrimination and minimal collateral damage.[35] By this point, ERWs were not new. The United States began research on ERWs in the mid-1950s after a 1954 nuclear test at Bikini Atoll in the Marshall Islands.[36] The test's fallout radiation injured Japanese fishermen, which caused an international controversy and renewed efforts at U.S. laboratories to explore "clean" nuclear weapons concepts.[37] Lawrence Livermore National Laboratory began research on reducing thermonuclear weapons' fission yields, the primary source of radioactivity. Samuel Cohen, the "father of the neutron bomb," made a preliminary calculation indicating that fusion-based devices could be as effective as fission-based weapons and would release less than one-tenth of the blast and heat effects. In 1965, the United States began developing the Sprint missile, which as part of the Sentinel/Safeguard BMD program would use an ERW against an enemy intercontinental ballistic missile's (ICBM's) reentry vehicle. The system became operational on October 1, 1975, but one day later the U.S. House of Representatives voted to shut down the program, citing concerns over cost and effectiveness.[38]

The Soviets themselves also developed an ERW but claimed not to need or deploy the weapon. In 1961, Soviet President Nikita Khrushchev said the ERW was meant "to kill people but preserve all riches."[39] Yet that same year, Colonel M. Pavlov published an article in *Red Star* on the weapon's effectiveness.[40] In November 1978, Soviet President Leonid Brezhnev told a group of visiting U.S. senators that the Soviet Union had tested its own neutron bomb "many years ago . . . but never started production."[41] In 1979, a *PLA Daily* article noted: "Reportedly, the Soviet army already has thousands of tactical nuclear warheads and rockets . . . and that after the United States, they also successfully developed a neutron bomb."[42]

After the *Washington Post* revealed U.S. ERW plans and labeled the weapon the "killer neutron warhead," international backlash was swift. Soviet leaders and propaganda denounced the weapon as the "perfect capitalist bomb," because the radiation killed people while the reduced blast left property intact.[43] Some leftist European newspapers labeled the ERW the "supercapitalist weapon."[44] Soviet leaders also alleged the weapon was inconsistent with President Carter's emphasis on human rights. Later in 1981, the CIA and the Interagency Active Measures Working Group (led by the U.S. State Department) documented the Soviet role in the anti-ERW movement and on other foreign policy issues.[45] Soviet "active measures" included manipulation, disinformation, and the use of disarmament and peace issues, among others, "to insinuate Soviet policy views" and undermine U.S. policy.[46]

In April 1978, President Carter decided to postpone ERW production. In his memoirs, he cites frustration with the division among European leaders (such as the Germans "playing footsie" on the issue) and decided production without deployment was an illogical choice.[47] President Ronald Reagan, describing the ERW as a "defensive weapon" and a "deterrent to a conflict," decided to restart production of the W79 and to store the warheads with their delivery vehicles but to defer the decision on deployment to Europe.[48]

Chinese leaders followed the ERW controversy and seemed particularly interested in, if not amused by, the Soviet reaction to the weapon. The Xinhua News Agency prepared summaries of Western press stories for Chinese leaders, known as "internal reference materials," that almost certainly included news on the ERW. The Chinese press also carried stories about Walter Pincus's *Washington Post* articles and the ERW that were largely factual, unlike the Soviet condemnation of the weapon. On July 16, 1977, the *People's Daily* simply reported that Carter asked Congress to agree to ERW production.[49]

The Soviets noticed and grew alarmed over Beijing's muted response. An August 13 Chinese-language broadcast from Moscow demanded, "What is the stand of the Peking leaders toward the neutron bomb and all nuclear weapons? Why have Chinese newspapers, magazines, and radio stations remained silent about the neutron bomb?" The broadcast proceeded to ridicule Mao's "paper tiger" concept and other world views.[50]

On September 21, 1977, General Zhang Aiping, who ran strategic weapons programs as head of the Science and Technology Commission for National Defense (NDSTC), broke Beijing's "silence" over the neutron bomb with a poem in the *People's Daily*:

> *Steel alloys are not strong, and*
>
> *Neutron bombs are not difficult.*
>
> *When heroes study the sciences intensely,*
>
> *They can storm all earth's strategic passes.*[51]

The next day, the newspaper carried another short article describing ERWs and explaining their basic features.[52] The Soviets drew the obvious conclusion that China's leaders had decided to develop an ERW and ran articles denouncing China for its interest in the weapon. They also accused Beijing of supporting the U.S. decision to deploy the weapon in Europe.[53] Chinese media and diplomats did support U.S. ERW deployment in Europe to counter Soviet aggression. In February 1978, in the midst of the ERW controversy, the CIA reported that "Chinese propagandists have also taken approving note of statements . . . of reports on U.S. development of the neutron bomb, cruise missiles, and other weapons systems."[54] Chinese leaders later criticized the Carter administration's decision to postpone ERW production that April. In a meeting with National Security Advisor Zbigniew Brzezinski in May 1978, Chinese Foreign Minister Huang Hua criticized the U.S. failure "to get a corresponding concession from the Soviet side. On the other hand, it has given rise to an open debate between the U.S. and its allies. We hope that the U.S. side will give serious consideration to the views of the Chinese side in this regard."[55]

The "failed concession" likely refers to the administration's failure to obtain a Soviet pledge to limit deployment of the SS-20 intermediate-range ballistic missile. In November 1981, *China*

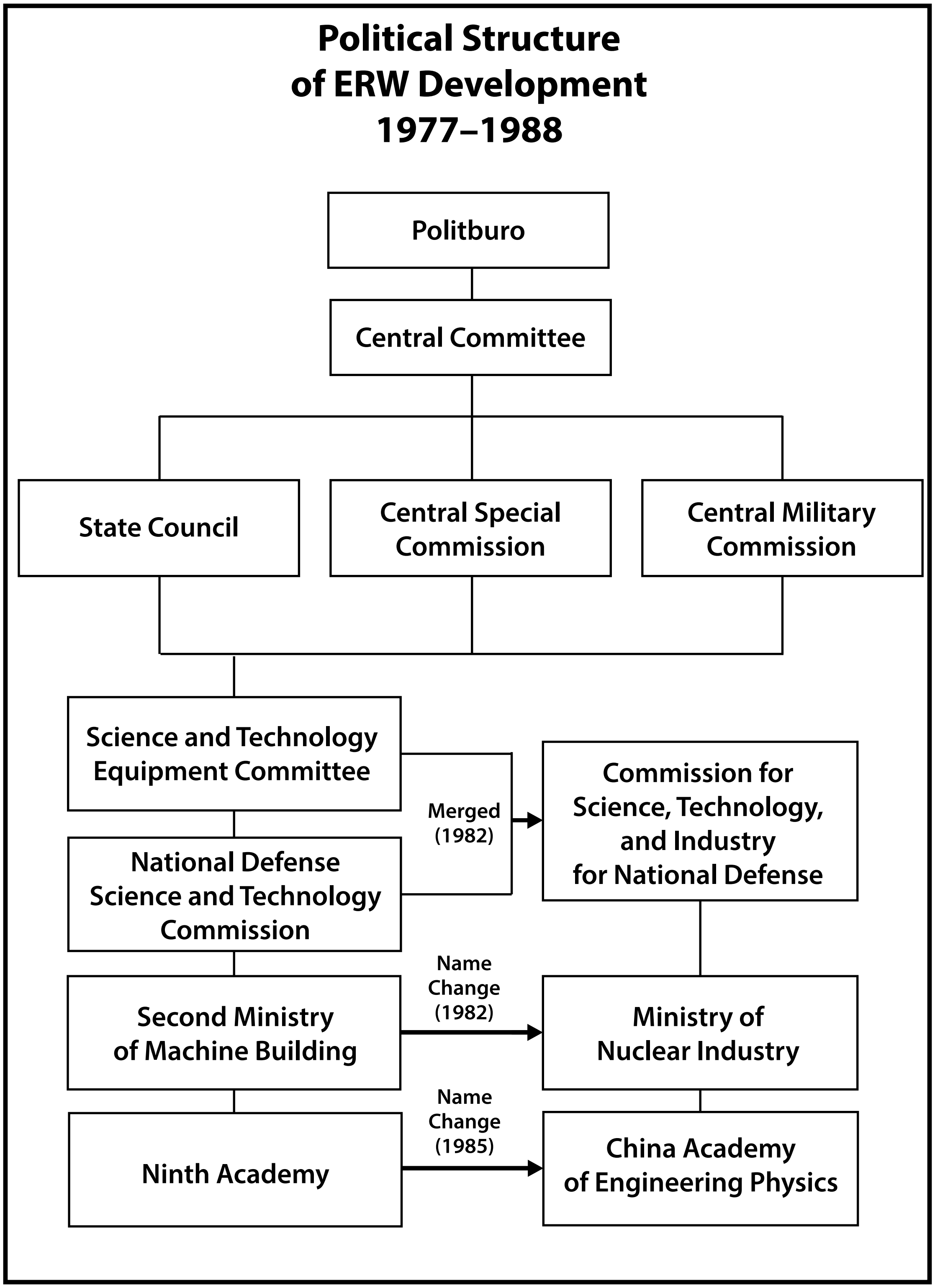
Cartoon from *China Daily* in November 1981. The front protestor is a missile stamped "SS-20, Made in the USSR."

Daily published a cartoon of protestors against the ERW. One "protestor" is an SS-20 missile labeled "Made in the USSR," wearing a trench coat, and carrying a sign reading "No U.S. neutron bombs in Europe."[56] The accompanying article "Soviet Hand Seen in New Pacificism" shared the U.S. Government's view that the Soviets were using manipulation and disinformation to mobilize the anti-ERW movement.[57] That same year, China's United Nations representative Yang Hushan rejected a Soviet motion to ban ERWs, saying that the Soviets only wanted to do so out of self-interest and that the ERW should be included in broader disarmament efforts.[58]

PRC Institutions Involved in the ERW Program

Within the PRC, deliberations and decisionmaking on nuclear weapons involved the government bodies as shown in the chart, "Political Structure of ERW Development, 1977–1988."[59]

Political Institutions. The Politburo is a group of China's preeminent leaders who exercise influence over all PRC policy and appoint key leaders. This smaller group is appointed by the broader Central Committee, which comprises over 200 Communist Party members. The State Council, which comprises leaders of state institutions, heads the institutions of the state (as opposed to the party) and leads the day-to-day administration of the country. The Party's Central


Political Structure
of ERW Development
1977–1988
Politburo
Central Committee
State Council
Central Special Commission
Central Military Commission
Science and Technology Equipment Committee
National Defense Science and Technology Commission
Merged (1982)
Commission for Science, Technology, and Industry for National Defense
Second Ministry of Machine Building
Name Change (1982)
Ministry of Nuclear Industry
Ninth Academy
Name Change (1985)
China Academy of Engineering Physics

Military Commission (CMC) commands the PRC's armed forces and in conjunction with the State Council provides top-down directives for China's defense industrial complex.[60]

Weapons Development Decisionmaking. The Central Special Commission (CSC) of the Politburo was established in 1962 to oversee China's strategic weapons programs and includes vice premiers and leaders throughout the military industrial complex.[61] The National Defense Science and Technology Commission was established in 1958 under Marshal Nie Rongzhen to take charge of strategic weapons programs, and it reported directly to the CMC and the Politburo.[62] In 1982, the NDSTC was merged with the National Defense and Technology Commission to form the Commission for Science, Technology, and Industry for National Defense (COSTIND), which was responsible with overseeing development of conventional and strategic weapons systems.

Weapons Development Institutions. The Second Ministry of Machine Building (renamed the Ministry of Nuclear Industry in 1982) administered bureaus and academies that were in charge of research institutes and laboratories.[63] The Ninth Academy, renamed the China Academy of Engineering Physics (CAEP) in 1982, designed and tested China's nuclear weapons, including the ERW.

Phase One, Decision and Initial Research (1977–1979): "What Others Have Already Done, We Also Must Do"

In 1977, China's nuclear weaponeers received an order to conduct "initial research" [预先研究] on an ERW, which lasted until 1979 or 1980.[64] Zhu Guangya, described as a key interlocutor between politicians and the weaponeers, recalls that in 1977, Deng discussed equipment and scientific issues and stressed spending resources on limited and carefully chosen programs.[65] Zhu had constant contact with the CSC, a coordinating committee making decisions about strategic weapons programs that was chaired by the premier and reported to the Politburo.[66] In 1978 and 1979, Deng, Nie Rongzhen, Zhang Aiping, and other CSC members chose priorities based on the international strategic situation and "step by step designated the direction of China's development of nuclear weapons equipment."[67] This direction likely would have included completion of the "Three Grasps" (an intercontinental ballistic missile, a submarine-launched ballistic missile, and a communications satellite) and the ERW.[68]

In the late 1970s, the PRC faced a tense strategic environment and drastic political changes in government. Small clashes between Chinese and Soviet troops continued along China's border with Mongolia (a Soviet satellite state) and rivers in China's eastern sector.[69] Soviet deployments along the border increased, reaching 54 divisions in the early 1980s, at a time when

PLA conventional capabilities were weak.[70] During the 1969 Sino-Soviet border dispute, border tensions "had begun to go beyond Mao's expectations," causing panic within the PRC leadership.[71] The PRC's 1979 invasion of Vietnam to counter growing Soviet influence encountered significant challenges in mobilization, communication, and logistics.[72] China's atrophying conventional capabilities were a casualty of the Great Proletarian Cultural Revolution, which lasted from 1966 until Mao Zedong's death in 1976. During that time, the PRC was politically paralyzed, and 82 of China's 125 military academies were shut down.[73] These 82 academies represented 97 percent of the command schools, 50 percent of the technical schools, and 75 percent of the medical schools.[74]

By 1977 key military figures in China's post-Mao leadership included Deng Xiaoping, Marshal Ye Jianying [叶剑英], and General Zhang Aiping. All three leaders had worked together in 1975 to revamp China's military R&D centers and to reduce factionalism within the nuclear and missile complexes.[75] Deng was purged a second time in late 1975 but returned to power in July 1977 to take posts on the State Council, the Central Committee, the CMC, and the PLA General Staff.[76] By then, Marshal Ye was already a key advisor to Hua Guofeng (Mao's chosen successor) and supported Deng's restoration only to limited responsibilities.[77] As part of a compromise, Ye and Deng were assigned shared responsibility for military modernization in 1977.[78] Zhang Aiping was a loyal Deng supporter, for which he was criticized and hospitalized from 1975 to 1977 during the last 2 years of the Cultural Revolution.[79] General Zhang survived under Marshal Ye's protection and in 1977 resumed responsibilities for the NDSTC, became a member of the CSC, and was appointed director of the Science and Technology Equipment Committee of the CMC.[80] Zhang's 1977 neutron bomb poem was actually a response to Marshal Ye's poem on the importance of Chinese technological modernization.[81]

Under new leadership, China's military strategy began transitioning from "luring the enemy deep" [诱敌深入] to "active defense" [积极防御].[82] The former was a defense-in-depth strategy in which the PLA would retreat to strategic positions and absorb a Soviet armored thrust before using better positions and guerrilla warfare to wear down overstretched enemy lines. The latter is one of Mao Zedong's defense principles in which Chinese defenses quickly halt enemy offenses and either launch a counterstrike or draw out a protracted war. In December 1977, Marshal Ye, after meeting with the CMC, codified the guideline as "active defense, luring the enemy in deep." The aim was to stabilize the PLA's "active defense" in 1980. While China's strategic guidelines do not directly guide nuclear strategy, Zhu Guangya reports that at the 1978 and 1979 CSC meetings, China's international strategic situation and "active defense" strategic guidelines were starting points in deliberations over nuclear weapons development.[83]

With these changes in strategy, Deng's military priority was to shift resources to conventional force modernization. In December 1977, the CMC and State Council jointly decided to "make conventional weapons the main focus" [以常规武器为主], in effect reversing a 20-year commitment to strategic weapons–based force modernization.[84] The shift was the beginning of Deng's efforts to reform the PLA by focusing on better equipment and training, while cutting personnel and reducing emphasis on strategic programs. Even with the prioritization of conventional weapons, General Zhang secured support for some strategic weapons programs such as the Three Grasps.[85]

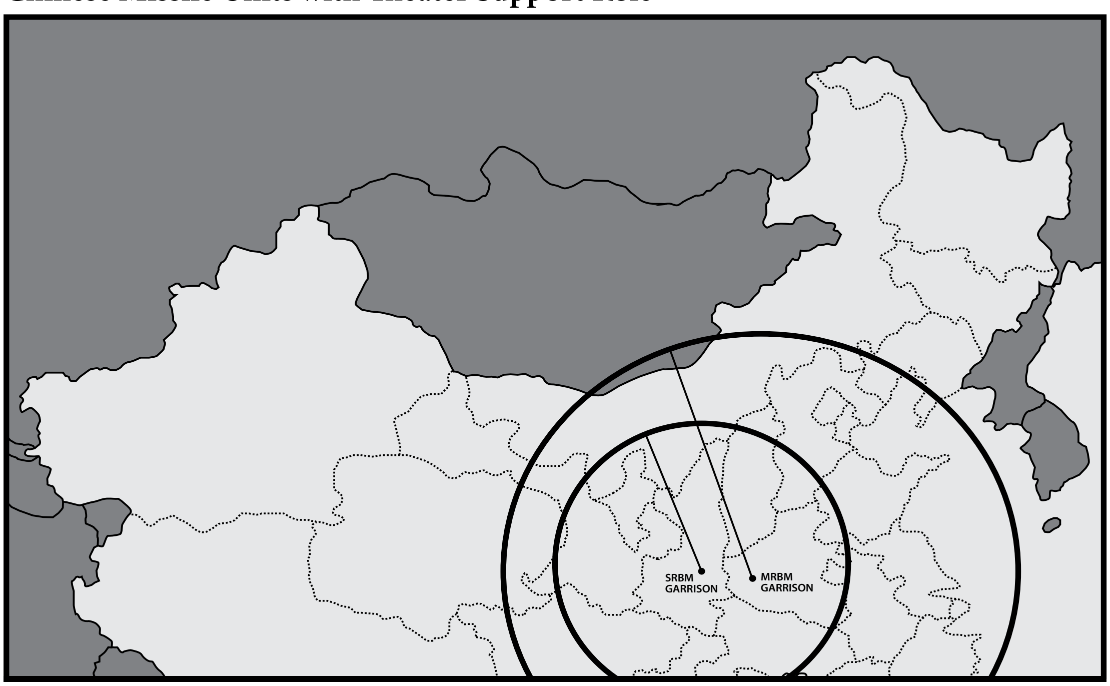
In this political context, two potential drivers for the ERW order were Deng's emphasis on the weapon's normative value and/or domestic politics at the time. Zhu and another weaponeer, Chen Junxiang [陈俊祥], commented on the importance Deng placed on developing a new generation of nuclear weapons to match U.S. and Soviet capabilities.[86] They recall Deng's visit to the Ninth Academy in 1966, where he told personnel, "What others have already done, we also must do; what others have not yet done, we certainly must also do."[87] This mindset likely drove Deng's prioritization of China's new generation of nuclear weapons in the 1970s and 1980s, which would include the ERW. If the decision followed a top-down track, the ERW as a symbol of China's modernity and the obvious consternation it caused the Soviets likely were key drivers.

If the decision was bottom-up in nature, a driver may have been Deng's need to secure General Zhang's support for conventional force modernization, in which case the ERW was a "fourth grasp."[88] General Zhang was a key ERW advocate by 1980, though evidence on his 1977 views is incomplete. Further down the chain of command, Zhou Guangzhao, then Director of the Ninth Academy, reportedly first decided China needed an ERW to "avoid nuclear blackmail," an argument echoing Chairman Mao's logic for the first atomic bomb.[89] To obtain support from superiors and relevant departments, Zhou sent his wife Zheng Aiqin [郑爱琴] and Wang Jihai [王继海] to superior agencies to explain the ERW's basic concepts.[90] He Xiantu and Wang Jihai also went to the Second Bureau of Machinery Building to assess the technology and capacity to produce the necessary materials.[91] Zhou himself personally accompanied a group visiting a unit in Beijing to assess development of "certain technologies."[92] Consistent with Sagan's "domestic politics" model, leaders from the military and labs were key ERW advocates.

Some other weaponeers were critical of the ERW, citing its limited strategic value and disruptive resource demands. In 1977, Huang Zuqia [黄祖洽], China's leader in neutron physics and a key scientist in the hydrogen bomb program, argued ERWs were not "clean" [干净] nuclear weapons (as U.S. advocates had argued), had limited utility, and were ineffective against tanks equipped with specialized armor.[93] In 1979, Liu Huaqiu, who was involved with the warhead's testing from 1982 to 1988, authored a 12-page report called *A Review of the Neutron Bomb* [中子弹综述], which is not available to the public.[94] We may infer some of his arguments against the weapon from his 1988 writings, in which Liu argued China's nuclear doctrine would not allow use of the ERW; the sparsely populated border with the Soviet Union did not require it; and that China should spend the resources on more useful military technologies like precision-guided munitions (PGMs).[95]

Debate over the ERW's strategic value likely also included discussions of whether existing systems already fulfilled the strategic requirement for an ERW.[96] In 1973 or 1974, the U.S. Intelligence Community, for the first time since 1965, observed field launch sites for Chinese SRBMs that covered potential invasion routes through Mongolia and the Chinese province of Xinjiang, though the force "probably [did] not exceed 10 launchers."[97] The map below shows an MRBM garrison extending this coverage into Mongolia.[98] Since these missiles targeted rural areas and not cities, the ERW's reduced blast and enhanced radiation effects were unnecessary and represented a niche capability.

Chinese Missile Units with Theater Support Role



It is odd that there is no evidence of the Second Artillery (China's core nuclear force) making this argument or playing any role in the ERW deliberations. Deng played a major role in the appointment of his political ally Li Shuiqing [李水清] as the unit's commander in August 1977. Deng commented that Li lacked experience in "artillery and public security," but Li had supported Deng's initial attempts at military reform in 1976, opposed the Gang of Four, and joined Deng on the CMC in August 1977.[99] The Second Artillery and other military institutions also did not have access to studies on nuclear strategy and did not discuss strategy themselves until the mid-1980s.[100] As Lewis and Hua write, the commanders "merely imagined that nuclear strategy was a matter to be debated and decided upon by leaders in the Central Military Commission."[101] It is hard to imagine an ally of Deng Xiaoping with little experience in nuclear strategy opposing the ERW decision or playing an independent role in the ERW debate.

The weaponeers also worried that the ERW order would disrupt their highest priority modernization program, the urgent completion of miniaturized warheads for the DF-4 and DF-5 ICBMs. In January 1974, the NDSTC put forth the concept of "trial operational deployment" for the DF-4 and DF-5 to meet the "urgent demand for war-fighting readiness,"[102] and in September 1977, the CMC called for the DF-5's completion before 1980, when China deployed its first few DF-5 ICBMs.[103] Yu Min [于敏], a leader of theoretical design work for the nuclear weapons complex, recalls that in the 1970s, the weaponeers were developing new warheads and were ordered to "make increased yields and miniaturization the focus of development."[104] The goals were to improve "miniaturization, mobility, penetrability, safety, and reliability" [小型、机动、突防、安全、可靠].[105]

By 1975 or 1976, miniaturization research encountered difficulties, especially with ignition.[106] He Xiantu recalls that "early on, under Yu Min's leadership we already researched a type of theory of thermonuclear burn, but did not research an approach for achieving ignition."[107] In a thermonuclear device, this "ignition" could refer to the plutonium primary for driving the secondary, or to a neutron source that the primary triggers to release neutrons. The weaponeers struggled with both. Yu Min recalls great difficulty in miniaturizing the warhead's primary, a task he had focused on since the early 1970s. He had led initial calculations, measurements, and the hot testing, but despite the successful test, by 1976 he was still concerned that the primaries were not suitable for weapons.[108] That year, the weaponeers encountered calculation errors for a primary with "new capabilities" [新性能].[109] Lewis and Xue write that a key obstacle to miniaturization in the 1970s was replacing the mechanical neutron initiator in the center of China's original warheads.[110] In 1975, He Xiantu led a small group to address these unsolved challenges.[111]

Despite concerns over resource demands and feasibility of the ERW, the weaponeers likely completed initial ERW research in 1979 or 1980. In 1979, Liu Huaqiu completed his report, *A Review of the Neutron Bomb*.[112] During He Xiantu's promotion in 1980, he reported on conclusions and principles of the ERW and said that he and his group "completed a great amount of research work."[113] Also at this time, key scientists transferred from the nuclear weapons complex. In 1980, ERW advocate Zhou Guangzhao traveled abroad and joined the China Academy of Sciences (CAS), and Huang Zuqia left for Beijing Normal University.[114]

This exodus left the onus of the ERW's development on Yu Min, who in 1980 was promoted to become a deputy director of the Ninth Academy and put in charge of warhead development.[115] Yu Min expressed concerns over his ERW and warhead miniaturization assignments to Qian Sanqiang [钱三强] at CAS. Qian offered Yu Min a position at CAS, noting that Zhou and Huang had already left the weapons complex; wouldn't Yu Min "like to avoid problems and walk away too?" After assessing the situation, Yu Min decided that "even if he needed to transfer, the leaders would not allow him to leave." His orders were "to use the most advanced technology to make increased yields and miniaturization the focus of the development of the second generation of nuclear weapons, and at the same time develop a neutron bomb." He had confidence in the nuclear weapons research institute's team and technologies but reasoned that on the theoretical side he was the only leader who had experience, understood the assignment, and could make necessary decisions. In the end, Yu Min could only "refuse Qian Sanqiang's good intentions," but he clearly was not optimistic.[116]

The remaining weaponeers also probably acquiesced to their reality of declining political clout and increased competition for their resources. General Zhang Aiping's replacement of Marshal Nie Rongzhen as head of NDSTC in 1975 marked a decline in status for the commission and in turn for nuclear weapons programs.[117] The December 1977 CMC and State Council decision to focus on conventional weapons also signaled a fundamental shift away from strategic weapons. With a declining patronage network and looming fallow period for warhead development, weaponeers needed to be politically adroit and responsive to the wishes of top party leaders. Xue Bencheng, the Assistant Chief Technical Coordinator for the ERW program, said the weaponeers had to "stress politics" [讲政治].[118] "For conducting China's nuclear tests, funding was not easy to come by. Use of funds required political foresight, and bearing responsibility to the party and people."[119] This "political foresight" would likely include not resisting Deng and Zhang's order to develop an ERW despite the concerns of some weaponeers.

Phase Two, Research and Development (1980–1984): Developing the "Second Generation of Light Boats"

China's assessment of the international environment underwent major shifts in 1979 and 1980. The moribund Sino-Soviet Treaty of Friendship, Alliance, and Mutual Assistance officially expired in February 1979, after which China initiated a disastrous attack on Vietnam.[120] The Soviet Union's December 1979 invasion of Afghanistan added to Chinese concerns about the security of its own territory. In 1980, Deng Xiaoping officially approved active defense as a military strategic guideline, focusing on how to defend China from a limited invasion by the Soviet Union. Instead of "luring the enemy deep" into an agrarian country, China needed to defend cities and protect key economic and political centers.[121] China's leaders and the PLA assumed that the Soviets would use TNWs early in a conflict. Chong-Pin Lin writes that China's military strategists assumed the Soviets would use nuclear weapons early in a conflict despite their conventional superiority.[122] One book from Soldiers Publishing House [战士出版社] noted the Soviets could use nuclear, chemical, and/or biological weapons early to quickly alter the balance of force and cited their emphasis on "gaining mastery by striking first" [先发制人].[123, 124] This emphasis on striking first contrasted with China's emphasis on "gaining mastery by striking second" [后发制人].

In 1980, General Zhang Aiping, still head of the NDSTC, indicated how the ERW could fit into this new strategic environment. After the normalization of U.S.-China relations in 1979, the two countries conducted military and scientific exchanges. In 1980, George A. "Jay" Keyworth, head of the Physics Division at Los Alamos National Laboratory, traveled to China, where General Zhang was his host.The two discussed China's military strategy for defense against a Soviet invasion, which Zhang said was to retreat southward and use cities as defensive bulwarks. ERWs would be part of this strategy. "For you," Zhang said, "the neutron bomb has no use. But for us, well . . . you have this game in the United States—bowling? You bowl. We need to bowl neutron bombs over the Soviet border."[125]

Chinese media coverage of France's ERW development reflected a rise in the weapon's normative value as a symbol of technological prowess.[126] In July 1980, *People's Daily* reported that France decided to build an ERW in 1976 and would decide whether to produce it by 1982 or 1983. The article also claimed that, according to foreign reports, the French ERW's effective perimeter was 30 kilometers in diameter, compared to the U.S. ERW's 2 kilometers.[127] Another article argued France developed the ERW in order to maintain the military balance with the Soviet Union and that it was "a way for France to seek major power status [大国地位]."[128] In the 1980s, China began researching and discussing nuclear strategies of "medium-sized nuclear powers" like France, which would likely include discussions of ERWs.[129]

In 1982, the strategic weaponeers' political clout increased as bureaucratic reforms moved General Zhang and other strategic weapons advocates to key posts. That same year, Deng appointed General Zhang as deputy secretary general of the CMC and Minister of Defense.[130] One of his main CMC responsibilities was to oversee and coordinate defense science, technology, and industrial affairs.[131] In 1982, the Commission for Science, Technology and Industry for National Defense brought conventional and strategic weapons programs under the same administrative roof, but the latter clearly held the advantage.[132] As Feigenbaum notes, "because so many strategic weaponeers had survived the Cultural Revolution while their [National Defense Industry Office, or NDIO] antagonists had not, they dominated the new headquarters even though the focus of military R&D had shifted toward the NDIO's old charge of conventional weapons."[133] He Long and Luo Ruiqing (who had opposed Nie's emphasis on strategic programs) died in 1968 and 1978, respectively.[134] COSTIND's first director, Chen Bin [陈彬], was a bureaucrat with a mixed background in science, technology, and diplomatic matters, but he did not have clear policy preferences or the same clout as Zhang or Marshal Nie.[135] COSTIND led the Ninth Academy and the Northwest Nuclear Test Site tests.[136]

By this time the weaponeers had two primary tasks, which were to "use advanced technology to make higher yields and miniaturization the core of second generation nuclear weapons' development, and at the same time develop a neutron bomb."[137] To complete both assignments with the limited resources available, the weaponeers identified common principles that applied to both miniaturized warheads and ERWs, rather than designing each system independently. According to He Xiantu, after receiving the ERW order, the weaponeers combined research on the ERW and miniaturization.[138] The research expanded to multiple research groups; He's group addressed ERW principles and one-dimensional theoretical design.[139] The weaponeers divided the design problems into their constituent parts and solved them individually before integrating the solutions into final designs.

Common principles included a miniaturized primary (which Yu Min was already addressing) and an optimized secondary. China had already struggled with deuterium and tritium to "boost" its weapons, or make more efficient use of fissile material.[140] Increased resources for an ERW program could help the weaponeers master principles for both the ERW and miniaturized warheads. He Xiantu also started research on relevant ignition theory and led a group exploring a "new approach" that Zhou Guangzhao believed could solve basic ERW principles and design issues.[141]

Yu Min stressed that the weaponeers follow three important guidelines.[142] First, they needed to implement the central leadership's nuclear weapons development guidelines of "limited objectives, advanced technologies" [有限目标，先进技术]. Specifically, they needed to consolidate efforts, spend less money, deal with practical matters, use advanced planning and thought, advance technology, and thereby "grasp the goals of higher levels of threat [yield], miniaturized nuclear weapons and the neutron bomb, and gradually close the gap with nuclear powers." Second, they needed to choose their technological paths carefully, because errors could be costly. Yu Min described the process of miniaturizing the primary as "drawing near a precipice," due to the difficulty of determining how small the primary could be and still drive the secondary. Third, after deciding on a technological path, they needed to assess and solve key points of the physics and technology problems.

China's nuclear testing took a phased approach of testing principles, according to Chen Junxiang. Specifically, they followed various "rules of three" to be cautious and conserve limited resources.[143] Phased targets followed the "three news" [三新], which were new principles, new materials, and new structure. Testing goals stressed the "three clarities" [三清], which were distinguishing between important goals and superfluous items, between factors that influenced success or failure and factors that yielded different results, and between tests that determined success and failure and tests for scientific research.[144] Organization and implementation stressed the "trilogy" [三部曲] of prudently confirming goals for the first step, encouraging a free exchange of ideas for the second step, and organizing groups to solve technological problems for the third step.[145] Limiting test objectives made it easier to diagnose problems and learn from successes and failures.

Xue Bencheng and others all stressed the limited resources available for nuclear tests.[146] The weaponeers worked to improve capabilities to conduct and monitor the tests to get better information. For example, after the May 4, 1983 (CHIC-29), test in a tunnel in Lop Nor's Bei Shan (North Mountain), scientists "for the first time drilled rapidly into the testing area to obtain radioactive samples for analysis." They also made advances in physics testing equipment near the site.[147]

From 1982 to 1988, China conducted six tests related to the ERW (CHIC-28-32, -34). Chinese media paid special attention to the December 1984 test (CHIC-32), described as a "principles breakthrough" [原理突破] for the ERW and miniaturization. Deng Jiaxian, who was Director of the Ninth Academy's Theory Branch, is often described as "the father of China's hydrogen bomb." Deng and Yu Min were close friends (test site workers affectionately referred to them as "fatty" and "baldy") and worked together on the program.[148] Deng wrote a poem to commemorate this test, which would also be the last in which he participated:

The red cloud attacks the highest heavens,

and a thousand nuclear forces rock the earth.

After twenty years of hard climbing,

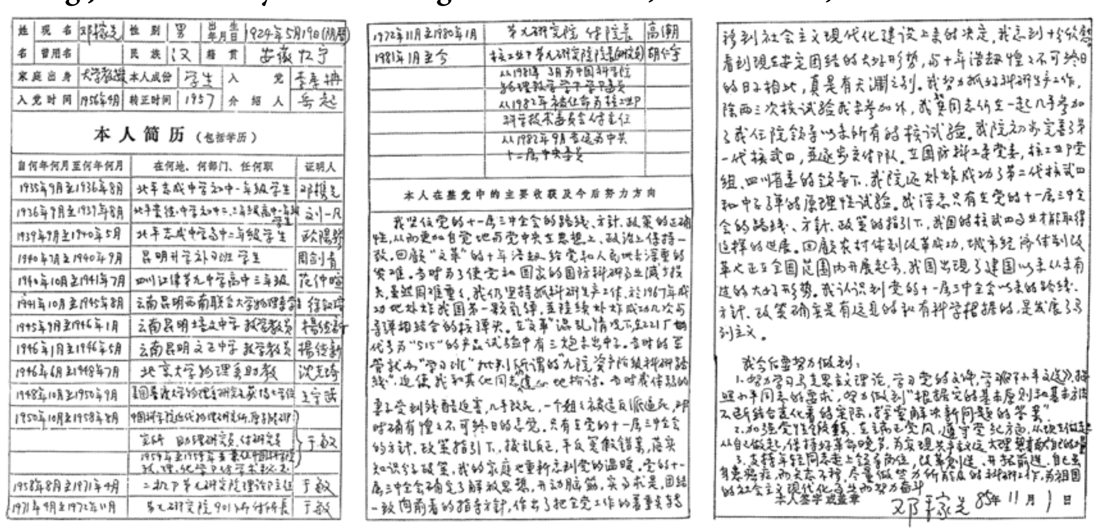
the second generation of light boats has passed the bridge.[149]

From his hospital bed in November 1985, Deng wrote in his Party Registration Form (below) that among his accomplishments as a CCP member, "our institute successfully detonated principles tests for second generation nuclear weapons and the neutron bomb."[150]

Phase Three, Reevaluation before Completion (1985–1988): "Does China Need the Neutron Bomb?"

After a successful principles test for the "second generation" of nuclear weapons, completing and deploying the ERW was a politically and technologically feasible option. Instead, China

Deng Jiaxian's Party Member Registration Form, November 1, 1985



paused its nuclear testing for 30 months (until CHIC-33 on June 5, 1987), and did not test the ERW until September 29, 1988 (CHIC-34). This pause coincided with two key policy changes by Deng Xiaoping.

First, Deng saw an improved international environment as the Soviet military became bogged down in Afghanistan. Predicting 10 to 15 years of peace, he shifted resources to technological and civilian enterprises. Deng cut the size of the PLA by one million personnel, and in March 1986 he initiated the 863 program to focus on numerous dual-use technologies for civilian and military use. Programs for laser technology, space, biotechnology, information technology, automation and manufacturing technology, energy, and advanced materials laid the foundation for China's economic development and defense modernization to the present day.[151] Another important event was Soviet President Mikhail Gorbachev's July 1985 declaration of a moratorium on nuclear testing, which lasted until February 1987. During the moratorium, Gorbachev challenged U.S. President Ronald Reagan to sign a treaty banning nuclear tests.[152] China's weaponeers grew concerned that the United States would accept calls for a Comprehensive Test Ban Treaty (CTBT).[153]

Second, Deng's new retirement policy for PRC leaders and party elders, included in the 1982 revised party constitution, went into effect. On September 22, 1985, Ye Jianying, Nie Rongzhen, and Zhang Aiping all retired from the CMC and Central Committee. Ye and Nie retired from the Politburo, and Ye retired from the Politburo's Standing Committee.[154] Ding Henggao, Marshal Nie's son-in-law, became the new head of COSTIND, but he lacked the political clout of Marshal Nie. These changes effectively left the ERW without a champion.

The prospect of halting nuclear testing alarmed the weaponeers because they had not turned success in mastering principles into tested final designs. As of 1986, Yu Min reported that despite 10 years of research on miniaturization, the weaponeers still needed to weaponize the designs. Yu Min wrote two reports to the new Ninth Academy director Hu Renyu [胡仁宇] that year emphasizing this point.[155] Before his death from cancer in 1986, Deng Jiaxian called Yu Min and Hu Side [胡思得] to his hospital bedside. They composed a report to the Central Committee warning that other nuclear weapons states could soon exhaust their need for further nuclear testing and that political pressure could mount to conclude a CTBT. China needed to accelerate its nuclear testing to complete a miniaturized warhead design in advance of the test ban. Instead of going through bureaucratic channels, the weaponeers relied on personal ties to deliver the report directly to Deng, perhaps reflecting the weakened political standing of their leadership. The Central Committee approved the report and provided the necessary resources.

On June 5, 1987, China conducted a large-scale underground nuclear test, presumably to finalize the miniaturized DF-5 warhead, which Yu Min and others had been working on for at least a decade. Deng Jiaxian posthumously received a National Science and Technology Advancement (NSTA) award in July 1987 for the "Breakthrough of [redacted] Bomb Equipment" [xxxx弹装置的突破].[156] China's progress toward miniaturization culminated in an ERW design test on September 29, 1988 (CHIC-34).

Prior to the ERW test, nuclear weapons personnel seemed uninterested in the ERW itself but proud of the technologies used. Liu Huaqiu, who wrote the 1979 classified study on the ERW, became a Senior Specialist at COSTIND and later Associate Research Fellow at the China Defense Science and Technology Information Center. In 1988, Liu wrote three pieces arguing China did not need the ERW, including a monograph for Stanford University and a two-part article entitled "Does China Need the Neutron Bomb?" in *Military World* [军事世界]. In these pieces, Liu argued that ERWs contradicted China's NFU doctrine, did not suit China's geography, were too costly, required too much plutonium and tritium for mass production, and were not as cost-effective as PGMs.[157] Liu did add, however, "But this is not to say that China should not research and develop neutron bomb technology. . . . Due to the potential applications of this technology, China needs to research it and master it as a technology reserve."[158]

Other scientists described the test as the culmination of intense efforts at warhead design and new advancements in technology. According to Yu Min, "By the end of the 1980s they had completed their assignment to break through principles of new types of miniaturized primaries."[159] Their testing equipment was also much more advanced. In June 1988, Zhu Guangya wrote a report on ERW test preparations and equipment, saying that "it was necessary to have every advancement, and it must not have any of the old stuff" [要有所前进，不能老一套].[160] On September 29, 1988, this "new stuff" succeeded, and afterward Yu Min claimed China's technological level "climbed a step" [上了一个台阶].[161] Yu Min formally retired from the CAEP that year.[162] In July 1989, Deng Jiaxian posthumously received a second NSTA award for "A Major Breakthrough in Nuclear Weapons" [核武器的重大突破].[163]

Phase Four, Last Round of Modernization (1989–1996): "Climbing the Precipice"

In 1989, the weaponeers formed a small group to put forth a plan for new type of warhead with increased capabilities.[164] From 1990 to 1996, the weaponeers conducted 11 nuclear tests (CHIC-35 through CHIC-45), most likely to develop miniaturized warheads for the DF-31 and DF-31A ICBMs and the JL-2 SLBM.[165] During an interview in 2000, Xue Bencheng said that this round of modernization required delicate calculations and preparations, and all with limited resources. Xue described these challenges as "climbing the precipice" [爬陡坡].[166] After the successful "climb," China signed the CTBT on September 24, 1996.[167]

Analysis and Implications for Today

What strands produced the outcome of ERW development without deployment, and to what extent do they apply today? This section assesses each variable's influence upon China's ERW program's phases and final outcome. Each explains different aspects of the program; none provides a complete explanation. Moreover, the drivers were susceptible to the role of changing political coalitions as an intervening variable. The section then uses these variables to assess the ERW's current status, other Chinese weapons development decisions, and other states' nuclear weapons programs.

China's *perceptions of its strategic environment* align with the ERW program until 1985 but fail to explain the final 1988 test. From 1977 to 1979, Sino-Soviet relations were openly hostile and influenced China's military strategy, which became more ambitious in a time of military weakness. Transitioning away from giving ground or "luring the enemy in deep" to holding territory through "active defense" came as the Sino-Vietnamese War revealed severe problems with conventional force structure and mobilization. The gap between strategy and capability could explain General Zhang Aiping's and others' interest in a weapon that could both alarm

Table. Changes in Variables Throughout ERW Program

	Phase 1: Decision and Initial Research (1977–1979)	Phase 2: Research and Development (1980–1984)	Phase 3: Reevaluation before Completion (1985–1988)
Strategic environment of PRC	Very tense	Very tense	Relaxed
Strategic value of the ERW	Debated	High	Low
Normative value of the ERW	Very positive	Positive but debated	Negative
Resource demands	High and disruptive resource demands	R&D demands lowered by synergy with miniaturization program	Low demands to complete design, but high for production
Technological feasibility	Very difficult	Feasible to master principles	Feasible to complete design
ERW coalition status	Strong	Very strong	None

the Soviets and deter a Soviet armored thrust. Zhu Guangya's recollection of meetings in 1978 and 1979 also explicitly references "active defense" as a starting point in deliberations. This variable does not, however, explain the final decision to test. Gorbachev's ascent to power in the Soviet Union and continuous improvement in U.S.-China relations relaxed China's strategic environment, as reflected in Deng's prediction of peace in 1985. By 1986, China's strategic environment was arguably the most relaxed since the PRC's founding, and yet Deng ordered the ERW's completion that year.

The ERW's *strategic value* mostly correlates with these changes in China's strategic environment, but the case study shows interesting debates at all phases. From 1977 to 1979, a key question was intent, or whether China could deter the Soviets by merely claiming a certain capability and not necessarily deploying it. Another issue was whether existing smaller nuclear weapons could substitute for the ERW and fulfill the same objectives. By 1980, General Zhang Aiping indicated these issues were resolved and that the capability to use ERWs closer to cities was strategically valuable. Chinese assumptions that the Soviets would use nuclear weapons early in a conflict addressed any concerns about nuclear doctrine issues. The 1985 pause and quick restart demonstrate that strategic value does not depend solely upon the contemporary strategic environment. Liu Huaqiu's "technology reserve" argument indicates a longer term perspective on strategic value. The weaponeers' argument that testing in advance of the CTBT was required to master ERW technology ultimately was persuasive.

Currently, China's strategic environment and the ERW's strategic value support keeping the weapon in the "technology reserve." China's conventional forces are strong, leaving the Russians, ironically, to rely on TNWs to offset conventional inferiority. The PRC's focus has shifted instead to conventional force modernization, and especially to development of anti-access/area denial (A2/AD) capabilities to delay and prevent U.S. military intervention in the region. Research for this study found no authoritative or reliable Chinese military literature regarding potential ERW use in a regional or Taiwan conflict scenario.

The ERW's *normative value* for China started high as a part of "matching capabilities" of other advanced powers but became negative as the United States and France renounced their ERW programs. In 1977, the ERW as a "new generation" nuclear weapon connoted technological prestige, and Soviet sensitivity to the weapon likely encouraged the Chinese to pursue the capability. Chinese studies of medium-sized nuclear powers—like France in the 1980s—could also have influenced ERW decisionmaking. By the time the Central Committee called for the ERW's completion in 1986, however, a taboo against the weapon was well established. By broadcasting its ability to build an ERW (announced in 1999), but publicly claiming not to need the weapon, China in effect split the difference. The PRC both garnered the prestige of mastering the technology and demonstrated restraint by not deploying the weapon. Today, China keeps the same compromise. The PRC's rebuttal to the Cox Report of "mastering ERW technology" [掌握中子弹技术] is deliberate in its wording, and the same language appears in other pieces that list the ERW as a technological accomplishment. The ERW case study suggests that in other cases, such as ASAT, BMD, or HGV weapons systems, China may decide to "master" a technology but respond to normative pressures against production and deployment.

The *resource demands* and *technological feasibility* of the ERW were intertwined and sometimes at odds during China's program. During the decision stage, weaponeers had to accept a technologically difficult assignment in order to maintain resources amid competition and shifting leadership priorities. The approach of combining ERW and miniaturization research to examine "principles" conserved resources and secured political support. The drawback of this synergy, however, was slower progress, evidenced by the weaponeers' admission that the December 1984 test was a "principles" test of a device unsuitable for weaponization. A longer R&D timeline also increased exposure to the influence of external events, as seen in the 1985 retirement policy's decimation of the ERW coalition. The case study also highlights the differences between resources needed for R&D and those needed for deployment. The former requires highly trained personnel, funding, political support, and testing resources, while the latter requires sufficient quantities of materials such as plutonium and tritium and effective delivery systems. In this context, contemporary analyses of China's nuclear forces should consider available stockpiles of plutonium, tritium, and any other necessary materials.[168]

This focus on resource constraints is very relevant for current analyses of nuclear programs in states with limited resources, such as North Korea, Pakistan, and Iran. Limited resources exacerbate bureaucratic competition, making resource demands an important variable for weapons development programs. The ERW weaponeers' "principles" approach highlights the potential for synergy between separate systems or programs to increase returns on material investments. Such an approach may save resources, but, as in the ERW case, the tradeoff could be conservative design choices and slower progress.

Coalition politics strongly influenced the impact of these variables on decisionmaking throughout the ERW program. The case study highlights the roles of institutional capacity and policy entrepreneurs championing a program. The coalition for initial research came together in 1977 as Deng consolidated authority and strong leaders trumped weak institutions. One of Deng's motivations in supporting the ERW program could have been to help consolidate his authority by appealing to revolutionaries who, although not equal to Deng in status, were both friends and useful allies.[169] Marshals Nie and Ye both supported broader military modernization, and General Zhang, originally Nie's aide, returned to head the NDSTC in 1977. The preferences of these strong political leaders trumped the objections of the weaponeers and overrode competing priorities, such as completing the DF-5 warhead. The Second Artillery's absence in deliberations likely reflects its weak institutional capacity due to Li Shuiqing's dependence on Deng and its limited expertise on nuclear strategy. Regarding competing conventional force priorities, the deaths of He Long and Luo Ruiqing limited the ability of conventional weaponeers to capitalize on Deng's 1977 shift to conventional force modernization, as well as the 1982 creation of COSTIND.[170] In the final analysis, no group had the institutional capacity or political clout to check Deng and/or General Zhang's preference for ERWs.

Although the evidence is not definitive, it indicates General Zhang Aiping played the role of policy entrepreneur or champion for the ERW. In addition to his 1977 poem and 1980 "bowling" metaphor, the ERW program's progress correlates closely with his rise and retirement. From leading strategic programs as NDSTC's head in 1977 to overseeing all weapons development as CMC vice chairman in 1982, General Zhang could effectively champion the program. Just as quickly as Zhang and any coalition rose, however, it swiftly fell apart in 1985 as a casualty of the CCP's broader retirement policy. The weaponeers' solution was to circumvent the bureaucracy and deliver their proposal directly to Deng, who approved necessary resources. They were not the only weaponeers to take this approach. To propose a program focusing on high technology acquisition (later the 863 program), former nuclear weaponeer Wang Daheng [王大珩] asked his former office mate Zhang Hong (who had married Deng Xiaoping's daughter) to deliver the proposal to Deng directly.[171]

Today, China's military services and institutions have much greater input into weapons development decisions.[172] The CMC, still a crucial institution for those decisions, added all the service commanders as members in 2004, including the Second Artillery Commander.[173] As in the other services, the Second Artillery's Armament Department is responsible for research, development, and acquisition.[174] The department's Science and Technology Committee [二炮科技委] focuses on missile force requirements, and the service's Equipment Research Academy [二炮兵装备研究院] interacts with the defense industry.[175]

With more political clout and well-developed institutional capacity to articulate weapons requirements, China's military branches may reduce the role of coalition politics driven by top political leaders. Their increased stature, however, may be leading to a new era of factional politics among "lobbies." Competing budget priorities, successful negotiations, and external events all affected the PLA Navy's lobbying efforts, led by Admiral Liu Huaqing, for an aircraft carrier. The progress of China's space program is also marked by the rise and fall of coalitions. Early on, after initial successes, China's space program halted following the death of its patron, Lin Biao [林彪], in September 1971. An August 1970 plan to develop 8 launch vehicles and 14 satellites in 5 years also disappeared.[176] Since 2001, however, career space professionals' rise in the weapons development bureaucracy led to speculation of a "space gang" to advocate space programs.[177]

Toward a "Technology Reserve" Model: Match Capabilities but Defer Deployment

The ERW case study suggests an indigenous Chinese pathway toward arms control or restraint, with the compromise of researching capabilities for a "technology reserve." The study also shows there is a precedent for China to follow suit if other states restrain from deploying certain systems. The compromise, however, is that while China decided not to deploy the ERW, it still mastered the technology and gained a quick breakout capability to build it. This section introduces the technology reserve model in more depth and applies the variables to China's ASAT, BMD, and HGV systems to examine its potential applicability. This analytical framework also helps assess prospects for arms control agreements and PRC restraint from deployment.

China's ERW program suggests a technology reserve model of matching another state's military capabilities while deferring deployment. This model highlights the ideological importance Chinese leaders place on technological parity with advanced states and their determination to avoid being locked into long-term strategic disadvantages. The model does not apply to all of China's weapons development programs; the first atomic bomb and hydrogen bomb are examples of "hard yes" decisions requiring rapid completion and deployment.

The technology reserve model and the analytic framework for evaluating when it applies contribute to the literature on China's techno-nationalism and help to explain why the PRC might develop weapons against its doctrine or stated positions. Technological parity was an ideological driver in Deng's defense and civilian policy decisionmaking, and it persists in today's defense industry. Deng's mantra to "do what others have done" indicated a requirement to follow the technological leads of other states and a desire to match them qualitatively (if not in quantity). Matching capabilities and mastering technologies provide a normative value in demonstrating China's great power status. "A seat at the table," or the Chinese variant "a place for one's mat," and the literature on China's defense industry trying to "catch up" all illustrate a similar idea.[178] Feigenbaum's "Chinese techno-nationalism" links the civilian and military aspects by arguing PRC leaders believe "technological development is intrinsically strategic."[179] This ideological driver naturally extends to weapons development decisions by generating the need to match the capability of the weapons systems of other great powers, but not necessarily to match their numbers of deployed weapons. Deng's call to finish the "Three Grasps" of an ICBM, SLBM, and communication satellite, no matter how primitive or how few, demonstrates this concept.

China's desire to avoid being locked into strategic disadvantages is a long-term security driver. Adding the ERW to China's "technology reserve" acknowledged its limited strategic value but did not explicitly renounce the capability. This idea of a "reserve" or hedging is not unique to China; the weapons R&D of other states also sometimes brushes up against existing doctrines or policies denouncing a particular system. For example, an ongoing nonproliferation challenge is managing hedging and nuclear latency by technologically advanced states such as Japan, which focuses attention on the question of how much time advanced states might need to build a nuclear weapon.[180] In cases of vertical proliferation, a prototype or final design does not necessarily indicate imminent production and deployment. China's ERW case demonstrates the alternative of keeping the design in the "technology reserve" in case the security environment changes or a norm against the system breaks down. The knowledge that China possesses the capability but has chosen not to deploy it may deter other countries from deploying certain advanced weapons systems. China's ability to produce weapons based on its technology reserve also increases intelligence challenges in predicting future Chinese military capabilities. The question becomes one of intent instead of capabilities, which without trust or verification can aggravate the U.S.-China security dilemma.

Progress and intent of China's BMD and ASAT programs are salient to the compatibility between what the PRC says and does. The PRC criticized the U.S. decision to field BMD systems but tested the same technology in 2010.[181] Most recently, on July 23, 2014, the PRC announced its third successful missile intercept test in 4 years.[182] The PRC also pushed for negotiations on the proposed Prevention of an Arms Race in Outer Space (PAROS) Treaty, but it tested an ASAT system in 2007.[183] The variables for the ERW case study help explain the contradiction and assess prospects for arms control or deployment.

Understanding BMD systems is important both for building them and for developing countermeasures to defeat them. As Lora Saalman observes, the PRC's stance on BMD has evolved from criticism of U.S. and Soviet policies, to countermeasures against U.S. BMD, and finally to developing its own capabilities.[184] Changes in China's strategic environment help explain the transition. Initially the PRC's small nuclear arsenal made ensuring penetrability a high priority, raising the strategic value of research for penetration aids. Eventually the technology matured, and the PRC grew concerned about U.S. theater missile defense deployments to Asia.

Thus, potential drivers for the PRC to develop its own BMD systems included matching capabilities, avoiding coercion, and increasing the PRC's negotiation leverage. This logic echoes China's original rationale for nuclear weapons (including the ERW) and reflects a higher normative value for BMD. In the 1980s, the resource demands and feasibility of BMD systems were prohibitively high for China, but as Brad Roberts writes, "Over time, the Chinese government drew a distinction between research and deployment, opposing the latter but not the former."[185]

As the PRC's BMD technology matures and military expenditures increase, the question is Beijing's intent. China's 2008 Defense White Paper contains the first mention of the PLAAF seeking to "increase its capabilities for carrying out . . . air and missile defense."[186] Successful tests satisfy the PRC's diplomatic objectives regarding the United States but do not indicate a deployed capability.[187] As long as the United States and Russia are bound by the Intermediate-Range Nuclear Forces (INF) Treaty, neither state can deploy the medium-range ballistic missiles that China's systems are designed to counter. A PRC decision to deploy BMD could result from either the technology maturing to intercept ICBMs, increased PRC concern over MRBMs of India or Taiwan, or U.S. or Russian withdrawal from the INF Treaty.[188] For the near term, China is more likely to keep BMD on a slow development path or in its technology reserve, leaving modest opportunity for arms control agreements with the United States and Russia.

This study's analytic framework suggests that the PRC is likely to continue developing and may eventually deploy ASAT systems. The U.S. presence in East Asia and potential for military intervention are key concerns of the PRC's current strategic environment, leading to greater consideration of A2/AD strategies and capabilities. The U.S. military currently enjoys superior command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) capabilities via its space assets. China's concept of "informationized warfare" focuses on integrating platforms for greater C4ISR connectivity and developing systems to counter adversaries' C4ISR capabilities.[189] In this context, ASAT's strategic value is very high and threatens a key U.S. advantage with a cost-effective and asymmetric means. Exploiting U.S. dependence on space assets, ASAT systems could deter U.S. action in a regional or Taiwan scenario. ASAT technology is very feasible for the PRC, evidenced by the successful ASAT test in January 2007. Satellites in orbit are also easier to track and intercept, making ASAT systems more effective with hit-to-kill technology than BMD systems. The PRC tested the SC-19 missile in both ASAT and BMD modes, indicating a synergy between systems that lessens resource demands.[190]

The key question for arms control prospects is the normative value of ASAT systems and the codification of that norm into an international treaty, such as the proposed PAROS Treaty. China's 2007 ASAT test completely fragmented the FengYun-1C satellite, creating space debris and over 40,000 fragments large enough to disable or destroy a satellite. While international backlash to the test was swift, it does not indicate a taboo against such systems, as the United States and former Soviet Union had already tested such systems. Any norm would need to be codified into international law, such as the proposed PAROS Treaty, but whether the treaty would cover ground-based ASAT systems is an open question. Furthermore, after over two decades of work on hit-to-kill technologies, it is doubtful the PRC would use ASAT capabilities simply as a "bargaining chip" in negotiations with the United States.[191] In the final analysis, all variables and the lack of a constraining treaty indicate China is likely to continue to develop and may eventually deploy ASAT capabilities.

Advanced hypersonic weapons, such as the HGV prototype the PRC reportedly tested three times in 2014, are in a more nascent stage.[192] An HGV warhead can be paired with any ballistic missile and can execute a pull-up maneuver after reentering the atmosphere.[193] With this pull-up, the missile has an extended range and approaches its target at a flatter glide that is harder to detect than a ballistic trajectory.[194] An HGV could potentially extend the DF-21 MRBM's range from 2,000 kilometers (km) to 3,000 km, and the DF-31's from 8,000 km to 12,000 km.[195]

For China's strategic environment, HGV technology has applications for tactical and strategic objectives. A maneuverable HGV would be an upgrade for the DF-21D anti-ship ballistic missile, which China may have begun deploying in limited numbers in 2011.[196] Strategically, an HGV-extended DF-31 could either improve nuclear forces or allow the PRC to hold more U.S. assets and even cities at risk with conventional warheads. At both the strategic and tactical levels, the potential strategic value of HGVs could be high, but it is unclear if the costs are worth the benefits. If existing systems already fulfill these strategic objectives, the PLA may not need such an expensive upgrade or boutique capability. It is also unclear how much HGV upgrades improve penetration of BMD systems. As James Acton notes, whether BMD systems can be altered to track an HGV's heat signature is unknown.[197] The feasibility and resource demands are also open questions. Feasibility issues include guidance and structural challenges, and resource demands could include specialized materials, such as composites to withstand high temperatures.[198]

The HGV's normative value is also an open question. One possible driver is China matching U.S. capabilities to avoid coercion, in this case the threat of Conventional Prompt Global Strike (CPGS) to China's nuclear arsenal and command and control centers.[199] This argument echoes China's statements following its first nuclear weapons test and implies a high normative value for developing such a capability, but not necessarily deployment. A second possibility is a transition from a "passive" [被动] approach of "catching up" with the United States and toward more self-driven innovation. The U.S. Air Force tested HGV technology in the 1960s before shelving it, putting the PRC in a position of catching up with an old technology.[200] However, with the renewed international interest in hypersonic weapons (such as CPGS), the PRC could gain prestige by being the first to deploy such a capability.

For influencing China's threat perceptions or the HGV's strategic value, U.S. options are limited but include public reaction. The evidence is inconclusive, but hostile Sino-Soviet relations and Soviet alarm at the ERW appeared to be drivers in Chinese decisionmaking. For U.S. policymakers today, contemporary discussions of China's HGV, BMD, and ASAT capabilities would benefit from calm responses. Panic over China's HGV as a "missile defense buster," for example, is counterproductive and plays into advocates' arguments, whereas thoughtful analysis makes limitations and technological challenges clear and may encourage restraint.[201]

Conclusions and Areas for Future Analysis

The opacity of China's nuclear weapons programs, especially TNWs, makes it hard to confirm or disprove any one system's status. The puzzle of why China developed an ERW but did not deploy it is such an example. This study cannot prove a negative but does present as accurate an explanation as possible based on primary sources. The ERW coalition's rise and fall, the weaponeers' "principles" approach, and the final decision to add the ERW to China's "technology reserve" present plausible explanations to several key questions. This conclusion is not a naive dismissal of Chinese TNW development—China's stockpile of "warheads without a primary mission" still raises concerns that could be dispelled by greater transparency and dialogue. Instead, this analysis provides analysts with a Chinese perspective on how these events transpired.

The case study contributes to broader analyses of China's weapons development decisions and programs, such as how sensitive Chinese decisions are to U.S. actions and the impact of PRC domestic politics. In this case, U.S. decisions did not affect China's final decision. The original threat of Soviet armored thrusts and Chinese conventional forces' setbacks against Vietnam help illustrate China's multidimensional security environment. Beijing's current security calculus includes concerns about Russia, Japan, India, and the United States. PRC politics, on the other hand, appear to have had a direct and often inadvertent impact on the weapons development decisions. The 1985 retirement policy was not aimed at the ERW, but the program was nearly a casualty. Contemporary decisions such as Admiral Liu's aircraft carrier demonstrate the rise of "lobbies" and factional politics within the CMC, a subject warranting further research.

China's ERW program also provides insights into what is necessary for a weapons program to succeed *and* progress all the way to deployment. This case study contributes to previous analyses of factors such as how the nuclear weapons complex interacts with political leaders, weaponeers' freedom to make decisions, and the persistence of a strategic imperative.[202] It also draws more attention to the often-important role of competing priorities and limited resources, including personnel and fissile materials. The final decision to test without deploying also poses questions about deterrence, namely whether merely demonstrating a capability is sufficient to deter adversaries.

The norms analysis draws attention to a pervasive theme of PRC security analyses in which technological parity is an ideological matter for China's leaders. This insight helps explain the final decision to "split the difference" on the ERW's prestige and opprobrium by testing without deployment. It also presents the technology reserve model of matching a capability or grasping a technology but deferring on decisions of procurement, operations, and deployment. For BMD, ASAT, and HGV systems, this model helps frame issues such as why China develops capabilities contrary to its doctrine, and under what circumstances China would move to deployment. While not applicable to all weapons developments, the model urges caution in and presents a competing hypothesis to analyses of China's weapons procurement.

Last, this study's methodology draws from Chinese open source research techniques, such as RAND's 2003 report *A Poverty of Riches*. It also points to an urgent need to update such discussions, which took place when Internet research was in a nascent stage and before the rise of social media platforms. Analyses of contemporary Chinese weapons development programs could benefit immensely from biographies and personnel-specific media. Social media and blogs, though not authoritative on their own, are incredibly useful for leads on programs' histories, challenges, and politics. When properly corroborated with more authoritative sources, such platforms could help analyses of many China security issues and programs "climb a step."

Notes

[1] See Charles Ferguson, Evan S. Medeiros, and Phillip C. Saunders, "Chinese Tactical Nuclear Weapons," in *Tactical Nuclear Weapons: Emergent Threats in an Evolving Security Environment*, ed. Alistair Millar and Brian Alexander (Washington, DC: Brassey's, 2003), 110–126.

[2] Chong-Pin Lin, *China's Nuclear Weapons Strategy: Tradition Within Evolution* (Lexington, MA: Lexington Books, 1988), 89.

[3] *Proliferation Digest* (Washington, DC: Central Intelligence Agency, March 29, 1996), approved for public release October 2003, and available at <www.foia.cia.gov/sites/default/files/document_conversions/89801/DOC_0000996348.pdf>; Xinhua, "The Neutron Bomb" [中子弹], in *People's Daily* [人民日报], September 22, 1977; and Li Meng [李萌] and Li Wei [李伟], "Uncovered: Absolutely Not Stolen Neutron Bomb Technology" [揭密：绝非窃取的中子弹技术], *China National Condition and Strength* [中国国情国力], no. 6 (2006), 45.

[4] *Handbook of the Chinese People's Liberation Army*, DDB-2680-32-84 (Washington, DC: Defense Intelligence Agency, 1984), 70.

[5] Quotation from *Proliferation Digest*, March 29, 1996.

[6] *Proliferation: Threat and Response* (Washington, DC: Office of the Secretary of Defense, years 1996 through 2001 were reviewed); *Annual Report on the Military Power of the People's Republic of China*, *Report to Congress Pursuant to the FY2000 National Defense Authorization Act* (Washington, DC: Department of Defense, 2002), 16, 24–50, 50; Jeffrey G. Lewis, *The Minimum Means of Reprisal* (Cambridge, MA: American Academy of Arts and Sciences, 2007), 46–47; Ferguson, Medeiros, and Saunders, 110–126.

[7] Gregory Kulacki, "China's Nuclear Arsenal: Status and Evolution," Union of Concerned Scientists, October 2011, available at <www.ucsusa.org/sites/default/files/legacy/assets/documents/nwgs/UCS-Chinese-nuclear-modernization.pdf>.

[8] *2013 Report to Congress of the U.S.-China Economic and Security Review Commission* (Washington, DC: Government Printing Office, 2013). For an excellent discussion of the H-6K and China's tactical nuclear delivery options, see Dennis M. Gormley, Andrew S. Erickson, and Jingdong Yuan, *A Low-Visibility Force Multiplier: Assessing China's Cruise Missile Ambitions* (Washington, DC: National Defense University Press, 2014), 57–58, 74–75.

[9] Lewis, *The Minimum Means of Reprisal*, 40, 45.

[10] People's Republic of China, Information Office of the State Council, *Facts Speak Louder Than Words and Lies Will Collapse by Themselves—Further Refutation of the Cox Report*, July 15, 1999. Italics added for emphasis.

[11] M. Taylor Fravel and Evan S. Medeiros, "China's Search for Assured Retaliation: The Evolution of Chinese Nuclear Strategy and Force Structure," *International Security* 35, no. 2 (2010), 74–75.

[12] Mark Stokes, *China's Nuclear Warhead Storage and Handling System* (Arlington, VA: Project 2049 Institute, 2010), 8.

[13] It is common for Chinese media to cite foreign sources for specifics on program costs and capabilities. In the case of the ERW, the only cost estimate this author could find is from a *PLA Daily* article in 1981, which reads, "At the same time the cost of neutron bombs is relatively low. According

to foreign estimates, each neutron bomb warhead costs $900,000 USD, and the cost of two neutron warheads for use in 8-inch Howitzers is equal to buying three M-60 battle tanks." See Yin Chun [寅春], "The Neutron Bomb—Killer of Tank Formations" [中子弹--集群坦克的克星], *PLA Daily* [解放军报], August 30, 1981, 3.

[14] Liu Huaqiu, *China and the Neutron Bomb* (Stanford, CA: Center for International Security and Arms Control, 1988), 43.

[15] Yang Guoning, assistant director of the 7th Machinery Bureau, declared, "The country was broke!" and described Zhou Enlai's exasperation at being unable to fund programs such as Project 714, China's first manned space program. See Gregory Kulacki and Jeffrey G. Lewis, *A Place for One's Mat: China's Space Program, 1956–2003* (Cambridge, MA: American Academy of Arts and Sciences, 2008), 21, available at <http://carnegie.org/fileadmin/Media/Publications/PDF/spaceChina.pdf>.

[16] John W. Lewis and Xue Litai, *China Builds the Bomb* (Stanford, CA: Stanford University Press, 1988), 155–160; John W. Lewis and Xue Litai, *China's Strategic Seapower: The Politics of Force Modernization in the Nuclear Age* (Stanford, CA: Stanford University Press, 1994), 177–178.

[17] Liu, *China and the Neutron Bomb*; Liu Huaqiu [刘华秋], "Does China Need the Neutron Bomb? (Part 1)" [中国需要中子弹吗？(上)], *Military World* [军事世界] 1, no. 1 (August 1988), 71–75; Liu Huaqiu, "Does China Need the Neutron Bomb? (Part 2)" [中国需要中子弹吗？(下)], *Military World* [军事世界] 1, no. 2 (September/October 1988), 59–63.

[18] Ted Greenwood, *Making the MIRV: A Study of Defense Decision Making* (Cambridge, MA: Ballinger Publishing Co., 1975), 148.

[19] Ibid.

[20] Scott Sagan, "Why Do States Build Nuclear Weapons?: Three Models in Search of a Bomb," *International Security* 21, no. 3 (Winter 1996–1997), 57–63.

[21] Ibid., 73–85.

[22] Johnston also notes the need for a public forum to demonstrate good behavior and receive public benefits from such behavior. Given Chinese opacity over its nuclear arsenal, this model admittedly is limited in its utility for the ERW case. See Alastair I. Johnston, *Social States: China in International Institutions, 1980–2000* (Princeton: Princeton University Press, 2008), 76–86.

[23] Nina Tannenwald, *The Nuclear Taboo: The United States and the Non-Use of Nuclear Weapons since 1945* (Cambridge: Cambridge University Press, 2007), 273–293.

[24] Benjamin Ostrov, *Conquering Resources: The Growth and Decline of the PLA's Science and Technology Commission for National Defense* (Armonk, NY: M.E. Sharpe, 1991).

[25] Lewis and Xue, *China Builds the Bomb*, 129.

[26] Ibid., 130–132; Lewis, *The Minimum Means of Reprisal*, 58–59.

[27] Sagan, "Why Do States Build Nuclear Weapons?" 63–64.

[28] John W. Kingdon, *Agendas, Alternatives, and Public Policies* (Boston: Little, Brown, 1984).

[29] Donald MacKenzie, *Inventing Accuracy: A Historical Sociology of Nuclear Missile Guidance* (Cambridge, MA: MIT Press, 1990); Thomas B. Allen and Norman Polmar, *Rickover: Father of the Nuclear Navy* (Washington, DC: Potomac Books, 2007).

[30] Christopher J. Yung, "The PLA Navy 'Lobby' and Its Influence over China's 'Maritime Sovereignty' Policies," in *PLA Influence on China's National Security Policymaking*, ed. Philip C. Saunders and Andrew Scobell (Stanford, CA: Stanford University Press, forthcoming).

[31] United States House of Representatives, Select Committee on U.S. National Security and Military/Commercial Concerns with the People's Republic of China, *The Final Report of the Select Committee on U.S. National Security and Military/Commercial Concerns with the People's Republic of China* (Washington, DC: Government Printing Office, 1999).

[32] He Xiantu [贺贤土], "He Xiantu: Experience and Learning from Participation in Nuclear Weapons' Research and Development (Part 2)" [贺贤土：参加核武器研制的经历与体会(二)], *QQ blog*, June 15, 2007, available at <http://hexiantu.qzone.qq.com/bloglist?bid=2&secondary=1>.

[33] Xu Qunfei [徐群飞], *He Xiantu* [贺贤土传] (Ningbo, China: Ningbo Publishing House [宁波出版社], 2005); He Xiantu [贺贤土], "Mr. Zhou Guangzhao and China's Nuclear Weapons Endeavors" [周光召先生与我国核武器事业], *Physics* [物理] 38, no. 5 (2009), 304–307.

[34] Walter Pincus, "Neutron Killer Warhead Buried in ERDA Budget," *The Washington Post*, June 6, 1977; Walter Pincus, "Pentagon Pushes Neutron Shell for Artillery Forces," *The Washington Post*, June 24, 1977. For a history of the ERW's development in the United States, see Samuel T. Cohen, *The Neutron Bomb: Political, Technological, and Military Issues* (Cambridge, MA: Institute for Foreign Policy Analysis, 1978), and Samuel T. Cohen, *The Truth about the Neutron Bomb: The Inventor of the Bomb Speaks Out* (New York: Morrow, 1983).

[35] For an excellent discussion of the debate on deploying the ERW in Europe, see Sherri L. Wasserman, *The Neutron Bomb Controversy: A Study in Alliance Politics* (New York: Praeger, 1983).

[36] Cohen, *The Neutron Bomb*, 5–20.

[37] The test also served as inspiration for the creation of Godzilla by Japanese filmmaker Ishiro Honda.

[38] Eric Croddy, James J. Wirtz, and Jeffrey A. Larsen, *Weapons of Mass Destruction: An Encyclopedia of Worldwide Policy, Technology, and History* (Oxford: ABC-Clio, 2004), 356–358.

[39] "The New Neutron Bomb Crisis," *The Washington Post*, August 11, 1981, A14.

[40] S.T. Cohen, "Fusion in Our Future: The DOVE of War," *National Review*, December 27, 1993.

[41] Kevin Klose, "Brezhnev Says Soviets Tested But Didn't Make 'Neutron Bomb,'" *The Washington Post*, November 18, 1978, A1.

[42] Kong Lingtong [孔令铜], "Observations on Future Types of Warfare" [未来战争样式刍议], *PLA Daily* [解放军报], September 7, 1979.

[43] Term coined by former Lawrence Livermore National Laboratory Director Harold Brown and often repeated by former Soviet General Secretary Leonid Brezhnev, who also called it the "ultimate capitalist weapon."

[44] Wasserman, *The Neutron Bomb Controversy*, 63.

[45] See Bob Woodward, *Veil: The Secret Wars of the CIA, 1981–1987* (New York: Simon and Schuster, 1987),170–172; Fletcher Schoen and Christopher J. Lamb, *Deception, Disinformation, and Strategic Communications: How One Interagency Group Made a Major Difference*, Institute for Natioanl Strategic Studies Strategic Perspectives 11 (Washington, DC: NDU Press, 2012).

[46] Ibid.

[47] Jimmy Carter, *Keeping Faith: Memoirs of a President* (Toronto: Bantam Books, 1982), 231–234.

[48] Wayne Biddle, "Neutron Bomb: An Explosive Issue," *The New York Times*, November 15, 1981; Ronald Reagan, "Remarks on Signing the Economic Recovery Tax Act of 1981 and the Omnibus Budget Reconciliation Act of 1981, and a Question-and-Answer Session with Reporters," press conference, August 13, 1981, University of Texas.

[49] "U.S. President Carter Asks Congress to Agree to Neutron Bomb Production" [美国总统卡特要求国会同意生产中子弹], *People's Daily* [人民日报], July 16, 1977; "The Neutron Bomb" [中子弹], *People's Daily* [人民日报], August 11, 1977.

[50] Foreign Broadcast Information Service (FBIS), Document ID SOV-77-159, "Moscow Scores Peking's Silence about Neutron Bomb," from *Moscow*, in Russian, August 13, 1977.

[51] Poem by Zhang Aiping: "No Limits to What Can Be Climbed—On Reading Marshal Ye's Poem 'Storm the Strategic Pass'" [无限不可攀--读叶帅《攻关》], *People's Daily* [人民日报], September 21, 1977. Translation by author.

[52] "The Neutron Bomb" [中子弹], Xinhua News Agency [新华社], September 22, 1977.

[53] FBIS, Document ID SOV-77-185, "Poems Indicate PRC Prepared to Produce Neutron Bombs," from *Moscow Radio Peace and Progress*, in Russian, September 22, 1977; FBIS, Document ID SOV-77-188, "PRC's Nuclear Tests, Intention to Produce Neutron Bombs Scored," from *Moscow*, in Russian, September 28, 1977; FBIS, Document ID SOV-77-199, "Poetic Directives' Show PRC Interest in Neutron Bomb," from *Moscow Literaturnaya Gazeta*, in Russian, October 14, 1977; FBIS, Document ID SOV-78-029, "China Warned Against Encouraging, Seeking Neutron Bomb," from *Alma-Ata Kazakhstanskaya Pravda*, in Russian, February 10, 1978.

[54] Central Intelligence Agency, "Sino-U.S. Relations: Better Vibrations from Peking," February 28, 1978, approved for public release September 2000, available at <www.foia.cia.gov/sites/default/files/document_conversions/89801/DOC_0000438382.pdf>.

[55] Department of State, Office of the Historian, "109. Memorandum of Conversation. Subject: Summary of Dr. Brzezinski's Meeting with Foreign Minister Huang Hua," in *Foreign Relations of the United States, 1977–1980*, Volume XIII, *China*, available at <http://history.state.gov/historicaldocuments/frus1977-80v13/d109>.

[56] As the cartoon appeared in *China Daily*, international edition, November 10, 1981. Used with permission of artist Zhang Yaoning [张耀宁]. Accessed via microfiche through the Fung Library Fairbank Center for Chinese Studies, Harvard Depository.

[57] Chen Weibin, "Soviet Hand Seen in New Pacifism," *China Daily*, November 10, 1981.

[58] *Collection of Meeting Documents Related to China's Delegation to the United Nations: 1981. 7–12* [中国代表团出席联合国有关会议文件集 : 1981. 7–12] (Beijing: World Affairs Press [世界知识出版社], 1981), 69.

[59] It should be noted that these bodies underwent major changes in structure and influence throughout the ERW program. The graph and descriptions are for basic reference.

[60] Mark Stokes, *China's Strategic Modernization: Implications for the United States* (Carlisle, PA: U.S. Army War College, 1999), 5.

[61] Tai Ming Cheung, *Fortifying China: The Struggle to Build a Modern Defense Economy* (Ithaca, NY: Cornell University Press, 2009), 29–30; Stokes, *China's Strategic Modernization*, 5–6.

[62] Cheung, *Fortifying China*, 29.

[63] Ibid.

[64] Gu Xiaoying [顾小英] and Zhu Mingyuan [朱明远], *Our Father Zhu Guangya* [我们的父亲朱光亚] (Beijing: People's Publishing House [人民出版社], 2009), 129; Xu, *He Xiantu*, 125.

[65] Evan A. Feigenbaum, *China's Techno-Warriors: National Security and Strategic Competition from the Nuclear to the Information Age* (Stanford: Stanford University Press, 2003), 41; Zhu Guangya [朱光亚], "Remembering Comrade Xiaoping's Attention to National Defense Technologies' Development" [忆小平同志关怀国防科技发展二三], in *Remembering the Military Strategist Deng Xiaoping* [回忆军事家邓小平], ed. Zhang Liangcun [张良村] (Beijing: People's Liberation Army Press [解放军出版社], 2004), 164.

[66] Feigenbaum, *China's Techno-Warriors*, 46.

[67] Zhu, "Remembering Comrade Xiaoping," 164.

[68] Feigenbaum, *China's Techno-Warriors*, 54–55.

[69] See M. Taylor Fravel, *Strong Borders, Secure Nation: Cooperation and Conflict in China's Territorial Disputes* (Princeton: Princeton University Press, 2008), 215–216.

[70] Ibid.

[71] Ibid.

[72] Edward O'Dowd, *Chinese Military Strategy in the Third Indochina War: The Last Maoist War* (London: Routledge, 2007), 111–121.

[73] Thomas J. Bickford, "Professional Military Education in the Chinese People's Liberation Army: A Preliminary Assessment of Problems and Prospects," in *A Poverty of Riches: New Challenges and Opportunities in PLA Research*, ed. James C. Mulvenon and Andrew N.D. Yang (Santa Monica, CA: RAND, 2003), 6.

[74] Ibid.

[75] Ezra Vogel, *Deng Xiaoping and the Transformation of China* (Cambridge, MA: Belknap Press, 2001), 102.

[76] On July 22, 1977, the Communist Party officially restored Deng to the offices of Vice Premier of the State Council, Vice-Chairman of the Central Committee, Vice-Chairman of the Military Commission, and Chief of the General Staff of the People's Liberation Army.

[77] Benjamin Young describes Deng and Ye as having a tense relationship and argues that Deng "did not really respect Ye." See Benjamin Young, *Deng: A Political Biography* (Armonk, NY: M.E. Sharpe, 1998), 202–203, and Vogel, *Deng Xiaoping and the Transformation of China*, 186–187.

[78] Ibid.

[79] Vogel, *Deng Xiaoping and the Transformation of China*, 151–152.

[80] Ziyun Huang [黄子云], "For Developing 'Two Bombs and One Satellite' Ye Jianying Urgently Requested Zhang Aiping to Come Off the Sidelines" [为研制"两弹一星" 叶剑英力邀张爱萍再次出山], China Communist Party News Network [中国共产党新闻网], December 5, 2011, as reprinted by the Ministry of National Defense of the People's Republic of China at <www.mod.gov.cn/hist/2011-12/05/content_4323021_3.htm>; Feigenbaum, *China's Techno-Warriors*, 238; and Frederick C. Teiwes and Warren Sun, *The End of the Maoist Era: Chinese Politics During the Twilight of the Cultural Revolution, 1972–1976* (Armonk, NY: M.E. Sharpe, 2007), 416–419.

[81] The full title of General Zhang's poem was "No Limits to What Can Be Climbed—On Reading Marshal Ye's Poem 'Storm the Strategic Pass.'"

[82] Dr. M. Taylor Fravel (professor at the Massachusetts Institute of Technology) in discussion with the author, July 2014. I thank Dr. Fravel for his time and insights into the evolution of Chinese military strategy.

[83] Zhu, "Remembering Comrade Xiaoping," 164.

[84] Feigenbaum, *China's Techno-Warriors*, 79–83.

[85] Ibid., 83.

[86] Chen Junxiang's roles ranged from technician to Deputy Director of Operations of the Laboratory for Shock Wave and Detonation Physics Research. See Li Hong [李宏], "Harbin Institute of Military Engineering Alumnus Chen Junxiang Comes to Campus to Participate in Sunshine Forum Activities" [哈军工老校友陈俊祥来校参加阳光论坛活动], *Harbin Institute of Military Engineering Memorial* [哈军工纪念馆], September 29, 2012, available at <www.gongxue.cn>.

[87] Chen Junxiang [陈俊祥], "Nuclear Weapons Development Path with Chinese Characteristics" [中国特色的核武器发展道路], in *Two Bombs, One Satellite* [两弹一星] (Beijing: Jiuzhou Press, 2001), 157; Zhu, "Remembering Comrade Xiaoping," 162.

[88] Feigenbaum, *China's Techno-Warriors*, 83.

[89] Xu, *He Xiantu*, 125; He Xiantu, "He Xiantu: Experience and Learning from Participation in Nuclear Weapons Research and Development (Part 2)"; and He Xiantu, "Mr. Zhou Guangzhao and China's Nuclear Weapons Endeavors."

[90] Wang Jihai was another scientist at the Ninth Academy and later Institute of Applied Physics and Computational Mathematics.

[91] He Xiantu states they went to the Ministry of Nuclear Industry, which was the Second Ministry of Machinery Building's new name as of 1982.

[92] Xu, *He Xiantu*, 125.

[93] Huang Zuqia [黄祖洽], "How Did the Neutron Bomb Issue Come About?" [中子弹是怎么一会事？], *Physics* [物理], no. 5 (1977), 293–296.

[94] Liu's citation on page 39 of his 1988 monograph appears to reference the 1979 report *A Review of the Neutron Bomb* [中子弹综述], which is listed as being held at the 714 Institute of the Seventh Academy of Shipbuilding.

[95] Liu, *China and the Neutron Bomb*; Liu, "Does China Need the Neutron Bomb? (Part 1)"; and Liu, "Does China Need the Neutron Bomb? (Part 2)."

[96] I thank Brandon Babin for this point.

[97] *China's Strategic Attack Programs*, NIE 13-8-74 (Washington, DC: Director of Central Intelligence, 1974), 11–12. Approved for public release May 2004.

[98] Ibid. Map is not drawn to scale.

[99] The Gang of Four was a political faction of four Chinese Communist Party leaders: Mao Zedong's last wife Jiang Qing, Zhang Chunqiao, Yao Wenyuan, and Wang Hongwen. They rose to power during the Cultural Revolution and opposed Deng Xiaoping, Zhou Enlai, and Ye Jianying. Also, *High Level Leaders of the Second Artillery* [第二炮兵高级将领传], Second Artillery Political Department [第二炮兵政治部], 2006, 238–240.

[100] Alastair Iain Johnston, "China's Old New Thinking," *International Security* 20, no. 3 (Winter 1995–1996); and John W. Lewis and Hua Di, "China's Ballistic Missile Programs: Technologies, Strategies, Goals,"*International Security* 17, no. 2 (Fall 1992), 20.

[101] Lewis and Hua, "China's Ballistic Missile Programs," 20.

[102] Ibid., 18.

[103] Lewis and Xue, *China's Strategic Seapower*, 180–184, 308; and Jeffrey G. Lewis, "Trial Operational Deterrence," *Arms Control Wonk*, March 21, 2014.

[104] According to Yu Min, the order came from the Science and Technology Commission for National Defense [国防科工委] and the Second Ministry of Machinery Building [二机部].

[105] *China Today: Scientific and Technological Undertakings of National Defense* [当代中国的国防科技事业], Book Two [下卷] (Beijing: Contemporary China Press [当代中国出版社], 1992), 223.

[106] Xu, *He Xiantu*, 129.

[107] Ibid.

[108] *Song Jian,* Biographies of the Founders of the Nuclear, Missile, and Satellite Program, 58–59.

[109] Ibid., 53.

[110] Lewis and Xue, *China's Strategic Seapower*, 177–178.

[111] Xu, *He Xiantu*, 129.

[112] Online entries for the report indicate that it was published in January 1979.

[113] Xu, *He Xiantu*, 130.

[114] "Huang Zuqia: A Nuclear Weapons Expert Builds a Dream at the Almond Altar" [黄祖洽：核武大家 筑梦杏坛], *Guangming Daily* [光明日报], August 29, 2013, as it appears at <http://dangshi.people.com.cn/n/2013/0829/c85037-22735818-4.html>.

[115] Yang Lijie [杨立杰], ed., "Zhou Guangzhao Biographic Notes" [周光召简历], Xinhua Net [新华网], January 2002, available at <http://news.xinhuanet.com/ziliao/2002-01/23/content_250843.htm>; Zheng Shaotang [郑绍唐], *Yu Min* [于敏], 103–106.

[116] Song, *Biographies of the Founders of the Nuclear, Missile, and Satellite Program*, 55.

[117] Ostrov, *Conquering Resources*, 55; Lewis and Xue, *China's Strategic Seapower*, 117.

[118] "Stressing politics" was part of Communist Party vernacular from 1998 to the early 2000s. Jiang Zemin's "Three Stress Campaign" emphasized the need for party members to study politics and adapt ideology to changing circumstances.

[119] Wang Liang [王沛] and He Yuwen [何玉文], "Hearing a Clap of Thunder in a Silent Place: Remembering Chief Engineer Xue Bencheng of the China Academy of Engineering Physics" [于无声处听惊雷：记中国工程物理研究院总工程师薛本澄], *Sichuan Daily* [四川日报], June 11, 2001.

[120] Edward C. O'Dowd, *Chinese Military Strategy in the Third Indochina War: The Last Maoist War* (London: Routledge, 2007), 111–121; and Richard H. Immerman and Petra Goedde, *The Oxford Handbook of the Cold War* (Oxford: Oxford University Press, 2013), 137.

[121] The 1987 edition of *Science of Military Strategy* [战略学] presents a limited approach of using positional and mobile warfare along with combined operations to counter an invasion. See Gao Rui, ed., *Science of Military Strategy* [战略学] (Beijing: AMS Press, 1987); and M. Taylor Fravel, "The Evolution of China's Military Strategy: Comparing the 1987 and 1999 Editions of

Zhanluexue," in *China's Revolution in Doctrinal Affairs: Emerging Trends in the Operational Art of the Chinese People's Liberation Army*, ed. James Mulvenon and David Finkelstein (Washington, DC: CNA, 2005).

[122] Lin, *China's Nuclear Strategy*, 83.

[123] Soldiers Publishing House [战士出版社] was the predecessor to the PLA Publishing House.

[124] Chen Guangtian [陈光田], *Defense Against Nuclear Surprise Attacks* [核袭击的防护] (Beijing: Soldiers Publishing House [战士出版社], 1981), 63–64.

[125] Dan Stober and Ian Hoffman, *A Convenient Spy: Wen Ho Lee and the Politics of Nuclear Espionage* (New York: Simon & Schuster, 2002), 53–54.

[126] It is worth noting PRC leaders were adamant about beating France to the hydrogen bomb.

[127] Ru Sheng [汝生] and Li Qun [利群], "The Neutron Bomb and France's National Defense" [中子弹与法国防务], *People's Daily* [人民日报], July 24, 1980.

[128] Zhang Gengchen [张庚辰], "Why Is France Developing the Neutron Bomb?" [法国为什么发展中子弹?] *World Affairs* [世界知识], no. 19 (1980), 8–9.

[129] Xue Litai, "Evolution of China's Nuclear Strategy," in *Strategic Views from the Second Tier: The Nuclear Weapons Policies of France, Britain, and China*, ed. John C. Hopkins and Weixing Hu (New Brunswick, NJ: Transaction Publishers, 1995).

[130] Vogel notes the importance of General Zhang having both posts. After the Lin Biao incident, the Minister of Defense as a position lost political clout. See Vogel, *Deng Xiaoping and the Transformation of China*, 543.

[131] Cheung, *Fortifying China*, 50.

[132] Feigenbaum, *China's Techno-Warriors*, 107–109.

[133] Ibid.

[134] Lewis and Xue, *China Builds the Bomb*, 131–132; Feigenbaum, *China's Techno-Warriors*, 107.

[135] Ostrov, *Conquering Resources*, 71.

[136] Xie, *Dangdai*, 223.

[137] Song, *Biographies of the Founders of the Nuclear, Missile, and Satellite Program*, 55.

[138] Xu, *He Xiantu*, 129.

[139] Ibid., 128.

[140] Lewis and Xue, *China Builds the Bomb*, 155–160; Lewis and Xue, *China's Strategic Seapower*, 177–178.

[141] Xu, *He Xiantu*, 126.

[142] Song, *Biographies of the Founders of the Nuclear, Missile, and Satellite Program*, 57–58.

[143] Chen, "Nuclear Weapons Development Path with Chinese Characteristics," 160–161.

[144] Chen elaborates on the risks of "搭车," meaning "to hitch a ride." The concern was that other scientific programs or tests would "hitch a ride" on these tests and detract from important goals.

[145] Chen describes the second step as "encouraging academic democracy." Many weaponeers' accounts recall the freedom of members to express ideas and concerns.

[146] Wang and He, "Hearing a Clap of Thunder in a Silent Place," *Sichuan Daily*.

[147] Xie, *Dangdai*, 274.

[148] Song, *Biographies of the Founders of the Nuclear, Missile, and Satellite Program*, 293.

[149] Poem appears in Song, *Biographies of the Founders of the Nuclear, Missile, and Satellite Program*, as well as numerous news articles and biographies on Deng Jiaxian. Translation by author.

[150] Xu Luxi [许鹿希], *A Bibliographic Sketch of Deng Jiaxian in Pictures* [邓稼先图片传略] (Hefei, Anhui: Anhui Education Publishing House [安徽教育出版社], 2003).

[151] Cheung, *Fortifying China*, 190–192.

[152] "Gorbachev Extends Nuclear Test Moratorium Till Jan. 1: Challenges Reagan to Sign Pact," *Los Angeles Times*, August 18, 1986.

[153] Song Jian, *Biographies of the Founders of the Nuclear, Missile, and Satellite Program*, 56–63.

[154] Ostrov, *Conquering Resources*, 72–73.

[155] Song, *Biographies of the Founders of the Nuclear, Missile, and Satellite Program*, 63–64.

[156] Xu, *A Bibliographic Sketch of Deng Jiaxian in Pictures*, 37.

[157] Liu, *China and the Neutron Bomb*; Liu, "Does China Need the Neutron Bomb? (Part 1)"; and Liu, "Does China Need the Neutron Bomb? (Part 2)."

[158] Liu, "Does China Need the Neutron Bomb? (Part 2)," 61–62.

[159] The full quotation reads, "By the end of the 1980s they had completed their assignment to break through principles of new types of miniaturized primaries." See Song, *Biographies of the Founders of the Nuclear, Missile, and Satellite Program*, 61.

[160] Gu Xiaoying and Gu Mingyuan, *Our Father Zhu Guangya*, 129.

[161] Ibid.

[162] Zhi Ming [志明] and Chang Yong [昌勇], "Yu Min, China's 'Father of the Hydrogen Bomb': From a Top Secret Name to Lifting the Ban" [中国"氢弹之父"于敏：从名字绝密到解禁], Xinhua News Agency [新华网], as it appears in *Sina* [新浪], available at <http://news.sina.com.cn/c/2003-05-31/1906175609s.shtml>.

[163] Xu, *A Bibliographic Sketch of Deng Jiaxian in Pictures*, 37.

[164] "Model Practitioner of the 'Two Bombs Spirit'—Remembering CAEP Chief Engineer Xue Bencheng" ["两弹精神"的模范实践者--记中国工程物理研究院总工程师薛本澄], Xinhua Online [新华网], June 17, 2001, reprinted by *Sina*, available at <http://mil.news.sina.com.cn/2001-06-17/24265.html>.

[165] *Annual Report on the Military Power of the People's Republic of China*, *Report to Congress Pursuant to the FY2000 National Defense Authorization Act* (Washington DC: Department of Defense, 2009); U.S. Pacific Command Posture: Hearing before the Committee on Armed Services, U.S. Senate, 113th Congress (2014), Statement of Admiral Samuel J. Locklear, U.S. Navy, Commander, U.S. Pacific Command; Robert Karniol, "US Making Waves over China's Sea-Based Nuclear Deterrent," *South China Morning Post*, April 11, 2014.

[166] Wang and He, "Hearing a Clap of Thunder in a Silent Place."

[167] "Status of Signature and Ratification," Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty, available at <www.ctbto.org/the-treaty/status-of-signature-and-ratification/>.

[168] For example, see reports from the Fissile Material Working Group.

[169] Ezra Vogel elaborates that Deng had a tense relationship with Marshal Ye, despite sharing similar policy goals and common opposition to the Gang of Four. Ye was a key advisor to Hua Guofeng before Deng replaced Hua as China's paramount leader. In 1977, there was much debate

about what role Deng would play after rehabilitation from being purged. The compromise was for Ye and Deng to lead jointly China's military modernization. General Zhang Aiping was an ally and subordinate to both leaders.

[170] Lewis and Xue, *China Builds the Bomb*, 131–132; Feigenbaum, *China's Techno-Warriors*, 107.

[171] Kulacki and Lewis, *A Place for One's Mat*, 22–23.

[172] Cheung, *Fortifying China*; and Michael S. Chase, "The PLA's Second Artillery Force as a Customer of China's Defense Industry," in *The Chinese Defense Economy Takes Off: Sector-By-Sector Assessments and the Role of Military End-Users*, ed. Tai Ming Cheung (San Diego: The University of California Institute on Global Conflict and Cooperation, 2013), 83–87.

[173] Chase, "The PLA's Second Artillery Force as a Customer of China's Defense Industry," 83–87.

[174] Ibid.

[175] Ibid.

[176] James C. Moltz, *Asia's Space Race: National Motivations, Regional Rivalries, and International Risks* (New York: Columbia University Press, 2011), 80–81.

[177] Kevin Pollpeter, "The Stars of China's Space Program: The Rise of a 'Space Gang'"? The Jamestown Foundation *China Brief* 17, September 19, 2007, available at <www.jamestown.org/programs/chinabrief/single/?tx_ttnews%5Btt_news%5D=4417&tx_ttnews%5BbackPid%5D=197&no_cache=1#.U43lRfldUb8>.

[178] Lora Saalman, "China's Hypersonic Weapons Development," talk at the Carnegie Endowment for International Peace, April 8, 2014; Kulacki and Lewis, *A Place for One's Mat*; and Cheung, *Fortifying China*.

[179] Feigenbaum, *China's Techno-Warriors*, 39.

[180] Scott Sagan, "Nuclear Latency and Nuclear Proliferation," in *Forecasting Nuclear Proliferation in the 21st Century*, ed. William C. Potter and Gaukhar Mukhatzhanova (Stanford: Stanford University Press, 2010), 80–101.

[181] Brad Roberts, *China and Ballistic Missile Defense* (2003), 23–31; Lora Saalman, "China's Evolution on Ballistic Missile Defense," *Proliferation Analysis* (Carnegie Endowment for International Peace, August 23, 2012).

[182] Liu Kun [刘昆], "Ministry of Defense: China within its Borders Successfully Conducted a Land-Based Anti-Missile Technology Test" [国防部：中国在境内成功进行陆基反导技术试验], *Global Times Online* [环球网], July 23, 2014.

[183] "Proposed PAROS Treaty," Inventory of International Nonproliferation Organizations and Regimes, Center for Nonproliferation Studies, updated December 3, 2012.

[184] Saalman, "China's Evolution on Ballistic Missile Defense."

[185] Roberts, *China and Ballistic Missile Defense*, 2.

[186] *China's National Defense in 2008* (Beijing: Information Office of the State Council of the People's Republic of China, 2009), 26–27.

[187] Ting Shi, "China Says Third Missile-Defense Test in Four Years Successful," *Bloomberg.com*, July 24, 2014.

[188] The Obama administration charges Russia violated the Intermediate-Range Nuclear Forces Treaty by testing ground-launched cruise missiles. See Michael R. Gordon, "U.S. Says Russia Tested

Cruise Missile, Violating Treaty," *The New York Times*, July 28, 2014; and Jeffrey G. Lewis, "An Intercontinental Ballistic Missile," *Foreign Policy*, online edition, Voice section, April 25, 2014.

[189] Eric C. Anderson and Jeffrey G. Engstrom, "Capabilities of the Chinese People's Liberation Army to Carry Out Military Action in the Event of a Regional Military Conflict," Science Applications International Corporation, prepared for the U.S.-China Economic and Security Review Commission, March 2009.

[190] Bill Gertz, "Inside the Ring," *The Washington Times*, March 9, 2011; Gregory Kulacki and Jeffrey G. Lewis, "Understanding China's Antisatellite Test," *The Nonproliferation Review* 15, no. 2 (2008).

[191] Kulacki and Lewis, *Understanding China's Antisatellite Test*, 342.

[192] Bill Gertz, "China Conducts Third Flight Test of Hypersonic Strike Vehicle," *The Washington Free Beacon*, December 4, 2014.

[193] Bradley Perrett, Bill Sweetman, and Michael Fabey, "U.S. Navy Sees Chinese HGV as Part of Wider Threat," *Aviation Week*, January 27, 2014.

[194] Ibid.

[195] Ibid.

[196] Andrew Erickson, "Taiwan 2011 National Defense Report: DF-21D ASBMs 'have been produced and deployed in small numbers in 2010,'" *China Sign Post*, July 21, 2011.

[197] James Acton, *Silver Bullet?* (Washington, DC: Carnegie Endowment for International Peace, 2013), available at <http://carnegieendowment.org/files/cpgs.pdf>; James Acton, "China's Hypersonic Weapons Development," talk at the Carnegie Endowment for International Peace, April 8, 2014.

[198] Perret, Sweetman, and Fabey, "U.S. Navy Sees Chinese HGV as Part of Wider Threat." Lora Saalman also goes into tremendous detail on technical challenges for HGV development. See Lora Saalman, "Prompt Global Strike: China and the Spear," independent faculty research at the Asia-Pacific Center for Security Studies, April 16, 2014.

[199] Saalman, "Prompt Global Strike," 4.

[200] Perret, Sweetman, and Fabey, "U.S. Navy Sees Chinese HGV as Part of Wider Threat"; Saalman, "Prompt Global Strike."

[201] "Missile Defense Buster: China Tests New Hypersonic Glide Vehicle," Reuters, January 15, 2014.

[202] For example, Jacques Hymans examines how bureaucratic organizations and relationships affect nuclear program success, and Donald MacKenzie's work on guidance systems looks at sociological factors behind a weapon's development as a critique to "technological determinism." See Jacques E. Hymans, *Achieving Nuclear Ambitions: Scientists, Politicians and Proliferation* (Cambridge: Cambridge University Press, 2012); and MacKenzie, *Inventing Accuracy.*

Acknowledgments

This work was possible with support from the Center for the Study of Chinese Military Affairs, Institute for National Strategic Studies, at the National Defense University (NDU). I thank the center for its generosity in resources and time to support this study. I am indebted to Dr. Phillip C. Saunders for his mentoring, patience, and unrelenting push for better analysis. I am also very grateful to Dr. Jeffrey G. Lewis at the Center for Nonproliferation Studies for discussions on the subject and guidance during initial research. For transitioning to Washington, DC, and NDU, I greatly appreciate support from Stephanie Lieggi, Jennifer Dahnke, Whitney Cushing, Peter Zell, Brittany Porro, Denise Der, and Jessica Drun. Numerous librarians aided my tracking down of primary sources, in particular Ann Flower and Monica Wilmot at the Monterey Institute of International Studies. This work also benefited from research assistance and resources at the National Defense University Library, the Global Resources Center at the George Washington University, the Harvard-Yenching Library at Harvard University, and the Asian Division of the Library of Congress. I greatly appreciate commentary on earlier drafts from Dr. Paul Godwin, Bonnie Hoops, and Catherine Dill. I also thank Brandon Babin, Mike Urena, and Erik Quam at the U.S. State Department, and Vincent Manzo, Greg Weaver, Cynthia Carras, Henry Yep, and anonymous officials for being generous with their time talking to me about this subject and its applicability to contemporary issues. This paper's contents are entirely my own responsibility. Last but not least, I thank my parents for supporting my decisions to study a challenging language and challenging issues. This piece is dedicated to them.

About the Author

Jonathan Ray wrote this paper while serving as a Contract Researcher in the Center for the Study of Chinese Military Affairs, Institute for National Strategic Studies, at the National Defense University. Currently, he is a Research Associate at Defense Group, Inc., where he conducts research and analysis using Chinese-language sources on foreign policy, national security, and science and technology issues. Mr. Ray has conducted research on China and nonproliferation issues for the Center for Nonproliferation Studies, Pacific Northwest National Laboratory, the Naval Postgraduate School, and Global Commercial Insights, LLC. His work has appeared in *Arms Control Wonk*, *Arms Control Today*, and *The Proceedings of the Institute of Nuclear Materials Management (INMM) Annual Meeting*. He received his Bachelor's degree in China Asia-Pacific Studies from Cornell University, completed advanced Mandarin training at Brigham Young University, and received a Master's degree in Nonproliferation and Terrorism Studies from the Monterey Institute of International Studies.

Center for Strategic Research Senior Fellows

COL KRIS BAUMAN, USAF
Senior Military Fellow

MR. JOHN A. COPE
Senior Research Fellow

DR. T.X. HAMMES
Distinguished Research Fellow

MR. FRANK G. HOFFMAN
Senior Research Fellow

DR. CHRISTOPHER J. LAMB
Distinguished Research Fellow

DR. ANDRE LE SAGE
Senior Research Fellow

DR. THOMAS F. LYNCH III
Distinguished Research Fellow

MR. LEO G. MICHEL
Distinguished Research Fellow

DR. DENISE NATALI
Senior Research Fellow

COL RICHARD OUTZEN, USA
Senior Military Fellow

DR. JAMES J. PRZYSTUP
Senior Research Fellow

DR. NICHOLAS ROSTOW
Senior Director

DR. PHILLIP C. SAUNDERS
Distinguished Research Fellow

DR. CHRISTOPHER D. YUNG
Senior Research Fellow

For a complete list of INSS publications, researchers, and staff, visit http://inss.ndu.edu

NDU Press